
**Information technology — Database
languages — SQL multimedia and
application packages —**

**Part 5:
Still image**

*Technologies de l'information — Langages de bases de données —
Multimédia SQL et paquetages d'application —*

Partie 5: Image fixe



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Contents	Page
Foreword	vi
Introduction	vii
1 Scope	1
2 Normative references	2
3 Terms and definitions, notations and conventions	3
3.1 Terms and definitions	3
3.1.1 Terms and definitions provided in ISO/IEC 13249-1:2002	3
3.1.2 Terms and definitions provided in this part of ISO/IEC 13249	3
3.1.3 Terms and definitions taken from ISO/IEC 9075-9:2001	4
3.1.4 Terms and definitions taken from ISO/IEC 10918-1:1994	4
3.1.5 Terms and definitions taken from ISO/IEC 15444-1:2000	4
3.2 Notations	4
3.2.1 Notations provided in ISO/IEC 13249-1:2002	4
3.2.2 Notations provided in this part of ISO/IEC 13249	4
3.3 Conventions	4
4 Concepts	5
4.1 Introduction	5
4.2 Concepts taken from ISO/IEC 9075-9:2001	6
4.3 Types representing still images	6
4.3.1 Attributes of the SI_StillImage type	6
4.3.2 Methods of the SI_StillImage type	6
4.4 Image features	7
4.4.1 Feature types	8
4.4.2 Assessing the similarity of images	8
4.5 Complementary SQL-invoked regular functions	9
4.6 Auxiliary type SI_Color	11
4.7 The Still Image Information Schema	11
5 Still Image Types	12
5.1 SI_StillImage Types and Routines	12
5.1.1 SI_StillImage Type	12
5.1.2 SI_StillImage Methods	17
5.1.3 SI_setContent Method	22
5.1.4 SI_changeFormat Method	23
5.1.5 SI_Scale Methods	24
5.1.6 SI_Resize Methods	26
5.1.7 SI_Rotate Method	28
5.1.8 SI_Thumbnail Methods	29
5.1.9 SI_InitFeatures method	30
5.1.10 SI_ClearFeatures method	30
5.1.11 SI_Score Methods	31
5.1.12 Functions Complementing SI_StillImage Methods	33
5.1.13 SI_chgContent Function	35
5.1.14 SI_convertFormat Function	35
5.1.15 SI_scaleImage Function	35
5.1.16 SI_zoomImage Function	36
5.1.17 SI_resizeImage Function	36
5.1.18 SI_rotateImage Function	37
5.1.19 SI_getThmbnl Function	37
5.1.20 SI_getSizedThmbnl Function	37
5.1.21 SI_setImageFrts Function	38

5.1.22	SI_resetImageFtrs Function	38
5.1.23	Functions Complementing Observer Functions of Type SI_StillImage	39
5.1.24	Functions not intended for Public Use	40
6	Feature Types	49
6.1	SI_AverageColor Type and Routines	49
6.1.1	SI_AverageColor Type	49
6.1.2	SI_AverageColor Methods	50
6.1.3	SI_Score Method	51
6.1.4	SI_findAvgClr Function	51
6.1.5	SI_mkAvgClr Function	52
6.1.6	SI_ScoreByAvgClr Function	52
6.2	SI_ColorHistogram Type and Routines	52
6.2.1	SI_ColorHistogram Type	52
6.2.2	SI_ColorHistogram Methods	54
6.2.3	SI_Append Method	56
6.2.4	SI_Score Method	57
6.2.5	SI_findClrHstgr Function	57
6.2.6	SI_mkClrHstgr Function	58
6.2.7	SI_arrayClrHstgr Function	58
6.2.8	SI_appendClrHstgr Function	58
6.2.9	SI_ScoreByClrHstgr Function	59
6.3	SI_PositionalColor Type and Routines	59
6.3.1	SI_PositionalColor Type	59
6.3.2	SI_PositionalColor Method	60
6.3.3	SI_Score Method	61
6.3.4	SI_findPstnlClr Function	62
6.3.5	SI_ScoreByPstnlClr Function	62
6.4	SI_Texture Type and Routines	62
6.4.1	SI_Texture Type	62
6.4.2	SI_Texture Method	63
6.4.3	SI_Score Method	64
6.4.4	SI_findTexture Function	65
6.4.5	SI_ScoreByTexture Function	65
6.5	SI_FeatureList Type and Routines	65
6.5.1	SI_FeatureList Type	65
6.5.2	SI_FeatureList Method	67
6.5.3	SI_setFeature Methods	69
6.5.4	SI_Score Method	71
6.5.5	SI_mkFtrList Function	73
6.5.6	SI_ScoreByFtrList Function	73
6.5.7	Regular Functions Complementing SI_setFeature Methods	74
6.5.8	Regular Functions Complementing Observer Functions of type SI_FeatureList	75
6.6	Auxiliary Types and Routines	77
6.6.1	SI_Color Type	77
6.6.2	SI_RGBColor Method	77
6.6.3	SI_mkRGBClr Function	78
7	SQL/MM Still Image Information Schema	80
7.1	Introduction	80
7.2	SI_FEATURES view	80
7.3	SI_IMAGE_FORMATS view	80
7.4	SI_IMAGE_FORMAT_CONVERSIONS view	80
7.5	SI_IMAGE_FORMAT_FEATURES view	80
7.6	SI_THUMBNAIL_FORMATS view	81
7.7	SI_VALUES view	81
7.8	Short name views	81
8	SQL/MM Still Image Definition Schema	82
8.1	Introduction	82
8.2	SI_FEATURES base table	82

8.3	SI_IMAGE_FORMATS base table.....	83
8.4	SI_IMAGE_FORMAT_CONVERSIONS base table	84
8.5	SI_IMAGE_FORMAT_FEATURES base table	84
8.6	SI_THUMBNAIL_FORMATS base table	85
8.7	SI_VALUES base table.....	85
9	Status Codes	87
10	Conformance	88
10.1	Requirements for conformance.....	88
10.2	Features of ISO/IEC 9075-9:2001 required in this part of ISO/IEC 13249	91
10.3	Claims of conformance	92
Annex A	(informative).....	93
A.1	Implementation-defined Meta-variables	94
Annex B	(informative).....	95
B.1	Implementation-dependent Meta-variables	99
Index		100

Tables

Page

Table 1 – Method and function name correspondences.....	9
Table 2 – SQLSTATE class and subclass values	87

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 13249-5 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 32, *Data management and interchange*.

This second edition cancels and replaces the first edition (ISO/IEC 13249-5:2001), which has been technically revised.

ISO/IEC 13249 consists of the following parts, under the general title *Information technology — Database languages — SQL multimedia and application packages*:

- *Part 1: Framework*
- *Part 2: Full-Text*
- *Part 3: Spatial*
- *Part 5: Still image*
- *Part 6: Data mining*

Introduction

The purpose of this International Standard is to define multimedia and application specific types and their associated routines using the user-defined features in ISO/IEC 9075.

This document is based on the content of ISO/IEC International Standard Database Language (SQL).

The organization of this part of ISO/IEC 13249 is as follows:

- 1) Clause 1, "Scope", specifies the scope of this part of ISO/IEC 13249.
- 2) Clause 2, "Normative references", identifies additional standards that, through reference in this part of ISO/IEC 13249, constitute provisions of this part of ISO/IEC 13249.
- 3) Clause 3, "Definitions, notations, and conventions", defines the notations and conventions used in this part of ISO/IEC 13249.
- 4) Clause 4, "Concepts", presents concepts used in the definition of this part of ISO/IEC 13249.
- 5) Clause 5, "Still Image Types", defines the still image user-defined types and associated routines.
- 6) Clause 6, "Feature Types", defines the user-defined types provided for the manipulation of still image features.
- 7) Clause 7, "SQL/MM Still Image Information Schema" defines the SQL/MM Still Image Information Schema.
- 8) Clause 8, "SQL/MM Still Image Definition Schema" defines the SQL/MM Still Image Definition Schema.
- 9) Clause 9, "Status Codes", defines the SQLSTATE codes used in this part of ISO/IEC 13249.
- 10) Clause 10, "Conformance", defines the criteria for conformance to this part of ISO/IEC 13249.
- 11) Annex A, "Implementation-defined elements", is an informative Annex. It lists those features for which the body of this part of ISO/IEC 13249 states that the syntax or meaning or effect on the database is partly or wholly implementation-defined, and describes the defining information that an implementer shall provide in each case.
- 12) Annex B, "Implementation-dependent elements", is an informative Annex. It lists those features for which the body of this part of ISO/IEC 13249 states explicitly that the meaning or effect on the database is implementation-dependent.

Information technology — Database languages — SQL multimedia and application packages —

Part 5: Still image

1 Scope

This part of ISO/IEC 13249:

- a) introduces the still image part of ISO/IEC 13249 (all parts);
- b) gives the references necessary for this part of ISO/IEC 13249;
- c) defines notations and conventions specific to this part of ISO/IEC 13249;
- d) defines concepts specific to this part of ISO/IEC 13249;
- e) defines the still image user-defined types and their associated routines.

The still image user-defined types defined in this part of ISO/IEC 13249 adhere to the following.

- A still image user-defined type is generic to image handling. It addresses the need to store, manage and retrieve information based on aspects of inherent image characteristics such as height, width and format and based on image features such as average color, color histogram, positional color and texture. It also addresses the need to employ manipulation such as rotation, scaling, as well as similarity assessment.
- A still image user-defined type does not redefine the database language SQL directly or in combination with another still image data type.

The still image user-defined types are applicable to all different image formats. However, not all functionality can be used with all known still image formats.

An implementation of this part of ISO/IEC 13249 may exist in environments that also support information and content management, decision support, data mining and data warehousing systems.

Application areas addressed by implementations of this part of ISO/IEC 13249 include, but are not restricted to, graphics, multimedia, scientific research and medicine.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 9075-9:2001, *Information technology — Database languages — SQL — Part 9: Management of External Data (SQL/MED)*

ISO/IEC 13249-1:2002, *Information technology — Database languages — SQL multimedia and application packages — Part 1: Framework*

ISO/IEC 10918-1:1994, *Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines*

ISO/IEC 15444-1:2000, *Information technology — JPEG 2000 image coding system — Part 1: Core coding system*

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3 Terms and definitions, notations and conventions

3.1 Terms and definitions

3.1.1 Terms and definitions provided in ISO/IEC 13249-1:2002

This part of ISO/IEC 13249 makes use of all terms defined in ISO/IEC 13249-1:2002.

3.1.2 Terms and definitions provided in this part of ISO/IEC 13249

For the purposes of this document, the following terms and definitions apply.

3.1.2.1

basic image feature

a basic image feature is an image feature that is not a composite feature

3.1.2.2

color space

a set of conventions how to represent a color value

3.1.2.3

composite feature

an image feature, which consists of basic image features and their associated weights

3.1.2.4

image format

a set of conventions for storing the image data of still images in a specific compressed or uncompressed file format

3.1.2.5

image feature

characteristic (other than inherent image characteristics) of the raw image

3.1.2.6

inherent image characteristics

image format and particular physical characteristics of a still image

3.1.2.7

list of weighted features

see composite feature

3.1.2.8

most significant color

a single color representing the dominant color of a part of an image

3.1.2.9

raw image

a binary string that represents a certain image

3.1.2.10

similarity of images

a numerical measure obtainable by the comparison of two images; the measure is based on image features

3.1.2.11

still image

see "image" in Subclause 3.1.5, "Terms and definitions taken from ISO/IEC 15444-1:2000"

3.1.2.12

thumbnail

a raw image which was obtained from another raw image by downsizing

3.1.3 Terms and definitions taken from ISO/IEC 9075-9:2001

This part of ISO/IEC 13249 makes use of the following terms defined in ISO/IEC 9075-9:2001:

- a) datalink

3.1.4 Terms and definitions taken from ISO/IEC 10918-1:1994

This part of ISO/IEC 13249 makes use of the following terms defined in ISO/IEC 10918-1:1994:

- a) columns

NOTE 1 The use of "columns" here is as defined in the JPEG standard and not as defined in the SQL standard.

- b) component

- c) (digital) (still) image

NOTE 2 Parentheses around the text "digital" and "still" is a convention used by ISO/IEC 10918-1 to denote that the phrases "digital image", "still image", and "image" are interchangeable.

- d) image data

- e) interchange format

- f) (number of) lines

NOTE 3 Parentheses around the text "number of" is a convention used by ISO/IEC 10918-1 to denote that the phrases "number of lines" and "lines" are interchangeable.

- g) sample

3.1.5 Terms and definitions taken from ISO/IEC 15444-1:2000

This part of ISO/IEC 13249 makes use of the following terms defined in ISO/IEC 15444-1:2000:

- a) file format

- b) reference grid

3.2 Notations

3.2.1 Notations provided in ISO/IEC 13249-1:2002

The notations used in this part of ISO/IEC 13249 are defined in ISO/IEC 13249-1:2002.

3.2.2 Notations provided in this part of ISO/IEC 13249

This part of ISO/IEC 13249 uses the prefix 'SI_' for user-defined types, attributes and SQL-invoked routine names.

3.3 Conventions

The conventions used in this part of ISO/IEC 13249 are defined in ISO/IEC 13249-1:2002.

4 Concepts

4.1 Introduction

In the context of this part of ISO/IEC 13249, still images are effectively images consisting of 2-dimensional arrays of samples. The internal representation of components and samples in the raw image itself is image format specific. The color information in the image data might be represented by an index in a color look up table, represented by multiple components, multiple binary strings which represent the color values within a single component, or in any other image format specific way.

An image format is a set of conventions for storing images in a file format. An image consists of the representation and organization of data that constitute the samples of the components, and prescriptions about auxiliary data that control the interpretation and processing of the image information according to that format.

A color space, which is used to represent the color values in the image, is either defined implicitly by the image format or described in the header information of the raw image.

An image format is referenced by format indications. A format indication is a character string whose format and content is implementation-defined.

A binary string that adheres to a certain image format is called a raw image.

The inherent image characteristics of a raw image consist of:

- the format of the raw image;
- the width of the raw image is the number of points in the horizontal dimension of the reference grid of the image data;
- the height of the raw image is the number of points in the vertical dimension of the reference grid of the image data.

An image format is a format supported by an implementation (for short: a supported format) if the implementation is able to derive the inherent image characteristics from the raw image.

This part of ISO/IEC 13249 defines types and routines with provisions for storing and manipulating still images. This part of ISO/IEC 13249 consists of the following parts:

- The data type *SI_StillImage*, a value of which has the following structure:
 - a digital representation of a still image or a reference to it;
 - format conventions used for representing that still image;
 - physical characteristics of that still image (such as its height and width).
- Methods on the data type *SI_StillImage* for:
 - constructing *SI_StillImage* values;
 - obtaining the digital representation of an image, a reference to it, or the inherent image characteristics of the image;
 - obtaining a scaled still image from an *SI_StillImage* value;
 - obtaining a resized still image from an *SI_StillImage* value;
 - obtaining a rotated still image from an *SI_StillImage* value;
 - obtaining a thumbnail from an *SI_StillImage* value;
 - deriving a metric value that characterizes the content of the image with respect to features values.

- Feature data types that abstract from certain characteristics of the pictorial information contained in images; these data types provide facilities for:
 - deriving feature values from a given image;
 - constructing feature values;
 - deriving metric values that characterize the content of images with respect to feature values.
- Information Schema views that provide data describing certain capabilities of an implementation of this part of ISO/IEC 13249.

A conforming implementation of this part of ISO/IEC 13249 shall be based on SQL-implementations that support Core SQL as defined by ISO/IEC 9075-9:2001. A number of provisions are made for that purpose:

- No function name overloading is used for SQL-invoked regular functions that are intended for public use;
- For every method that is intended for public use, a corresponding SQL-invoked regular function is specified that provides the same services as the associated method;
- The lengths of the names of schemata, types and SQL-invoked regular functions that are intended for public use do not exceed 18 characters. If the name of a view of the Still Image Information Schema exceeds 18 characters, an equivalent view with a short identifier is also specified.

4.2 Concepts taken from ISO/IEC 9075-9:2001

The following concepts defined in ISO/IEC 9075 are used in this part of ISO/IEC 13249.

- a) binary string
- b) EXECUTE privilege
- c) function
- d) SQL-invoked regular function

4.3 Types representing still images

4.3.1 Attributes of the *SI_StillImage* type

The *SI_StillImage* type is an abstraction for still images, using the following attributes:

- The attribute *SI_content* to represent the raw image;
- The attribute *SI_contentLength* to represent the length of the raw image;
- The attribute *SI_reference* to represent the reference to the image content of the raw image;
- The attribute *SI_format* to represent a format indication; it identifies the image format of the raw image;
- The attribute *SI_width* to represent the width of the raw image;
- The attribute *SI_height* to represent the height of the raw image.
- The attribute *SI_retainFeatures* to specify that the image's features are to be computed and maintained automatically by the implementation.
- Additional implementation-dependent attributes to store the image features or a representation of image features.

4.3.2 Methods of the *SI_StillImage* type

The type *SI_StillImage* provides the following methods for public use:

- *SI_StillImage*: constructs an *SI_StillImage* value from a raw image;
- *SI_StillImage*: constructs an *SI_StillImage* value from a raw image and a character string representing a format indication; this method allows for user-supplied format indication when *SI_StillImage* values are to be constructed from a raw image whose format is not a supported one;

- *SI_StillImage*: constructs an *SI_StillImage* value from a reference to a raw image;
- *SI_StillImage*: constructs an *SI_StillImage* value from a reference to a raw image and a character string representing a format indication; this method allows for user-supplied format indication when *SI_StillImage* values are to be constructed from a raw image whose format is not a supported one;
- *SI_StillImage*: constructs an *SI_StillImage* value from a raw image and also extracts the supported image features. This method allows for a user-supplied integer value to indicate the need for image feature extraction. If the user-supplied integer value is 1 (one), the image features are extracted during value construction. If the user supplied integer value is 0 (zero), the method has the same effect as the invocation of the constructor method *SI_StillImage(content)*;
- *SI_setContent*: has the same effect as the invocation of the mutator function for the *SI_content* attribute, but additionally adjusts the values of the attributes that represent the inherent image characteristics;
- *SI_changeFormat*: has the same effect as the invocation of the mutator function for the *SI_format* attribute, but additionally adjusts the value of the attribute *SI_content* and the values of the attributes which represent the inherent image characteristics. The format conversion fails if the conversion between the source image format and the target image format is not supported;
- *SI_Scale*: obtains a scaled image from an *SI_StillImage* value. The raw image is scaled to fit into a bounding box defined by the specified height and width. The aspect ratio of the image's height and width shall be maintained;
- *SI_Scale*: obtains a scaled image from an *SI_StillImage* value. The raw image is scaled by the specified factor. The aspect ratio of the image's height and width shall be maintained;
- *SI_Resize*: obtains a resized image from an *SI_StillImage* value. The raw image is resized to the specified height and width. The aspect ratio of the image's height and width does not have to be maintained;
- *SI_Rotate*: obtains a rotated image from an *SI_StillImage* value. The raw image is rotated by the defined angle. For rotations by an angle that is not a multiple of 90 degrees, the raw image is padded and the height and width of the resulting still image are adjusted;
- *SI_Thumbnail*: obtains a thumbnail from an *SI_StillImage* value;
- *SI_InitFeatures*: indicates that the attributes for supported features (average color, color histogram, positional color, and texture) of the image are to be computed and kept updated.
- *SI_ClearFeatures*: indicates that the attributes for supported features of the image are to be discarded and no longer updated.
- *SI_Score*: returns a numerical value that is a measure of the similarity of the image feature value to a given feature value;
- *SI_content*: returns the representation of the raw image;
- *SI_contentLength*: returns the length in bytes of the representation of the raw image;
- *SI_reference*: returns the reference to the image content of the raw image;
- *SI_format*: returns the format indication of the image;
- *SI_height*: returns the number of points in the vertical dimension of the reference grid of the image;
- *SI_width*: returns the number of points in the horizontal dimension of the reference grid of the image.

4.4 Image features

Image features (for short: features) are used to characterize the pictorial information of an image by means other than inherent image characteristics. This part of ISO/IEC 13249 supports four basic features and one composite feature. The basic features are:

- *Average color feature*: this feature characterizes an image by its average color;
- *Color histogram feature*: this feature characterizes an image by the relative frequencies of the colors exhibited by the raw image;

- *Positional color feature*: let an image be divided into n by m rectangles; the positional color feature characterizes that image by the n by m most significant colors of these rectangles;
- *Texture feature*: this feature characterizes an image by the size of repeating items (coarseness), brightness variations (contrast), and the predominant direction (directionality).

All basic features can be derived from images. In addition, the two basic features average color feature and color histogram feature can be constructed by means of numerical values.

The composite feature is a list of up to 4 basic features, each of a different feature type. All the basic features in the composite feature are associated with a feature weight.

Features are represented by feature types. Values of those types are used for obtaining a quantitative measure for the similarity between two images represented as *SI_StillImage* values, say, I_1 and I_2 . If F_2 is some feature that characterizes the image I_2 , then a similarity measure for the images I_1 and I_2 is obtained from F_2 by a method *SI_Score* that takes I_1 as its parameter. For a given pair of images, the obtained similarity depends on the kind of feature used for comparison; the exact relationship is implementation-dependent.

4.4.1 Feature types

The basic features are represented by the following feature types:

- Average color feature: *SI_AverageColor*;
- Color histogram feature: *SI_ColorHistogram*;
- Positional color feature: *SI_PositionalColor*;
- Texture feature: *SI_Texture*.

The composite feature is represented by the feature type *SI_FeatureList*.

For all basic features methods and functions are provided that derive the corresponding feature value from an *SI_StillImage* value. The functions are:

- Average color feature: *SI_findAvgClr*;
- Color histogram feature: *SI_findClrHstgr*;
- Positional color feature: *SI_findPstnlClr*;
- Texture feature: *SI_findTexture*.

SI_AverageColor and *SI_ColorHistogram* values can also be obtained by methods *SI_AverageColor* and *SI_ColorHistogram*, respectively. The parameter of the first method is a color value that is used to represent the intended average color. The second method takes a first color value and a first frequency and returns an initial color histogram. This initial color histogram can be extended using the method *SI_Append*.

SI_FeatureList values shall be constructed from basic feature values and associated weights.

The observer and mutator functions of the basic feature types are not intended for public use. Thus, there are no GRANT statements granting EXECUTE privilege on these functions.

4.4.2 Assessing the similarity of images

Every feature type has a method *SI_Score*. This method can be used for obtaining numerical values that measure the similarity between two images. To that end, a distance function is used for this measurement. The returned numerical value for the distance indicates the difference between a given feature value and a still image value. Let F_1 be some feature value that characterizes an *SI_StillImage* values I_1 . Then

$F_1.SI_Score(I_2)$

returns a measure for the similarity of the *SI_StillImage* value I_2 to the feature value F_1 .

4.5 Complementary SQL-invoked regular functions

To ease conformance for implementation of this part of ISO/IEC 13249, each method intended for public use is complemented by an SQL-invoked regular function.

For each such method, the type of specified method, the method name, parameter types (if any), and the name of the corresponding SQL-invoked regular function is listed in Table 1 — Method and function name correspondences. Since the names of these functions are unique, their parameter types are not given.

Table 1 — Method and function name correspondences

Type Name	Method Name	Parameter Types (if any)	Function Name
SI_StillImage	SI_StillImage	BINARY LARGE OBJECT	SI_mkStillImage1
SI_StillImage	SI_StillImage	BINARY LARGE OBJECT, CHARACTER VARYING	SI_mkStillImage2
SI_StillImage	SI_StillImage	DATALINK	SI_mkStillImage3
SI_StillImage	SI_StillImage	DATALINK, CHARACTER VARYING	SI_mkStillImage4
SI_StillImage	SI_StillImage	BINARY LARGE OBJECT, INTEGER	SI_mkStillImage5
SI_StillImage	SI_StillImage	BINARY LARGE OBJECT, CHARACTER VARYING, INTEGER	SI_mkStillImage6
SI_StillImage	SI_setContent	BINARY LARGE OBJECT	SI_chgContent
SI_StillImage	SI_changeFormat	CHARACTER VARYING	SI_convertFormat
SI_StillImage	SI_Scale	INTEGER, INTEGER	SI_scaleImage
SI_StillImage	SI_Scale	DOUBLE PRECISION	SI_zoomImage
SI_StillImage	SI_Resize	INTEGER, INTEGER	SI_resizeImage
SI_StillImage	SI_Rotate	DOUBLE PRECISION	SI_rotateImage
SI_StillImage	SI_Thumbnail		SI_getThmbnl
SI_StillImage	SI_Thumbnail	INTEGER, INTEGER	SI_getSizedThmbnl
SI_StillImage	SI_InitFeatures		SI_setImageFtrs
SI_StillImage	SI_ClearFeatures		SI_resetImageFtrs
SI_StillImage	SI_content		SI_getContent
SI_StillImage	SI_contentLength		SI_getContentLngh
SI_StillImage	SI_reference		SI_getReference
SI_StillImage	SI_format		SI_getFormat
SI_StillImage	SI_height		SI_getHeight
SI_StillImage	SI_width		SI_getWidth
SI_AverageColor	SI_AverageColor	SI_StillImage	SI_findAvgClr
SI_AverageColor	SI_AverageColor	SI_Color	SI_mkAvgClr
SI_AverageColor	SI_Score	SI_StillImage	SI_ScoreByAvgClr
SI_ColorHistogram	SI_ColorHistogram	SI_StillImage	SI_findClrHstgr

Table 1 (continued)

Type Name	Method Name	Parameter Types (if any)	Function Name
SI_ColorHistogram	SI_ColorHistogram	SI_Color, DOUBLE PRECISION	SI_mkClrHstgr
SI_ColorHistogram	SI_ColorHistogram	SI_Color ARRAY, DOUBLE PRECISION ARRAY	SI_arrayClrHstgr
SI_ColorHistogram	SI_Append	SI_Color, DOUBLE PRECISION	SI_appendClrHstgr
SI_ColorHistogram	SI_Score	SI_StillImage	SI_ScoreByClrHstgr
SI_PositionalColor	SI_PositionalColor	SI_StillImage	SI_findPstnlClr
SI_PositionalColor	SI_Score	SI_StillImage	SI_ScoreByPstnlClr
SI_Texture	SI_Texture	SI_StillImage	SI_findTexture
SI_Texture	SI_Score	SI_StillImage	SI_ScoreByTexture
SI_FeatureList	SI_FeatureList	SI_AverageColor, DOUBLE PRECISION, SI_ColorHistogram, DOUBLE PRECISION, SI_PositionalColor, DOUBLE PRECISION, SI_Texture, DOUBLE PRECISION	SI_mkFtrList
SI_FeatureList	SI_setFeature	SI_AverageColor, DOUBLE PRECISION	SI_setAvgClrFtr
SI_FeatureList	SI_setFeature	SI_ColorHistogram, DOUBLE PRECISION	SI_setClrHstgrFtr
SI_FeatureList	SI_setFeature	SI_PositionalColor, DOUBLE PRECISION	SI_setPstnlClrFtr
SI_FeatureList	SI_setFeature	SI_Texture, DOUBLE PRECISION	SI_setTextureFtr
SI_FeatureList	SI_AvgClrFtr		SI_getAvgClrFtr
SI_FeatureList	SI_AvgClrFtrWght		SI_getAvgClrFtrW
SI_FeatureList	SI_ClrHstgrFtr		SI_getClrHstgrFtr
SI_FeatureList	SI_ClrHstgrFtrWght		SI_getClrHstgrFtrW
SI_FeatureList	SI_PstnlClrFtr		SI_getPstnlClrFtr
SI_FeatureList	SI_PstnlClrFtrWght		SI_getPstnlClrFtrW
SI_FeatureList	SI_TextureFtr		SI_getTextureFtr
SI_FeatureList	SI_TextureFtrWght		SI_getTextureFtrW
SI_FeatureList	SI_Score	SI_StillImage	SI_ScoreByFtrList
SI_Color	SI_RGBColor	INTEGER, INTEGER, INTEGER	SI_mkRGBClr

4.6 Auxiliary type *SI_Color*

Color values are encapsulated by the type *SI_Color*. An implementation shall provide constructor methods to obtain *SI_Color* values. Each constructor method is provided for a specific color space. Each function takes parameters that represent the intended color value in this color space. A constructor method *SI_RGBColor*, for the RGB color space, is defined in this part of ISO/IEC 13249. Constructor methods for other color spaces are implementation-defined.

4.7 The Still Image Information Schema

This part of ISO/IEC 13249 prescribes an Information Schema called *SI_INFORMTN_SCHEMA*. It contains views for the following purposes:

- a view *SI_FEATURES*, which lists the feature indications of the supported features;
- a view *SI_IMAGE_FORMATS*, which lists the format indications of the supported image formats and which operations are supported for images with this format;
- a view *SI_IMAGE_FORMAT_CONVERSIONS*, which lists pairs of format indications of image formats for which format conversions are supported;
- a view *SI_IMAGE_FORMAT_FEATURES*, which lists pairs of format indications and feature indications; images of the indicated image format support the extraction of the indicated feature and scoring with respect to that feature;
- a view *SI_THUMBNAIL_FORMATS*, which lists the format indications of image formats from which thumbnails can be derived;
- a view *SI_VALUES*, which lists implementation-defined meta-variable and their values.

5 Still Image Types

The types in this family provide for the storage and retrieval of still image values.

5.1 SI_StillImage Types and Routines

5.1.1 SI_StillImage Type

Purpose

The *SI_StillImage* type provides the definition of a still image type.

Definition

```
CREATE TYPE SI_StillImage
AS (
    SI_content BINARY LARGE OBJECT(SI_MaxContentLength),
    SI_contentLength INTEGER,
    SI_reference DATALINK SI_DLLinkControl SI_DLIntegrityOption
        SI_DLReadPermission SI_DLWritePermission
        SI_DLRecoveryOption SI_DLUnlinkOption,
    SI_format CHARACTER VARYING(SI_MaxFormatLength),
    SI_height INTEGER,
    SI_width INTEGER,
    SI_retainFeatures SMALLINT DEFAULT 0
    -- Additional implementation-dependent attributes
    -- to store computed image features
)
INSTANTIABLE
NOT FINAL

CONSTRUCTOR METHOD SI_StillImage
    (content BINARY LARGE OBJECT(SI_MaxContentLength))
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT,

CONSTRUCTOR METHOD SI_StillImage
    (content BINARY LARGE OBJECT(SI_MaxContentLength),
    explicitFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT,

CONSTRUCTOR METHOD SI_StillImage
    (reference DATALINK)
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT,
```

```

CONSTRUCTOR METHOD SI_StillImage
  (reference DATALINK,
   explicitFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT,

CONSTRUCTOR METHOD SI_StillImage
  (content BINARY LARGE OBJECT(SI_MaxContentLength),
   maintainFeatures INTEGER)
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT,

CONSTRUCTOR METHOD SI_StillImage
  (content BINARY LARGE OBJECT(SI_MaxContentLength),
   explicitFormat CHARACTER VARYING(SI_MaxFormatLength),
   maintainFeatures INTEGER)
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT,

METHOD SI_setContent
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT,

METHOD SI_changeFormat
  (targetFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT,

METHOD SI_Scale
  (height INTEGER,
   width INTEGER)
RETURNS SI_StillImage
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT,

```

```
METHOD SI_Scale
  (scaleFactor DOUBLE PRECISION)
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,
```

```
METHOD SI_Resize
  (height INTEGER,
   width INTEGER)
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT,
```

```
METHOD SI_Rotate
  (angle DOUBLE PRECISION)
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,
```

```
METHOD SI_Thumbnail()
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,
```

```
METHOD SI_Thumbnail
  (height INTEGER,
   width INTEGER)
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,
```

```
METHOD SI_InitFeatures()
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,
```

```
METHOD SI_ClearFeatures()
  RETURNS SI_StillImage
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,
```

```

METHOD SI_Score
  (averageColor SI_AverageColor)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,

METHOD SI_Score
  (colorHistogram SI_ColorHistogram)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,

METHOD SI_Score
  (positionalColor SI_PositionalColor)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,

METHOD SI_Score
  (texture SI_Texture)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT,

METHOD SI_Score
  (featureList SI_FeatureList)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.
- 2) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.
- 3) *SI_DLLinkControl* is the implementation-defined <datalink control definition> for the attribute *SI_reference* of the *SI_StillImage* type.
- 4) *SI_DLIntegrityOption* is the implementation-defined <integrity option> for the attribute *SI_reference* of the *SI_StillImage* type.
- 5) *SI_DLReadPermission* is the implementation-defined <read permission> for the attribute *SI_reference* of the *SI_StillImage* type.
- 6) *SI_DLWritePermission* is the implementation-defined <write permission> for the attribute *SI_reference* of the *SI_StillImage* type.
- 7) *SI_DLRecoveryOption* is the implementation-defined <recovery option> for the attribute *SI_reference* of the *SI_StillImage* type.

- 8) *SI_DLUnlinkOption* is the implementation-defined <unlink option> for the attribute *SI_reference* of the *SI_StillImage* type.
- 9) The attributes *SI_content*, *SI_contentLength*, *SI_reference*, *SI_format*, *SI_height*, *SI_width*, and *SI_retainFeatures* are read-only. There are no GRANT statements granting EXECUTE privilege on the mutator functions for *SI_content*, *SI_contentLength*, *SI_reference*, *SI_format*, *SI_height*, *SI_width*, and *SI_retainFeatures*.

Description

- 1) The *SI_StillImage* type provides for public use:
 - a) a method *SI_StillImage*(BINARY LARGE OBJECT),
 - b) a method *SI_StillImage*(BINARY LARGE OBJECT, CHARACTER VARYING),
 - c) a method *SI_StillImage*(DATALINK),
 - d) a method *SI_StillImage*(DATALINK, CHARACTER VARYING),
 - e) a method *SI_StillImage*(BINARY LARGE OBJECT, INTEGER),
 - f) a method *SI_StillImage*(BINARY LARGE OBJECT, CHARACTER VARYING, INTEGER),
 - g) a method *SI_setContent*(BINARY LARGE OBJECT),
 - h) a method *SI_changeFormat*(CHARACTER VARYING),
 - i) a method *SI_Scale*(INTEGER, INTEGER),
 - j) a method *SI_Scale*(DOUBLE PRECISION),
 - k) a method *SI_Resize*(INTEGER, INTEGER),
 - l) a method *SI_Rotate*(DOUBLE PRECISION),
 - m) a method *SI_Thumbnail*(),
 - n) a method *SI_Thumbnail*(INTEGER, INTEGER),
 - o) a method *SI_InitFeatures*(),
 - p) a method *SI_ClearFeatures*(),
 - q) a method *SI_Score*(*SI_AverageColor*),
 - r) a method *SI_Score*(*SI_ColorHistogram*),
 - s) a method *SI_Score*(*SI_PositionalColor*),
 - t) a method *SI_Score*(*SI_Texture*),
 - u) a method *SI_Score*(*SI_FeatureList*),
 - v) a function *SI_mkStillImage1*(BINARY LARGE OBJECT),
 - w) a function *SI_mkStillImage2*(BINARY LARGE OBJECT, CHARACTER VARYING),
 - x) a function *SI_mkStillImage3*(DATALINK),
 - y) a function *SI_mkStillImage4*(DATALINK, CHARACTER VARYING),
 - z) a function *SI_mkStillImage5*(BINARY LARGE OBJECT, INTEGER),
 - aa) a function *SI_mkStillImage6*(BINARY LARGE OBJECT, CHARACTER VARYING, INTEGER),
 - ab) a function *SI_chgContent*(*SI_StillImage*, BINARY LARGE OBJECT),
 - ac) a function *SI_convertFormat*(*SI_StillImage*, CHARACTER VARYING),
 - ad) a function *SI_scaleImage*(*SI_StillImage*, INTEGER, INTEGER),
 - ae) a function *SI_zoomImage*(*SI_StillImage*, DOUBLE PRECISION),
 - af) a function *SI_resizeImage*(*SI_StillImage*, INTEGER, INTEGER),
 - ag) a function *SI_rotateImage*(*SI_StillImage*, INTEGER, INTEGER),

ah) a function *SI_getThmbnl*(*SI_StillImage*),

ai) a function *SI_getSizedThmbnl*(*SI_StillImage*, *INTEGER*, *INTEGER*),

aj) a function *SI_setImageFtrs*(*SI_StillImage*),

ak) a function *SI_resetImageFtrs*(*SI_StillImage*).

- 2) *SI_retainFeatures* is either 0 (zero) or 1 (one). If the value is 0 (zero), then the implementation does not compute and maintain the values of the implementation-dependent attributes representing the image features (average color, color histogram, positional color and texture); otherwise, the implementation does compute and maintain the values of those attributes. The default value is 0 (zero).
- 3) Implementation-dependent attributes representing the average color feature; if not the null value, contains values that represent the average color feature of the *SI_StillImage* value.
- 4) Implementation-dependent attributes representing the color histogram feature; if not the null value, contains values that represent the color histogram feature of the *SI_StillImage* value.
- 5) Implementation-dependent attributes representing the positional color feature; if not the null value, contains values that represent the positional color feature of the *SI_StillImage* value.
- 6) Implementation-dependent attributes representing the texture feature; if not the null value, contains values that represent the texture feature of the *SI_StillImage* value.

5.1.2 SI_StillImage Methods

Purpose

Return a specified *SI_StillImage* value.

Definition

```
CREATE CONSTRUCTOR METHOD SI_StillImage
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    DECLARE fmt CHARACTER VARYING(SI_MaxFormatLength);
    DECLARE FormatError CONDITION FOR SQLSTATE '2FF10';

    SET fmt = SI_format(content);
    IF fmt IS NULL THEN
      SIGNAL FormatError
        SET MESSAGE_TEXT = 'illegal image format specification';
    END IF;
    RETURN SELF.
      SI_content(content).
      SI_contentLength(LENGTH(content)).
      SI_reference(CAST (NULL AS DATALINK)).
      SI_format(fmt).
      SI_height(SI_height(content)).
      SI_width(SI_width(content));
  END

CREATE CONSTRUCTOR METHOD SI_StillImage
  (content BINARY LARGE OBJECT(SI_MaxContentLength),
   explicitFormat CHARACTER VARYING(SI_MaxFormatLength))
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    DECLARE FormatError CONDITION FOR SQLSTATE '2FF10';
    DECLARE iFormat CHARACTER VARYING(SI_MaxFormatLength);
    DECLARE eFormat CHARACTER VARYING(SI_MaxFormatLength);
```

```

SET iFormat = TRIM(BOTH ' ' FROM SI_format(content));
SET eFormat = TRIM(BOTH ' ' FROM explicitFormat);
IF eFormat IS NULL OR
  NOT (
    (SI_supportedFormat(eFormat) = 1 AND
     CASE
       WHEN iFormat IS NULL THEN
         FALSE
       ELSE
         iFormat = eFormat
     END) OR
    (SI_supportedFormat(eFormat) = 0 AND
     iFormat IS NULL))
  ) THEN
  SIGNAL FormatError
  SET MESSAGE_TEXT = 'illegal image format specification';
END IF;
RETURN SELF.
SI_content(content).
SI_contentLength(LENGTH(content)).
SI_reference(CAST (NULL AS DATALINK)).
SI_format(explicitFormat).
SI_height(SI_height(content)).
SI_width(SI_width(content));
END

CREATE CONSTRUCTOR METHOD SI_StillImage
(reference DATALINK)
RETURNS SI_StillImage
FOR SI_StillImage
RETURN NEW SI_StillImage(SI_getDLContent(reference)).
  SI_content(CAST (NULL AS BINARY LARGE OBJECT(SI_MaxContentLength))).
  SI_contentLength(CAST (NULL AS INTEGER)).
  SI_reference(reference)

CREATE CONSTRUCTOR METHOD SI_StillImage
(reference DATALINK,
 explicitFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
FOR SI_StillImage
RETURN NEW SI_StillImage(SI_getDLContent(reference),explicitFormat).
  SI_content(CAST (NULL AS BINARY LARGE OBJECT(SI_MaxContentLength))).
  SI_contentLength(CAST (NULL AS INTEGER)).
  SI_reference(reference)

CREATE CONSTRUCTOR METHOD SI_StillImage
(content BINARY LARGE OBJECT(SI_MaxContentLength),
 maintainFeatures INTEGER)
RETURNS SI_StillImage
FOR SI_StillImage
BEGIN
  DECLARE fmt CHARACTER VARYING(SI_MaxFormatLength);
  DECLARE FormatError CONDITION FOR SQLSTATE '2FF10';

  SET fmt = SI_format(content);
  IF fmt IS NULL THEN
    SIGNAL FormatError
    SET MESSAGE_TEXT = 'illegal image format specification';
  END IF;
  RETURN
  CASE
    WHEN maintainFeatures = 1 THEN

```

```

        SELF.
            SI_content(content).
            SI_contentLength(LENGTH(content)).
            SI_reference(CAST (NULL AS DATALINK)).
            SI_format(fmt).
            SI_height(SI_height(content)).
            SI_width(SI_width(content)).
            SI_InitFeatures()
    ELSE
        SELF.
            SI_content(content).
            SI_contentLength(LENGTH(content)).
            SI_reference(CAST (NULL AS DATALINK)).
            SI_format(fmt).
            SI_height(SI_height(content)).
            SI_width(SI_width(content))
    END;
END

CREATE CONSTRUCTOR METHOD SI_StillImage
(content BINARY LARGE OBJECT(SI_MaxContentLength),
 explicitFormat CHARACTER VARYING(SI_MaxFormatLength),
 maintainFeatures INTEGER)
RETURNS SI_StillImage
FOR SI_StillImage
BEGIN
    DECLARE FormatError CONDITION FOR SQLSTATE '2FF10';
    DECLARE iFormat CHARACTER VARYING(SI_MaxFormatLength);
    DECLARE eFormat CHARACTER VARYING(SI_MaxFormatLength);

    SET iFormat = TRIM(BOTH ' ' FROM SI_format(content));
    SET eFormat = TRIM(BOTH ' ' FROM explicitFormat);
    IF eFormat IS NULL OR
        NOT (
            (SI_supportedFormat(eFormat) = 1 AND
            CASE
                WHEN iFormat IS NULL THEN
                    FALSE
                ELSE
                    iFormat = eFormat
            END) OR
            (SI_supportedFormat(eFormat) = 0 AND
            iFormat IS NULL)
        ) THEN
        SIGNAL FormatError
            SET MESSAGE_TEXT = 'illegal image format specification';
    END IF;
    RETURN
        CASE
            WHEN maintainFeatures = 1 THEN
                SELF.
                    SI_content(content).
                    SI_contentLength(LENGTH(content)).
                    SI_reference(CAST (NULL AS DATALINK)).
                    SI_format(explicitFormat).
                    SI_height(SI_height(content)).
                    SI_width(SI_width(content)).
                    SI_InitFeatures()
            ELSE
                SELF.

```

```

        SI_content(content) .
        SI_contentLength(LENGTH(content)) .
        SI_reference(CAST (NULL AS DATALINK)) .
        SI_format(explicitFormat) .
        SI_height(SI_height(content)) .
        SI_width(SI_width(content))

    END;

END

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.
- 2) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The method *SI_StillImage*(*BINARY LARGE OBJECT*) takes the following input parameter:
 - a) a *BINARY LARGE OBJECT* value *content*.
- 2) For the method *SI_StillImage*(*BINARY LARGE OBJECT*):
 - a) Let *FMT* be the result of the value expression: *SI_Format*(*content*).
 - b) Case:
 - i) If *FMT* is the null value, then an exception condition is raised: *SQL/MM Still Image exception – illegal image format specification*.
 - ii) Otherwise, return an *SI_StillImage* value with:
 - 1) the *SI_content* attribute set to *content*.
 - 2) the *SI_contentLength* attribute set to the value expression: *LENGTH*(*content*).
 - 3) the *SI_reference* attribute set to the null value.
 - 4) the *SI_format* attribute set to *FMT*.
 - 5) the *SI_height* attribute set to the value expression: *SI_height*(*content*).
 - 6) the *SI_width* attribute set to the value expression: *SI_width*(*content*).
- 3) The method *SI_StillImage*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*) takes the following input parameters:
 - a) a *BINARY LARGE OBJECT* value *content*,
 - b) a *CHARACTER VARYING* value *explicitFormat*.
- 4) For the method *SI_StillImage*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*):

Case:

 - a) If any of the following is True for an invocation of the method *SI_StillImage*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*), then an exception condition is raised: *SQL/MM Still Image exception – illegal image format specification*.
 - i) *explicitFormat* is the null value.
 - ii) Both of the following are False:
 - 1) *explicitFormat* indicates a supported image format, the image format derived from *content* is not the null value, and *explicitFormat* is equivalent to the format derived from *content*.
 - 2) *explicitFormat* indicates an unsupported image format, and the image format derived from *content* is the null value (i.e. no supported image format can be derived from *content*).
 - b) Otherwise, return an *SI_StillImage* value with:
 - i) the *SI_content* attribute set to *content*.

- ii) the *SI_contentLength* attribute set to the value expression: *LENGTH(content)*.
 - iii) the *SI_reference* attribute set to the null value.
 - iv) the *SI_format* attribute set to *explicitFormat*.
 - v) the *SI_height* attribute set to the value expression: *SI_height(content)*.
 - vi) the *SI_width* attribute set to the value expression: *SI_width(content)*.
- 5) The method *SI_StillImage(DATALINK)* takes the following input parameter:
- a) a DATALINK value *reference*.
- 6) The method *SI_StillImage(DATALINK, CHARACTER VARYING)* takes the following input parameter:
- a) a DATALINK value *reference*,
 - b) a CHARACTER VARYING value *explicitFormat*.
- 7) If any of the following is *True* for an invocation of the method *SI_StillImage(DATALINK, CHARACTER VARYING)*, then an exception condition is raised: *SQL/MM Still Image exception – illegal image format specification*.
- a) *explicitFormat* is the null value.
 - b) Both of the following is *False*:
 - i) *explicitFormat* indicates a supported image format, and *explicitFormat* is equivalent to the format derived from the image content *reference* is referencing.
 - ii) *explicitFormat* indicates an unsupported image format, and the image format derived from the image content *reference* is referencing is the null value (i.e. no supported image format can be derived from the image content *reference* is referencing).
- 8) The method *SI_StillImage(BINARY LARGE OBJECT, INTEGER)* takes the following input parameter:
- a) a BINARY LARGE OBJECT value *content*.
 - b) an INTEGER value *maintainFeatures*.
- 9) For the method *SI_StillImage(BINARY LARGE OBJECT, INTEGER)*:
- a) Let *FMT* be the result of the value expression: *SI_Format(content)*.
 - b) Case:
 - i) If *FMT* is the null value, then an exception condition is raised: *SQL/MM Still Image exception – illegal image format specification*.
 - ii) Otherwise, return an *SI_StillImage* value with:
 - 1) the *SI_content* attribute set to *content*.
 - 2) the *SI_contentLength* attribute set to the value expression: *LENGTH(content)*.
 - 3) the *SI_reference* attribute set to the null value.
 - 4) the *SI_format* attribute set to *FMT*.
 - 5) the *SI_height* attribute set to the value expression: *SI_height(content)*.
 - 6) the *SI_width* attribute set to the value expression: *SI_width(content)*.
 - 7) If *maintainFeatures* is equal 1 (one), then the *SI_StillImage* value regenerates the values of the all the implementation-dependent image feature attributes values.
- 10) The method *SI_StillImage(BINARY LARGE OBJECT, CHARACTER VARYING, INTEGER)* takes the following input parameters:
- a) a BINARY LARGE OBJECT value *content*,
 - b) a CHARACTER VARYING value *explicitFormat*,
 - c) an INTEGER value *maintainFeatures*.

11) For the method *SI_StillImage*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*):

Case:

- a) If any of the following is True for an invocation of the method *SI_StillImage*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*, *INTEGER*), then an exception condition is raised: SQL/MM Still Image exception – illegal image format specification.
 - i) *explicitFormat* is the null value.
 - ii) Both of the following are False:
 - 1) *explicitFormat* indicates a supported image format, the image format derived from *content* is not the null value, and *explicitFormat* is equivalent to the format derived from *content*.
 - 2) *explicitFormat* indicates an unsupported image format, and the image format derived from *content* is the null value (i.e. no supported image format can be derived from *content*).
- b) Otherwise, return an *SI_StillImage* value with:
 - i) the *SI_content* attribute set to *content*.
 - ii) the *SI_contentLength* attribute set to the value expression: *LENGTH(content)*.
 - iii) the *SI_reference* attribute set to the null value.
 - iv) the *SI_format* attribute set to *explicitFormat*.
 - v) the *SI_height* attribute set to the value expression: *SI_height(content)*.
 - vi) the *SI_width* attribute set to the value expression: *SI_width(content)*.
 - vii) If *maintainFeatures* is equal 1 (one), then the *SI_StillImage* value regenerates the values of the all the implementation-dependent image feature attributes values.

5.1.3 SI_setContent Method

Purpose

Update the *SI_StillImage* content.

Definition

```
CREATE METHOD SI_setContent
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    DECLARE NullInstance CONDITION FOR SQLSTATE '2202D';
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF01';

    IF SELF IS NULL THEN
      SIGNAL NullInstance
      SET MESSAGE_TEXT = 'null image value';
    END IF;
    IF TRIM(BOTH ' ' FROM SI_format(content)) <>
      TRIM(BOTH ' ' FROM SELF.SI_format) THEN
      SIGNAL InvalidInput
      SET MESSAGE_TEXT = 'incorrect image format';
    END IF;
    RETURN
    CASE
      WHEN SELF.SI_retainFeatures = 1 THEN
        SELF.
          SI_content(content).
          SI_contentLength(LENGTH(content)).
          SI_height(SI_height(content)).
          SI_width(SI_width(content)).
          SI_InitFeatures()
```

```

ELSE
    SELF.
        SI_content (content) .
        SI_contentLength (LENGTH (content)) .
        SI_height (SI_height (content)) .
        SI_width (SI_width (content))
END;
END

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.

Description

- 1) The method *SI_setContent*(*BINARY LARGE OBJECT*) takes the following input parameter:
 - a) a *BINARY LARGE OBJECT* value *content*.
- 2) If the *SI_retainFeatures* attribute is set to 1 (one), then the *SI_StillImage* value regenerates the values of the all the implementation-dependent image feature attributes values. If the *SI_retainFeatures* attribute is set to 0 (zero), then no action is necessary.

5.1.4 SI_changeFormat Method

Purpose

Convert the format of an *SI_StillImage* value and adjust affected attributes.

Definition

```

CREATE METHOD SI_changeFormat
(targetFormat CHARACTER VARYING (SI_MaxFormatLength))
RETURNS SI_StillImage
FOR SI_StillImage
BEGIN
    DECLARE UnsupportedConversion CONDITION FOR SQLSTATE '2FF11';
    DECLARE UnsupportedReferences CONDITION FOR SQLSTATE '2FF16';
    DECLARE localContent BINARY LARGE OBJECT (SI_MaxContentLength);

    IF SELF.SI_reference IS NOT NULL THEN
        SIGNAL UnsupportedReferences
        SET MESSAGE_TEXT =
            'format conversion not supported for references';
    END IF;
    IF NOT SI_supportedConversion(SELF.SI_format, targetFormat) = 1 THEN
        SIGNAL UnsupportedConversion
        SET MESSAGE_TEXT =
            'unsupported image format conversion specified';
    END IF;
    IF TRIM(BOTH ' ' FROM targetFormat) =
        TRIM(BOTH ' ' FROM SELF.SI_format) THEN
        RETURN SELF;
    ELSE
        SET localContent =
            SI_convert(SELF.SI_content, SELF.SI_format, targetFormat);
        RETURN
        CASE
            WHEN SELF.SI_retainFeatures = 1 THEN
                SELF.
                    SI_content (localContent) .
                    SI_contentLength (LENGTH (localContent)) .
                    SI_format (targetFormat) .

```

```

        SI_height(SI_height(localContent)).
        SI_width(SI_width(localContent)).
        SI_InitFeatures()
    ELSE
        SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_format(targetFormat).
            SI_height(SI_height(localContent)).
            SI_width(SI_width(localContent))
    END;
END IF;
END

```

Definitional Rules

- 1) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The method *SI_changeFormat*(*CHARACTER VARYING*) takes the following input parameter:
 - a) a *CHARACTER VARYING* value *targetFormat*.
- 2) Case:
 - a) If the image content is referenced by *SELF.SI_reference*, then an exception condition is raised: *SQL/MM Still Image exception – format conversion not supported for references*.
 - b) If the implementation does not support the conversion between the formats *SELF.SI_format* and *targetFormat*, then an exception condition is raised: *SQL/MM Still Image exception – unsupported image format conversion specified*.
 - c) If *targetFormat* and *SELF.SI_format* are equivalent, *SELF* is returned unchanged.
 - d) Otherwise,
 - i) *SELF.SI_content* is converted to the format *targetFormat*, and the values of *SELF.SI_contentLength*, *SELF.SI_format*, *SELF.SI_height*, and *SELF.SI_width* are adjusted to reflect the properties of the new value of *SELF.SI_content*.
 - ii) If the *SI_retainFeatures* attribute is set to 1 (one), then the *SI_StillImage* value regenerates the values of all the implementation-dependent image feature attributes values. If the *SI_retainFeatures* attribute is set to 0 (zero), then no action is necessary.

5.1.5 SI_Scale Methods

Purpose

Scale the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```

CREATE METHOD SI_Scale
    (height INTEGER,
     width INTEGER)
RETURNS SI_StillImage
FOR SI_StillImage
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF14';
    DECLARE UnsupportedReferences CONDITION FOR SQLSTATE '2FF17';
    DECLARE localContent BINARY LARGE OBJECT(SI_MaxContentLength);
    DECLARE scaleHeight INTEGER;
    DECLARE scaleWidth INTEGER;

```

```

IF SELF.SI_reference IS NOT NULL THEN
    SIGNAL UnsupportedReferences
    SET MESSAGE_TEXT =
        'scaling not supported for references';
END IF;
SET scaleHeight =
    CASE
        WHEN height IS NULL THEN
            width * CEIL(SELF.SI_height / SELF.SI_width)
        ELSE
            height
    END;
SET scaleWidth =
    CASE
        WHEN width IS NULL THEN
            height * CEIL(SELF.SI_width / SELF.SI_height)
        ELSE
            width
    END;
IF scaleHeight IS NULL OR
scaleWidth IS NULL OR
scaleHeight < 1 OR
scaleWidth < 1 OR
NOT SI_supportedScale(SELF.SI_format) = 1 THEN
    SIGNAL InvalidInput
    SET MESSAGE_TEXT =
        'illegal specification for scaling';
END IF;
SET localContent =
    SI_scaleImageData(SELF.SI_content, scaleHeight, scaleWidth);
RETURN
CASE
    WHEN SELF.SI_retainFeatures = 1 THEN
        SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_height(SI_height(localContent)).
            SI_width(SI_width(localContent)).
            SI_InitFeatures()
    ELSE
        SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_height(SI_height(localContent)).
            SI_width(SI_width(localContent))
    END;
END;

CREATE METHOD SI_Scale
(scaleFactor DOUBLE PRECISION)
RETURNS SI_StillImage
FOR SI_StillImage
RETURN SELF.SI_Scale(SELF.SI_height * scaleFactor,
    SELF.SI_width * scaleFactor)

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length of the binary representation of the *SI_StillImage* attribute *SI_content*.

Description

- 1) The method *SI_Scale*(*INTEGER*, *INTEGER*) takes the following input parameters:
 - a) an *INTEGER* value *height*,
 - b) an *INTEGER* value *width*.
- 2) Case:
 - a) If the image content is referenced by *SELF.SI_reference*, then an exception condition is raised: *SQL/MM Still Image exception – scaling not supported for references*.
 - b) If at least one of the parameters *height* and *width* is smaller than 1 (one), or if *SELF.SI_format* indicates that scaling is not supported for images with this format, then an exception condition is raised: *SQL/MM Still Image exception – illegal specification for scaling*.
 - c) Otherwise,
 - i) *SELF.SI_content* is scaled to fit into the bounding rectangle defined by the input parameters *height* and *width* by maintaining the aspect ratio of the size *SELF.SI_height* by *SELF.SI_width*. The values of *SELF.SI_contentLength*, *SELF.SI_height*, and *SELF.SI_width* are adjusted to reflect the properties of the new value of *SELF.SI_content*. The interpolation technique used to scale the image is implementation-defined.
 - ii) If the *SI_retainFeatures* attribute is set to 1 (one), then the *SI_StillImage* value regenerates the values of the all the implementation-dependent image feature attributes values. If the *SI_retainFeatures* attribute is set to 0 (zero), then no action is necessary.
- 3) The method *SI_Scale*(*DOUBLE PRECISION*) takes the following input parameter:
 - a) a *DOUBLE PRECISION* value *scaleFactor*.

5.1.6 SI_Resize Methods**Purpose**

Resize the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```

CREATE METHOD SI_Resize
  (height INTEGER,
   width INTEGER)
RETURNS SI_StillImage
FOR SI_StillImage
BEGIN
  DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF20';
  DECLARE UnsupportedReferences CONDITION FOR SQLSTATE '2FF21';
  DECLARE localContent BINARY LARGE OBJECT(SI_MaxContentLength);
  DECLARE resizeHeight INTEGER;
  DECLARE resizeWidth INTEGER;

  IF SELF.SI_reference IS NOT NULL THEN
    SIGNAL UnsupportedReferences
      SET MESSAGE_TEXT =
        'resizing not supported for references';
  END IF;
  SET resizeHeight =
    CASE
      WHEN height IS NULL THEN
        width * CEIL(SELF.SI_height / SELF.SI_width)
      ELSE
        height
    END;
  SET resizeWidth =
    CASE

```

```

        WHEN width IS NULL THEN
            height * CEIL(SELF.SI_width / SELF.SI_height)
        ELSE
            width
    END;
IF resizeHeight IS NULL OR
   resizeWidth IS NULL OR
   resizeHeight < 1 OR
   resizeWidth < 1 OR
   NOT SI_supportedResize(SELF.SI_format) = 1 THEN
    SIGNAL InvalidInput
        SET MESSAGE_TEXT =
            'illegal specification for resizing';
END IF;
SET localContent =
    SI_resizeImageData(SELF.SI_content,
        resizeHeight, resizeWidth);
RETURN
CASE
    WHEN SELF.SI_retainFeatures = 1 THEN
        SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_height(resizeHeight).
            SI_width(resizeWidth)
    ELSE
        SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_height(resizeHeight).
            SI_width(resizeWidth).
            SI_InitFeatures()
    END;
END
END

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length of the binary representation of the *SI_StillImage* attribute *SI_content*.

Description

- 1) The method *SI_Resize*(*INTEGER*, *INTEGER*) takes the following input parameters:
 - a) an *INTEGER* value *height*,
 - b) an *INTEGER* value *width*.
- 2) Case:
 - a) If the image content is referenced by *SELF.SI_reference*, then an exception condition is raised: *SQL/MM Still Image exception – resizing not supported for references*.
 - b) If at least one of the parameters *height* and *width* is smaller than 1 (one), or if *SELF.SI_format* indicates that resizing is not supported for images with this format, then an exception condition is raised: *SQL/MM Still Image exception – illegal specification for resizing*.
 - c) Otherwise,
 - i) *SELF.SI_content* is resized to a rectangle of size *height* by *width*. The aspect ratio of the image might change during the resizing. The values of *SELF.SI_contentLength*, *SELF.SI_height*, and *SELF.SI_width* are adjusted to reflect the properties of the new value of *SELF.SI_content*.
 - ii) If the *SI_retainFeatures* attribute is set to 1 (one), then the *SI_StillImage* value regenerates the values of the all the implementation-dependent image feature attributes values. If the *SI_retainFeatures* attribute is set to 0 (zero), then no action is necessary.

5.1.7 SI_Rotate Method

Purpose

Rotate the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```
CREATE METHOD SI_Rotate
  (angle DOUBLE PRECISION)
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF19';
    DECLARE UnsupportedReferences CONDITION FOR SQLSTATE '2FF18';
    DECLARE localContent BINARY LARGE OBJECT(SI_MaxContentLength);

    IF SELF.SI_reference IS NOT NULL THEN
      SIGNAL UnsupportedReferences
        SET MESSAGE_TEXT =
          'rotating not supported for references';
    END IF;
    IF NOT SI_supportedRotate(SELF.SI_format) = 1 THEN
      SIGNAL InvalidInput
        SET MESSAGE_TEXT =
          'illegal specification for rotating';
    END IF;
    SET localContent = SI_rotateImageData(SELF.SI_content, angle);
    RETURN
      CASE
        WHEN SELF.SI_retainFeatures = 1 THEN
          SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_height(SI_height(localContent)).
            SI_width(SI_width(localContent)).
            SI_InitFeatures()
        ELSE
          SELF.
            SI_content(localContent).
            SI_contentLength(LENGTH(localContent)).
            SI_height(SI_height(localContent)).
            SI_width(SI_width(localContent))
        END;
      END;
  END
```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.

Description

- 1) The method *SI_Rotate(DOUBLE PRECISION)* takes the following input parameter:
 - a) an DOUBLE PRECISION value *angle*.
- 2) Case:
 - a) If the image content is referenced by *SELF.SI_reference*, then an exception condition is raised: *SQL/MM Still Image exception – rotating not supported for references*.
 - b) If *SELF.SI_format* indicates that rotating is not supported for images with this format, then an exception condition is raised: *SQL/MM Still Image exception – illegal specification for rotating*.
 - c) Otherwise,

- i) *SELF.SI_content* is rotated by a number of degrees defined by the parameter *angle*. A positive angle rotates the image counter-clockwise; a negative angle rotates the image clockwise. The values of *SELF.SI_contentLength*, *SELF.SI_height*, and *SELF.SI_width* are adjusted to reflect the properties of the new value of *SELF.SI_content*. The interpolation technique used to rotate the image is implementation-defined.
- ii) If the *SI_retainFeatures* attribute is set to 1 (one), then the *SI_StillImage* value regenerates the values of all the implementation-dependent image feature attributes values. If the *SI_retainFeatures* attribute is set to 0 (zero), then no action is necessary.

5.1.8 SI_Thumbnail Methods

Purpose

The *SI_Thumbnail* method derives a thumbnail from an *SI_StillImage* value.

Definition

```
CREATE METHOD SI_Thumbnail()
  RETURNS SI_StillImage
  FOR SI_StillImage
  RETURN SI_Thumbnail(SI_ThumbnailHeight, SI_ThumbnailWidth)

CREATE METHOD SI_Thumbnail
  (height INTEGER,
   width INTEGER)
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF12';

    IF height > SELF.SI_height OR
       width > SELF.SI_height OR
       NOT SI_supportedThumbnail(SELF.SI_format) = 1 THEN
      SIGNAL InvalidInput
        SET MESSAGE_TEXT =
          'illegal specification for thumbnail generation';
    END IF;
    RETURN SI_deriveThumbnail(SELF, height, width);
  END
```

Definitional Rules

- 1) *SI_ThumbnailHeight* is the implementation-dependent height for the resulting thumbnail.
- 2) *SI_ThumbnailWidth* is the implementation-dependent width for the resulting thumbnail.

Description

- 1) The method *SI_Thumbnail()* takes no input parameters.
- 2) The method *SI_Thumbnail()* returns an *SI_StillImage* value representing the thumbnail. The values for the attributes *SI_height* and *SI_width* for the resulting thumbnail are implementation-dependent.
- 3) The method *SI_Thumbnail(INTEGER, INTEGER)* takes the following input parameters:
 - a) an INTEGER value *height*,
 - b) an INTEGER value *width*.
- 4) The method *SI_Thumbnail()* returns an *SI_StillImage* value representing the thumbnail. If at least one of the parameters *height* and *width* is larger than the values *SELF.SI_height* and *SELF.SI_width*, respectively, or if *SELF.SI_format* indicates that the derivation of a thumbnail from images with this format is not supported, then an exception condition is raised: *SQL/MM Still Image exception – illegal specification for thumbnail generation*.

5.1.9 SI_InitFeatures method

Purpose

Extract image features into the appropriate feature attributes and enable on-going synchronization.

Definition

```
CREATE METHOD SI_InitFeatures()
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    IF SELF.SI_content IS NULL OR
       SI_supportedFeature('SI_AverageColor', SELF) = 0 THEN
      -- Set implementation-dependent attributes representing
      -- average color to NULL
    ELSE
      -- Set implementation-dependent attributes representing
      -- average color to average color returned by
      -- SI_AverageColor(SELF)
    END IF;
    IF SELF.SI_content IS NULL OR
       SI_supportedFeature('SI_ColorHistogram', SELF) = 0 THEN
      -- Set implementation-dependent attributes representing
      -- color histogram to NULL
    ELSE
      -- Set implementation-dependent attributes representing
      -- color histogram to color histogram returned by
      -- SI_ColorHistogram(SELF)
    END IF;
    IF SELF.SI_content IS NULL OR
       SI_supportedFeature('SI_PositionalColor', SELF) = 0 THEN
      -- Set implementation-dependent attributes representing
      -- positional color to NULL
    ELSE
      -- Set implementation-dependent attributes representing
      -- positional color to positional color returned by
      -- SI_PositionalColor(SELF)
    END IF;
    IF SELF.SI_content IS NULL OR
       SI_supportedFeature('SI_Texture', SELF) = 0 THEN
      -- Set implementation-dependent attributes representing
      -- texture to NULL
    ELSE
      -- Set implementation-dependent attributes representing
      -- texture to texture returned by
      -- SI_Texture(SELF)
    END IF;
    RETURN SELF.SI_retainFeatures(1);
  END
```

Description

- 1) The method *SI_InitFeatures* takes no parameters.
- 2) Set the *SI_retainFeatures* attribute of SELF to 1 (one), indicating that the feature attributes are to be maintained whenever the value of the *SI_StillImage* value (represented by SELF) changes.
- 3) Compute the values of the all the implementation-dependent image feature attributes values of SELF.

5.1.10 SI_ClearFeatures method

Purpose

Clear image features from feature attributes and disable on-going synchronization.

Definition

```

CREATE METHOD SI_ClearFeatures()
  RETURNS SI_StillImage
  FOR SI_StillImage
  BEGIN
    --
    -- !! See Description
    --
    RETURN SELF.SI_retainFeatures(0);
  END

```

Description

- 1) The method *SI_ClearFeatures* takes no parameters.
- 2) Set the *SI_retainFeatures* attribute of SELF to 0 (zero), indicating that the feature attributes are not to be maintained when the value of the *SI_StillImage* value (represented by SELF) changes.
- 3) Set values of the all the implementation-dependent image feature attributes values of SELF to the null value.

5.1.11 SI_Score Methods**Purpose**

Returns the similarity of an image feature value to a feature value given as an argument.

Definition

```

CREATE METHOD SI_Score
  (averageColorFeature SI_AverageColor)
  RETURNS DOUBLE PRECISION
  FOR SI_StillImage
  RETURN averageColorFeature.SI_Score(SELF)

CREATE METHOD SI_Score
  (colorHistogramFeature SI_ColorHistogram)
  RETURNS DOUBLE PRECISION
  FOR SI_StillImage
  RETURN colorHistogramFeature.SI_Score(SELF)

CREATE METHOD SI_Score
  (positionalColorFeature SI_PositionalColor)
  RETURNS DOUBLE PRECISION
  FOR SI_StillImage
  RETURN positionalColorFeature.SI_Score(SELF)

CREATE METHOD SI_Score
  (textureFeature SI_Texture)
  RETURNS DOUBLE PRECISION
  FOR SI_StillImage
  RETURN textureFeature.SI_Score(SELF)

CREATE METHOD SI_Score
  (featureList SI_FeatureList)
  RETURNS DOUBLE PRECISION
  FOR SI_StillImage
  RETURN featureList.SI_Score(SELF)

```

Description

- 1) The method *SI_Score(SI_AverageColor)* takes the following input parameter:
 - a) an *SI_AverageColor* value *averageColorFeature*.

- 2) The method *SI_Score(SI_AverageColor)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better the average color value of SELF is characterized by the average color represented by *averageColorFeature*, which is used for scoring SELF.

Case:

- a) If SELF or *averageColorFeature* is the null value, or if SELF.*SI_content* and the result of the function invocation *SI_getDLContent(SELF.SI_reference)* is the null value, or if the average color feature is not supported for SELF, then the null value is returned.
- b) Otherwise, the exact relationship between *averageColorFeature*, SELF, and the result of *SI_Score(SI_AverageColor)* is implementation-dependent.

- 3) The method *SI_Score(SI_ColorHistogram)* takes the following input parameter:

- a) an *SI_ColorHistogram* value *colorHistogramFeature*.

- 4) The method *SI_Score(SI_ColorHistogram)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better the color histogram value of SELF is characterized by the color histogram represented by *colorHistogramFeature*, which is used for scoring SELF.

Case:

- a) If SELF or *colorHistogramFeature* is the null value, or if SELF.*SI_content* and the result of the function invocation *SI_getDLContent(SELF.SI_reference)* is the null value, or if the color histogram feature is not supported for SELF, then the null value is returned.
- b) Otherwise, the exact relationship between *colorHistogramFeature*, SELF, and the result of *SI_Score(SI_ColorHistogram)* is implementation-dependent.

- 5) The method *SI_Score(SI_PositionalColor)* takes the following input parameter:

- a) an *SI_PositionalColor* value *positionalColorFeature*.

- 6) The method *SI_Score(SI_PositionalColor)* returns a value greater than or equal to 0 (zero). For scoring SELF, SELF is effectively divided into *n* by *m* rectangles, such that the product of *n* and *m* equals *SI_NumberSections*. For each rectangle, the most significant color is implementation-defined. The lower the returned value, the better the *n* by *m* most significant colors of SELF is characterized by the most significant colors represented by *positionalColorFeature*, which is used for scoring SELF.

NOTE 4 The way in which SELF is divided into *SI_NumberSections* rectangles is implementation-dependent, as well as *n* and *m* itself. However, the division shall be performed in the same fashion for the *SI_Score(SI_PositionalColor)* method and the method *SI_PositionalColor(SI_StillImage)*.

Case:

- a) If SELF or *positionalColorFeature* is the null value, or if SELF.*SI_content* and the result of the function invocation *SI_getDLContent(SELF.SI_reference)* is the null value, or if the positional color feature is not supported for SELF, then the null value is returned.
- b) Otherwise, the exact relationship between *positionalColorFeature*, SELF, and the result of *SI_Score(SI_PositionalColor)* is implementation-dependent.

- 7) The method *SI_Score(SI_Texture)* takes the following input parameter:

- a) an *SI_Texture* value *textureFeature*.

- 8) The method *SI_Score(SI_Texture)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better the texture value of SELF is characterized by the texture represented by *textureFeature*, which is used for scoring SELF.

Case:

- a) If SELF or *textureFeature* is the null value, or if SELF.*SI_content* and the result of the function invocation *SI_getDLContent(SELF.SI_reference)* is the null value, or if the texture feature is not supported for SELF, then the null value is returned.
- b) Otherwise, the exact relationship between *textureFeature*, SELF, and the result of *SI_Score(SI_Texture)* is implementation-dependent.

- 9) The method *SI_Score(SI_FeatureList)* takes the following input parameter:
- a) an *SI_FeatureList* value *featureList*.
- 10) The method *SI_Score(SI_FeatureList)* returns the null value if one of the following is true:
- a) SELF is the null value.
 - b) *featureList* is the null value.
 - c) The values *featureList.SI_AvgClrFtr*, *featureList.SI_ClrHstgrFtr*, *featureList.SI_PstnlClrFtr*, and *featureList.SI_TextureFtr* are all the null value.
 - d) The sum of *featureList.SI_AvgClrFtrWght*, *featureList.SI_ClrHstgrFtrWght*, *featureList.SI_PstnlClrFtrWght*, and *featureList.SI_TextureFtrWght* is 0 (zero).
- 11) The method *SI_Score(SI_FeatureList)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better SELF is characterized by *featureList*, which is used for scoring SELF. Let *N* be the number of feature attributes of SELF that are not the null value. For *i* ranging from 1 (one) to *N*, let *F_i* be the value of that attribute, and *W_i* the value of the corresponding weight attribute. Then the result is:

$$\frac{\sum_{i=1}^N F_i \cdot SI_Score(image) \cdot W_i}{\sum_{i=1}^N W_i}$$

5.1.12 Functions Complementing SI_StillImage Methods

Purpose

Return a specified *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_mkStillImage1
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT
RETURN NEW SI_StillImage(content)

CREATE FUNCTION SI_mkStillImage2
  (content BINARY LARGE OBJECT(SI_MaxContentLength),
   explicitFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
RETURN NEW SI_StillImage(content, explicitFormat)

CREATE FUNCTION SI_mkStillImage3
  (reference DATALINK)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT
RETURN NEW SI_StillImage(reference)

CREATE FUNCTION SI_mkStillImage4
  (reference DATALINK,
   explicitFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
```

```

READS SQL DATA
RETURNS NULL ON NULL INPUT
RETURN NEW SI_StillImage(reference, explicitFormat)

CREATE FUNCTION SI_mkStillImage5
  (content BINARY LARGE OBJECT(SI_MaxFormatLength),
   maintainFeatures INTEGER)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
RETURN NEW SI_StillImage(content, maintainFeatures)

CREATE FUNCTION SI_mkStillImage6
  (content BINARY LARGE OBJECT(SI_MaxFormatLength),
   explicitFormat CHARACTER VARYING(SI_MaxFormatLength),
   maintainFeatures INTEGER)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
RETURN NEW SI_StillImage(content, explicitFormat, maintainFeatures)

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.
- 2) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The function *SI_mkStillImage1*(*BINARY LARGE OBJECT*) takes the following input parameter:
 - a) a BINARY LARGE OBJECT value *content*.
- 2) The function *SI_mkStillImage2*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*) takes the following input parameters:
 - a) a BINARY LARGE OBJECT value *content*,
 - b) a CHARACTER VARYING value *explicitFormat*.
- 3) The function *SI_mkStillImage3*(*DATALINK*) takes the following input parameter:
 - a) a DATALINK value *reference*.
- 4) The function *SI_mkStillImage4*(*DATALINK*, *CHARACTER VARYING*) takes the following input parameters:
 - a) a DATALINK value *reference*,
 - b) a CHARACTER VARYING value *explicitFormat*.
- 5) The function *SI_mkStillImage5*(*BINARY LARGE OBJECT*, *INTEGER*) takes the following input parameter:
 - a) a BINARY LARGE OBJECT value *content*,
 - b) an INTEGER value *maintainFeatures*.
- 6) The function *SI_mkStillImage6*(*BINARY LARGE OBJECT*, *CHARACTER VARYING*, *INTEGER*) takes the following input parameters:
 - a) a BINARY LARGE OBJECT value *content*,
 - b) a CHARACTER VARYING value *explicitFormat*,
 - c) an INTEGER value *maintainFeatures*.

5.1.13 SI_chgContent Function**Purpose**

Update the *SI_StillImage* content.

Definition

```
CREATE FUNCTION SI_chgContent
  (image SI_StillImage,
   content BINARY LARGE OBJECT(SI_MaxContentLength))
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN image.SI_setContent(content)
```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.

Description

- 1) The function *SI_chgContent(SI_StillImage, BINARY LARGE OBJECT)* takes the following input parameters:
 - a) an *SI_StillImage* value *image*,
 - b) a BINARY LARGE OBJECT value *content*.

5.1.14 SI_convertFormat Function**Purpose**

Convert the format of an *SI_StillImage* value and adjust affected attributes.

Definition

```
CREATE FUNCTION SI_convertFormat
  (image SI_StillImage,
   targetFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN image.SI_changeFormat(targetFormat)
```

Definitional Rules

- 1) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The function *SI_convertFormat(SI_StillImage, CHARACTER VARYING)* takes the following input parameters:
 - a) an *SI_StillImage* value *image*,
 - b) a CHARACTER VARYING value *targetFormat*.

5.1.15 SI_scaleImage Function**Purpose**

Scale the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```
CREATE FUNCTION SI_scaleImage
  (image SI_StillImage,
   height INTEGER,
   width INTEGER)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN image.SI_Scale(height, width)
```

Description

1) The function *SI_scaleImage(SI_StillImage, INTEGER, INTEGER)* takes the following input parameters:

- a) an *SI_StillImage* value *image*,
- b) an INTEGER value *height*,
- c) an INTEGER value *width*.

5.1.16 SI_zoomImage Function

Purpose

Scale the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```
CREATE FUNCTION SI_zoomImage
  (image SI_StillImage,
   scaleFactor DOUBLE PRECISION)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN image.SI_Scale(scaleFactor)
```

Description

1) The function *SI_zoomImage(SI_StillImage, DOUBLE PRECISION)* takes the following input parameters:

- a) an *SI_StillImage* value *image*,
- b) a DOUBLE PRECISION value *scaleFactor*.

5.1.17 SI_resizeImage Function

Purpose

Resize the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```
CREATE FUNCTION SI_resizeImage
  (image SI_StillImage,
   height INTEGER,
   width INTEGER)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN image.SI_Resize(height, width)
```

Description

- 1) The function *SI_resizeImage*(*SI_StillImage*, *INTEGER*, *INTEGER*) takes the following input parameters:
 - a) an *SI_StillImage* value *image*,
 - b) an *INTEGER* value *height*,
 - c) an *INTEGER* value *width*.

5.1.18 SI_rotateImage Function**Purpose**

Rotate the content of an *SI_StillImage* value and adjust affected attributes.

Definition

```
CREATE FUNCTION SI_rotateImage
  (image SI_StillImage,
   angle DOUBLE PRECISION)
  RETURNS SI_StillImage
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_Rotate(angle)
```

Description

- 1) The function *SI_rotateImage*(*SI_StillImage*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_StillImage* value *image*,
 - b) a *DOUBLE PRECISION* value *angle*.

5.1.19 SI_getThmbnl Function**Purpose**

The *SI_getThmbnl* derives a thumbnail from an *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_getThmbnl
  (image SI_StillImage)
  RETURNS SI_StillImage
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_Thumbnail()
```

Description

- 1) The function *SI_getThmbnl*(*SI_StillImage*) takes the following input parameter:
 - a) an *SI_StillImage* value *image*.

5.1.20 SI_getSizedThmbnl Function**Purpose**

The *SI_getSizedThmbnl* derives a thumbnail with user-supplied *height* and *width* values from an *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_getSizedThmbnl
  (image SI_StillImage,
   height INTEGER,
   width INTEGER)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN image.SI_Thumbnail(height, width)
```

Description

- 1) The function *SI_getSizedThmbnl*(*SI_StillImage*, *INTEGER*, *INTEGER*) takes the following input parameters:
 - a) an *SI_StillImage* value *image*,
 - b) an *INTEGER* value *height*,
 - c) an *INTEGER* value *width*.

5.1.21 SI_setImageFtrs Function

Purpose

Extract image features into the appropriate feature attributes and enable on-going synchronization.

Definition

```
CREATE FUNCTION SI_setImageFtrs
  (image SI_StillImage )
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
RETURN image.SI_InitFeatures()
```

Description

- 1) The function *SI_setImageFtrs*(*SI_StillImage*) takes the following input parameter:
 - b) an *SI_StillImage* value *image*.

5.1.22 SI_resetImageFtrs Function

Purpose

Clear image features from feature attributes and disable on-going synchronization.

Definition

```
CREATE FUNCTION SI_resetImageFtrs
  (image SI_StillImage)
RETURNS SI_StillImage
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
RETURN image.SI_ClearFeatures()
```

Description

- 1) The function *SI_resetImageFtrs*(*SI_StillImage*) takes the following input parameter:
 - a) an *SI_StillImage* value *image*.

5.1.23 Functions Complementing Observer Functions of Type SI_StillImage

Purpose

Obtain the value of the designated *SI_StillImage* attribute.

Definition

```
CREATE FUNCTION SI_getContent
  (image SI_StillImage)
  RETURNS BINARY LARGE OBJECT(SI_MaxContentLength)
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_content

CREATE FUNCTION SI_getContentLength
  (image SI_StillImage)
  RETURNS INTEGER
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_contentLength

CREATE FUNCTION SI_getReference
  (image SI_StillImage)
  RETURNS DATALINK
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_reference

CREATE FUNCTION SI_getFormat
  (image SI_StillImage)
  RETURNS CHARACTER VARYING(SI_MaxFormatLength)
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_format

CREATE FUNCTION SI_getHeight
  (image SI_StillImage)
  RETURNS INTEGER
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_height

CREATE FUNCTION SI_getWidth
  (image SI_StillImage)
  RETURNS INTEGER
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN image.SI_width
```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.
- 2) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The function *SI_getContent(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 2) *SI_getContent(SI_StillImage)* returns the binary representation of the attribute *SI_content* of the *SI_StillImage* value *image*.
- 3) The function *SI_getContentLength(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 4) *SI_getContentLength(SI_StillImage)* returns the length of the binary representation of the *SI_StillImage* value *image*.
- 5) The function *SI_getReference(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 6) *SI_getReference(SI_StillImage)* returns the datalink value referencing the image content of the *SI_StillImage* value *image*.
- 7) The function *SI_getFormat(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 8) *SI_getFormat(SI_StillImage)* returns the character representation of the image format indication of the *SI_StillImage* value *image*.
- 9) The function *SI_getHeight(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 10) *SI_getHeight(SI_StillImage)* returns the height of the *SI_StillImage* value *image*.
- 11) The function *SI_getWidth(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 12) *SI_getWidth(SI_StillImage)* returns the width of the *SI_StillImage* value *image*.

5.1.24 Functions not intended for Public Use

Purpose

These functions are only intended to be used within the methods *SI_StillImage*, *SI_setContent*, *SI_changeFormat*, *SI_Scale*, and *SI_Thumbnail*.

Definition

```
CREATE FUNCTION SI_getDLContent
    (reference DATALINK)
RETURNS BINARY LARGE OBJECT(SI_MaxContentLength)
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT
BEGIN
    --
    -- !! See Description
    --
END
```

```

CREATE FUNCTION SI_format
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
  RETURNS CHARACTER VARYING(SI_MaxFormatLength)
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  BEGIN
    --
    -- !! See Description
    --
  END

CREATE FUNCTION SI_height
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
  RETURNS INTEGER
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  BEGIN
    --
    -- !! See Description
    --
  END

CREATE FUNCTION SI_width
  (content BINARY LARGE OBJECT(SI_MaxContentLength))
  RETURNS INTEGER
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  BEGIN
    --
    -- !! See Description
    --
  END

CREATE FUNCTION SI_supportedFeature
  (featureName CHARACTER VARYING(SI_MaxFeatureNameLength),
   sourceImage SI_StillImage)
  RETURNS INTEGER
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  STATIC DISPATCH
  RETURN
  CASE
    WHEN EXISTS (
      SELECT *
        FROM SI_INFORMTN_SCHEMA.SI_IMAGE_FORMAT_FEATURES
       WHERE TRIM(BOTH ' ' FROM SI_FEATURE_NAME) =
             TRIM(BOTH ' ' FROM featureName) AND
             TRIM(BOTH ' ' FROM SI_FORMAT) =
             TRIM(BOTH ' ' FROM sourceImage.SI_format)
      ) THEN 1
    ELSE 0
  END

CREATE FUNCTION SI_convert
  (content BINARY LARGE OBJECT(SI_MaxContentLength),
   sourceFormat CHARACTER VARYING(SI_MaxFormatLength),
   targetFormat CHARACTER VARYING(SI_MaxFormatLength))

```

```

RETURNS BINARY LARGE OBJECT(SI_MaxContentLength)
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
BEGIN
  --
  -- !! See Description
  --
END

CREATE FUNCTION SI_supportedConversion
  (sourceFormat CHARACTER VARYING(SI_MaxFormatLength),
   targetFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS INTEGER
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT
RETURN
  CASE
    WHEN EXISTS (
      SELECT *
        FROM SI_INFORMTN_SCHEMA.SI_IMAGE_FORMAT_CONVERSIONS
       WHERE TRIM(BOTH ' ' FROM SI_SOURCE_FORMAT) =
             TRIM(BOTH ' ' FROM sourceFormat) AND
             TRIM(BOTH ' ' FROM SI_TARGET_FORMAT) =
             TRIM(BOTH ' ' FROM targetFormat)
    ) THEN 1
    ELSE 0
  END

CREATE FUNCTION SI_supportedFormat
  (specifiedFormat CHARACTER VARYING(SI_MaxFormatLength))
RETURNS INTEGER
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT
RETURN
  CASE
    WHEN EXISTS (
      SELECT *
        FROM SI_INFORMTN_SCHEMA.SI_IMAGE_FORMATS
       WHERE TRIM(BOTH ' ' FROM SI_FORMAT) =
             TRIM(BOTH ' ' FROM specifiedFormat)
    ) THEN 1
    ELSE 0
  END

CREATE FUNCTION SI_scaleImageData
  (imageData BINARY LARGE OBJECT(SI_MaxContentLength),
   height INTEGER,
   width INTEGER)
RETURNS BINARY LARGE OBJECT(SI_MaxContentLength)
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
BEGIN
  --
  -- !! See Description
  --
END

```

```

CREATE FUNCTION SI_supportedScale
  (sourceFormat CHARACTER VARYING(SI_MaxFormatLength))
  RETURNS INTEGER
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  RETURN
    CASE
      WHEN EXISTS (
        SELECT *
          FROM SI_INFORMTN_SCHEMA.SI_IMAGE_FORMATS
         WHERE TRIM(BOTH ' ' FROM SI_FORMAT) =
              TRIM(BOTH ' ' FROM sourceFormat) AND
              SI_SCALE = 'YES' )
        THEN 1
      ELSE 0
    END

CREATE FUNCTION SI_resizeImageData
  (imageData BINARY LARGE OBJECT(SI_MaxContentLength),
   height INTEGER,
   width INTEGER)
  RETURNS BINARY LARGE OBJECT(SI_MaxContentLength)
  DETERMINISTIC
  CONTAINS SQL
  CALLED ON NULL INPUT
  BEGIN
    --
    -- !! See Description
    --
  END

CREATE FUNCTION SI_supportedResize
  (sourceFormat CHARACTER VARYING(SI_MaxFormatLength))
  RETURNS INTEGER
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  RETURN
    CASE
      WHEN EXISTS (
        SELECT *
          FROM SI_INFORMTN_SCHEMA.SI_IMAGE_FORMATS
         WHERE TRIM(BOTH ' ' FROM SI_FORMAT) =
              TRIM(BOTH ' ' FROM sourceFormat) AND
              SI_RESIZE = 'YES' )
        THEN 1
      ELSE 0
    END

CREATE FUNCTION SI_rotateImageData
  (imageData BINARY LARGE OBJECT(SI_MaxContentLength),
   angle DOUBLE PRECISION)
  RETURNS BINARY LARGE OBJECT(SI_MaxContentLength)
  DETERMINISTIC
  CONTAINS SQL
  CALLED ON NULL INPUT
  BEGIN
    --
    -- !! See Description
    --
  END

```

```

CREATE FUNCTION SI_supportedRotate
  (sourceFormat CHARACTER VARYING(SI_MaxFormatLength))
  RETURNS INTEGER
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  RETURN
    CASE
      WHEN EXISTS (
        SELECT *
          FROM SI_INFORMTN_SCHEMA.SI_IMAGE_FORMATS
         WHERE TRIM(BOTH ' ' FROM SI_FORMAT) =
              TRIM(BOTH ' ' FROM sourceFormat) AND
              SI_ROTATE = 'YES' )
        THEN 1
      ELSE 0
    END

CREATE FUNCTION SI_deriveThumbnail
  (image SI_StillImage,
   height INTEGER,
   width INTEGER)
  RETURNS SI_StillImage
  DETERMINISTIC
  CONTAINS SQL
  CALLED ON NULL INPUT
  STATIC DISPATCH
  BEGIN
    --
    -- !! See Description
    --
  END

CREATE FUNCTION SI_supportedThumbnail
  (sourceFormat CHARACTER VARYING(SI_MaxFormatLength))
  RETURNS INTEGER
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  RETURN
    CASE
      WHEN EXISTS(
        SELECT *
          FROM SI_INFORMTN_SCHEMA.SI_THUMBNAIL_FORMATS
         WHERE TRIM(BOTH ' ' FROM SI_FORMAT) =
              TRIM(BOTH ' ' FROM sourceFormat)
        ) THEN 1
      ELSE 0
    END

```

Definitional Rules

- 1) *SI_MaxContentLength* is the implementation-defined maximum length for the binary representation of the *SI_StillImage* attribute *SI_content*.
- 2) *SI_MaxFeatureNameLength* is the implementation-defined maximum length for the character representation of a basic feature name.
- 3) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The function *SI_getDLContent(DATALINK)* takes the following input parameter:
 - a) a DATALINK value *reference*.
- 2) The function *SI_getDLContent(DATALINK)* returns the image content referenced by the DATALINK value *reference* as BINARY LARGE OBJECT. The result is the null value if the parameter does not reference an image.
- 3) The function *SI_format(BINARY LARGE OBJECT)* takes the following input parameter:
 - a) a BINARY LARGE OBJECT value *content*.
- 4) The function *SI_format(BINARY LARGE OBJECT)* determines the image format of its parameter *image*. The result is the null value if *image* is not in an image format that is amongst the implementation-defined set of supported image formats. The determination of the image format includes a verification of the consistency of the raw image itself.
- 5) The function *SI_height(BINARY LARGE OBJECT)* takes the following input parameter:
 - a) a BINARY LARGE OBJECT value *content*.
- 6) The function *SI_height(BINARY LARGE OBJECT)* determines and returns the height of its parameter *image*. The result is the null value if *image* is not in an image format amongst the implementation-defined set of supported image formats.
- 7) The function *SI_width(BINARY LARGE OBJECT)* takes the following input parameter:
 - a) a BINARY LARGE OBJECT value *content*.
- 8) The function *SI_width(BINARY LARGE OBJECT)* determines and returns the width of its parameter *image*. The result is the null value if *image* is not in an image format amongst the implementation-defined set of supported image formats.
- 9) The function *SI_supportedFeature(CHARACTER VARYING, SI_StillImage)* takes the following input parameters:
 - a) a CHARACTER VARYING value *featureName*,
 - b) an SI_StillImage value *sourceImage*.
- 10) For the function *SI_supportedFeature(CHARACTER VARYING, SI_StillImage)*:

Case:

 - a) If the view *SI_IMAGE_FORMAT_FEATURES* of the information schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_FORMAT* column value is equivalent to the value of *sourceImage.SI_format* and whose *SI_FEATURE_NAME* column value is equivalent to *featureName*, then the result of this function is 1 (one); i.e. the feature indicated by *featureName* is supported for *sourceImage*.
 - b) Otherwise, the result is 0 (zero); i.e. the feature indicated by *featureName* is not supported for *sourceImage*.
- 11) The function *SI_convert(BINARY LARGE OBJECT, CHARACTER VARYING, CHARACTER VARYING)* takes the following input parameters:
 - a) a BINARY LARGE OBJECT value *content*,
 - b) a CHARACTER VARYING value *sourceFormat*,
 - c) a CHARACTER VARYING value *targetFormat*.
- 12) The function *SI_convert(BINARY LARGE OBJECT, CHARACTER VARYING, CHARACTER VARYING)* converts the format of the image represented by the first parameter from the format indicated by the second parameter into the format indicated by the third parameter. The converted image is returned as a BINARY LARGE OBJECT value. If the format conversion fails, then an exception condition is raised: *SQL/MM Still Image exception – fatal error during image format conversion*.

13) The function *SI_supportedConversion*(*CHARACTER VARYING*, *CHARACTER VARYING*) takes the following input parameters:

- a) a *CHARACTER VARYING* value *sourceFormat*,
- b) a *CHARACTER VARYING* value *targetFormat*.

14) For the function *SI_supportedConversion*(*CHARACTER VARYING*, *CHARACTER VARYING*):

Case:

- a) If the view *SI_IMAGE_FORMAT_CONVERSIONS* of the information schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_SOURCE_FORMAT* and *SI_TARGET_FORMAT* column values are equivalent to *sourceFormat* and *targetFormat*, respectively, then the result of this function is 1 (one); i.e., an *SI_StillImage* value whose *SI_format* value is *sourceFormat* can be converted to an *SI_StillImage* value whose *SI_format* value is *targetFormat*.
- b) Otherwise, the result is 0 (zero); i.e., that conversion is not supported.

15) The function *SI_supportedFormat*(*CHARACTER VARYING*) takes the following input parameter:

- a) *CHARACTER VARYING* value *specifiedFormat*.

16) For the function *SI_supportedFormat*(*CHARACTER VARYING*):

Case:

- a) If the view *SI_IMAGE_FORMATS* of the information schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_FORMAT* column value is equivalent to *specifiedFormat*, then the result of this function is 1 (one); i.e. *specifiedFormat* is a supported image format.
- b) Otherwise, the result is 0 (zero); i.e. *specifiedFormat* is not a supported image format.

17) The function *SI_scaleImageData*(*BINARY LARGE OBJECT*, *INTEGER*, *INTEGER*) takes the following input parameters:

- a) a *BINARY LARGE OBJECT* value *imageData*,
- b) an *INTEGER* value *height*,
- c) an *INTEGER* value *width*.

18) The function *SI_scaleImageData*(*BINARY LARGE OBJECT*, *INTEGER*, *INTEGER*) returns a scaled version of its parameter *imageData*.

Case:

- a) If the scaling fails, then an exception condition is raised: SQL/MM Still Image exception – fatal error during image scaling.
- b) Otherwise, the parameters *height* and *width* specify an outer bounding rectangle for the result *RET*. The aspect ratio of the height and width of *imageData* shall be maintained for *RET*. Thus, the still image *ret* shall have a resulting height of $\text{MIN}(\text{height}, \text{SI_height}(\text{imageData}))$ and width of $\text{MIN}(\text{width}, \text{SI_width}(\text{imageData}))$.

19) The function *SI_supportedScale*(*CHARACTER VARYING*) takes the following input parameter:

- a) a *CHARACTER VARYING* value *sourceFormat*.

20) For the function *SI_supportedScale*(*CHARACTER VARYING*):

Case:

- a) If the view *SI_IMAGE_FORMATS* of the Information Schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_FORMAT* column value is equivalent to *sourceFormat* and whose *SI_SCALE* column value is equivalent to 'YES', then the result of this function is 1 (one); i.e. images whose format indication equals *sourceFormat* can be scaled.
- b) Otherwise, the result is 0 (zero); i.e. images whose format indication equals *sourceFormat* cannot be scaled.

21) The function *SI_resizeImageData*(*BINARY LARGE OBJECT*, *INTEGER*, *INTEGER*) takes the following input parameters:

- a) a *BINARY LARGE OBJECT* value *imageData*,
- b) an *INTEGER* value *height*,
- c) an *INTEGER* value *width*.

22) The function *SI_resizeImageData*(*BINARY LARGE OBJECT*, *INTEGER*, *INTEGER*) returns a resized version of its parameter *imageData*.

Case:

- a) If the resizing fails, then an exception condition is raised: SQL/MM Still Image exception – fatal error during image resizing.
- b) Otherwise, the parameters *height* and *width* specify the *height* and *width* for the result *ret*. The aspect ratio of the *height* and *width* of *imageData* might change for *ret*.

23) The function *SI_supportedResize*(*CHARACTER VARYING*) takes the following input parameter:

- a) a *CHARACTER VARYING* value *sourceFormat*.

24) For the function *SI_supportedResize*(*CHARACTER VARYING*):

Case:

- a) If the view *SI_IMAGE_FORMATS* of the Information Schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_FORMAT* column value is equivalent to *sourceFormat* and whose *SI_RESIZE* column value is equivalent to 'YES', then the result of this function is 1 (one); i. e. images whose format indication equals *sourceFormat* can be resized.
- b) Otherwise, the result is 0 (zero); i. e. images whose format indication equals *sourceFormat* cannot be resized.

25) The function *SI_rotateImageData*(*BINARY LARGE OBJECT*, *DOUBLE PRECISION*) takes the following input parameters:

- a) a *BINARY LARGE OBJECT* value *imageData*,
- b) a *DOUBLE PRECISION* value *angle*.

26) The function *SI_rotateImageData*(*BINARY LARGE OBJECT*, *DOUBLE PRECISION*) returns a rotated version of its parameter *imageData*.

Case:

- a) If the rotating fails, then an exception condition is raised: SQL/MM Still Image exception – fatal error during image rotation.
- b) Otherwise, the parameter *angle* specifies the amount of degrees the image should be rotated. A positive *angle* rotates the image counter-clockwise; a negative *angle* rotates the image clockwise. For rotations by an angle that is not a multiple of 90 degrees, the raw image is padded and the height and width of the resulting still image are adjusted. The image is not scaled together with the rotation.

27) The function *SI_supportedRotate*(*CHARACTER VARYING*) takes the following input parameter:

- b) a *CHARACTER VARYING* value *sourceFormat*.

28) For the function *SI_supportedRotate*(*CHARACTER VARYING*):

Case:

- a) If the view *SI_IMAGE_FORMAT* of the information schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_FORMAT* column value is equivalent to *sourceFormat* and whose *SI_ROTATE* column value is equivalent to 'YES', then the result of this function is 1 (one); i.e. images whose format indication equals *sourceFormat* can be rotated.
- b) Otherwise, the result is 0 (zero); i.e. images whose format indication equals *sourceFormat* cannot be rotated.

29) The function *SI_deriveThumbnail*(*SI_StillImage*, *INTEGER*, *INTEGER*) takes the following input parameters:

- a) an *SI_StillImage* value *image*,
- b) an *INTEGER* value *height*,
- c) an *INTEGER* value *width*.

30) The function *SI_deriveThumbnail*(*SI_StillImage*, *INTEGER*, *INTEGER*) derives and returns a thumbnail of its parameter *image*.

Case:

- a) If the thumbnail cannot be derived from *image*, then an exception condition is raised: SQL/MM Still Image exception – fatal error during thumbnail computation.
- b) Otherwise, let *ret* be the still image, which represents the derived thumbnail, that is returned by *SI_deriveThumbnail*. The attributes *ret.SI_height* and *ret.SI_width* are set to the specified *height* and *width*, respectively. The format of the resulting thumbnail *ret.SI_format* is the same as the format of the still image *image*.

31) The function *SI_supportedThumbnail*(*CHARACTER VARYING*) takes the following input parameter:

- a) a *CHARACTER VARYING* value *sourceFormat*.

32) For the function *SI_supportedThumbnail*(*CHARACTER VARYING*):

Case:

- a) If the view *SI_THUMBNAIL_FORMATS* of the information schema *SI_INFORMTN_SCHEMA* contains a row whose *SI_FORMAT* column value is equivalent to *sourceFormat*, then the result of this function is 1 (one); i.e. a thumbnail can be derived from an image whose format indication equals *sourceFormat*.
- b) Otherwise, the result is 0 (zero); i.e. a thumbnail cannot be derived from an image whose format indication equals *sourceFormat*.

6 Feature Types

The types in this family provide for the manipulation of still image features.

6.1 *SI_AverageColor* Type and Routines

6.1.1 *SI_AverageColor* Type

Purpose

Provide the definition of the feature type *SI_AverageColor* and facilities for scoring *SI_StillImage* values using values of the *SI_AverageColor* type.

Definition

```
CREATE TYPE SI_AverageColor
AS (
    SI_AverageColorSpec SI_Color
)
INSTANTIABLE
NOT FINAL

CONSTRUCTOR METHOD SI_AverageColor
(sourceImage SI_StillImage)
RETURNS SI_AverageColor
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT,

CONSTRUCTOR METHOD SI_AverageColor
(averageColor SI_Color)
RETURNS SI_AverageColor
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_Score
(image SI_StillImage)
RETURNS DOUBLE PRECISION
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
```

Definitional Rules

- 1) The attribute *SI_AverageColorSpec* is not for public use. There are no GRANT statements granting EXECUTE privilege on the observer and mutator functions for the attribute *SI_AverageColorSpec*.

Description

- 1) The *SI_AverageColor* type provides for public use:
 - a) a method *SI_AverageColor(SI_StillImage)*,
 - b) a method *SI_AverageColor(SI_Color)*,
 - c) a method *SI_Score(SI_StillImage)*,
 - d) a function *SI_findAvgClr(SI_StillImage)*,
 - e) a function *SI_mkAvgClr(SI_Color)*,
 - f) a function *SI_ScoreByAvgClr(SI_AverageColor, SI_StillImage)*.

2) The *SI_AverageColor* type represents color values that are interpreted as average color values using the attribute:

a) an *SI_Color* value *SI_AverageColorSpec*.

6.1.2 SI_AverageColor Methods

Purpose

Return a specified *SI_AverageColor* value.

Definition

```
CREATE CONSTRUCTOR METHOD SI_AverageColor
  (sourceImage SI_StillImage)
  RETURNS SI_AverageColor
  FOR SI_AverageColor
  BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF06';

    IF sourceImage IS NULL OR
       (sourceImage.SI_content IS NULL AND
        SI_getDLContent(sourceImage.SI_reference) IS NULL) OR
       NOT SI_supportedFeature('SI_AverageColor', sourceImage) = 1 THEN
      SIGNAL InvalidInput
      SET MESSAGE_TEXT =
        'bad input image; average color feature cannot be
        determined';
    END IF;
    --
    -- !! See Description
    --
  END

CREATE CONSTRUCTOR METHOD SI_AverageColor
  (averageColor SI_Color)
  RETURNS SI_AverageColor
  FOR SI_AverageColor
  BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF02';

    IF averageColor IS NULL THEN
      SIGNAL InvalidInput
      SET MESSAGE_TEXT =
        'incorrect average color feature specification';
    END IF;
    RETURN SELF.
    SI_AverageColorSpec(averageColor);
  END
```

Description

- 1) The method *SI_AverageColor(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.
- 2) If any of the following is *True* for an invocation of the method *SI_AverageColor(SI_StillImage)*, then an exception condition is raised: *SQL/MM Still Image exception – bad input image; average color feature cannot be determined*.
 - a) *sourceImage* is the null value.
 - b) *sourceImage.SI_content* is the null value and the result of the function invocation *SI_getDLContent(sourceImage.SI_reference)* is the null value.
 - c) *SI_AverageColor* feature is not supported for *sourceImage*.

- 3) The method *SI_AverageColor(SI_StillImage)* derives an *SI_AverageColor* value from the parameter *sourceImage*. To that end, for each component that is part of the color information for the image, the points in the reference grid are summed separately and the sum for each component is divided by the number of points in the reference grid. The values for each component, thus derived, defined the resulting color value.

NOTE 5 If the *sourceImage.SI_retainFeatures* attribute value is set to 1 (one), then the implementation-dependent attribute that represents the average color feature value in the parameter *sourceImage* may be used to construct the *SI_AverageColor* value.

- 4) The method *SI_AverageColor(SI_Color)* takes the following input parameter:
- a) an *SI_Color* value *averageColor*.
- 5) If the parameters of the method *SI_AverageColor(SI_Color)* is the null value, then an exception condition is raised: *SQL/MM Still Image exception – incorrect average color feature specification*.

6.1.3 SI_Score Method

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_AverageColor* value.

Definition

```
CREATE METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  FOR SI_AverageColor
  BEGIN
    --
    -- !! See Description
    --
  END
```

Description

- 1) The method *SI_Score(SI_StillImage)* takes the following input parameter:
- a) an *SI_StillImage* value *image*.
- 2) The method *SI_Score(SI_StillImage)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better the average color of *image* is characterized by the average color represented by the *SI_AverageColor* value used for scoring *image*.

Case:

- a) If SELF or *image* is the null value, or if *image.SI_content* and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value, or if the average color feature is not supported for *image*, then the null value is returned.
- b) Otherwise, the exact relationship between the values of *SI_AverageColor*, *SI_StillImage* and the result of *SI_Score(SI_StillImage)* is implementation-dependent.

6.1.4 SI_findAvgClr Function

Purpose

Return the *SI_AverageColor* value from an *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_findAvgClr
  (sourceImage SI_StillImage)
  RETURNS SI_AverageColor
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  STATIC DISPATCH
  RETURN NEW SI_AverageColor(sourceImage)
```

Description

- 1) The function *SI_findAvgClr(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.

6.1.5 SI_mkAvgClr Function

Purpose

Return a specified *SI_AverageColor* value.

Definition

```
CREATE FUNCTION SI_mkAvgClr
(averageColor SI_Color)
RETURNS SI_AverageColor
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN NEW SI_AverageColor(averageColor)
```

Description

- 1) The function *SI_mkAvgClr(SI_Color)* takes the following input parameter:
 - a) an *SI_Color* value *averageColor*.

6.1.6 SI_ScoreByAvgClr Function

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_AverageColor* value.

Definition

```
CREATE FUNCTION SI_ScoreByAvgClr
(feature SI_AverageColor,
image SI_StillImage)
RETURNS DOUBLE PRECISION
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN feature.SI_Score(image)
```

Description

- 1) The function *SI_ScoreByAvgClr(SI_AverageColor, SI_StillImage)* takes the following input parameters:
 - a) an *SI_AverageColor* value *feature*,
 - b) an *SI_StillImage* value *image*.

6.2 SI_ColorHistogram Type and Routines

6.2.1 SI_ColorHistogram Type

Purpose

Provide the definition of the feature type *SI_ColorHistogram* and facilities for scoring *SI_StillImage* values using values of the *SI_ColorHistogram* type.

Definition

```

CREATE TYPE SI_ColorHistogram
AS (
    SI_ColorsList SI_Color ARRAY[SI_MaxHistogramLength],
    SI_FrequenciesList
        DOUBLE PRECISION ARRAY[SI_MaxHistogramLength]
)
INSTANTIABLE
NOT FINAL

CONSTRUCTOR METHOD SI_ColorHistogram
(sourceImage SI_StillImage)
RETURNS SI_ColorHistogram
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT,

CONSTRUCTOR METHOD SI_ColorHistogram
(firstColor SI_Color,
 frequency DOUBLE PRECISION)
RETURNS SI_ColorHistogram
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

CONSTRUCTOR METHOD SI_ColorHistogram
(colors SI_Color ARRAY[SI_MaxHistogramLength],
 frequencies DOUBLE PRECISION ARRAY[SI_MaxHistogramLength])
RETURNS SI_ColorHistogram
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_Append
(color SI_Color,
 frequency DOUBLE PRECISION)
RETURNS SI_ColorHistogram
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_Score
(image SI_StillImage)
RETURNS DOUBLE PRECISION
LANGUAGE SQL
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT

```

Definitional Rules

- 1) *SI_MaxHistogramLength* is the implementation-defined maximum number of color/frequency pairs that are admissible in an *SI_ColorHistogram* feature value.

- 2) The attributes *SI_ColorsList* and *SI_FrequenciesList* are not for public use. There are no GRANT statements granting EXECUTE privilege on the observer and mutator functions for the attributes *SI_ColorsList* and *SI_FrequenciesList*.

Description

- 1) The *SI_ColorHistogram* type provides for public use:
 - a) a method *SI_ColorHistogram(SI_StillImage)*,
 - b) a method *SI_ColorHistogram(SI_Color, DOUBLE PRECISION)*,
 - c) a method *SI_ColorHistogram(SI_Color ARRAY, DOUBLE PRECISION ARRAY)*,
 - d) a method *SI_Append(SI_Color, DOUBLE PRECISION)*,
 - e) a method *SI_Score(SI_StillImage)*,
 - f) a function *SI_findClrHstgr(SI_StillImage)*,
 - g) a function *SI_mkClrHstgr(SI_Color, DOUBLE PRECISION)*,
 - h) a function *SI_arrayClrHstgr(SI_Color ARRAY, DOUBLE PRECISION ARRAY)*,
 - i) a function *SI_appendClrHstgr(SI_ColorHistogram, SI_Color, DOUBLE PRECISION)*,
 - j) a function *SI_ScoreByClrHstgr(SI_ColorHistogram, SI_StillImage)*.
- 2) The *SI_ColorHistogram* type represents a sequence of color/frequency pairs using the attributes:
 - a) an *SI_Color* ARRAY value *SI_ColorsList*,
 - b) a DOUBLE PRECISION ARRAY value *SI_FrequenciesList*, the DOUBLE PRECISION values of the array range from 0 (zero) to 100. The *i*-th value in this array is the frequency of the *i*-th color value in *SI_ColorsList*. The arrays *SI_ColorsList* and *SI_FrequenciesList* have the same number of elements.

6.2.2 SI_ColorHistogram Methods

Purpose

Return a specified *SI_ColorHistogram* value.

Definition

```
CREATE CONSTRUCTOR METHOD SI_ColorHistogram
  (sourceImage SI_StillImage)
  RETURNS SI_ColorHistogram
  FOR SI_ColorHistogram
  BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF08';

    IF sourceImage IS NULL OR
       (sourceImage.SI_content IS NULL AND
        SI_getDLContent(sourceImage.SI_reference) IS NULL) OR
       NOT SI_supportedFeature('SI_ColorHistogram', sourceImage) = 1 THEN
      SIGNAL InvalidInput
        SET MESSAGE_TEXT =
          'bad input image; color histogram feature cannot be
           determined';
    END IF;
    --
    -- !! See Description
    --
  END

CREATE CONSTRUCTOR METHOD SI_ColorHistogram
  (firstColor SI_Color,
   frequency DOUBLE PRECISION)
  RETURNS SI_ColorHistogram
  FOR SI_ColorHistogram
```

```

BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF03';

    IF firstColor IS NULL OR
       frequency IS NULL OR
       frequency < 0.0 OR frequency > 100.0 THEN
        SIGNAL InvalidInput
          SET MESSAGE_TEXT =
            'incorrect color histogram feature specification';
    END IF;
    RETURN SELF.
    SI_ColorsList (ARRAY[firstColor]).
    SI_FrequenciesList (ARRAY[frequency]);
END

CREATE CONSTRUCTOR METHOD SI_ColorHistogram
(colors SI_Color ARRAY[SI_MaxHistogramLength],
 frequencies DOUBLE PRECISION ARRAY[SI_MaxHistogramLength])
RETURNS SI_ColorHistogram
FOR SI_ColorHistogram
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF03';
    DECLARE i INTEGER;

    IF colors IS NULL OR
       frequencies IS NULL OR
       CARDINALITY(colors) <> CARDINALITY(frequencies) THEN
        SIGNAL InvalidInput
          SET MESSAGE_TEXT =
            'incorrect color histogram feature specification';
    END IF;
    SET i = 1;
    WHILE i <= CARDINALITY(frequencies) DO
        IF frequencies[i] < 0.0 OR frequencies[i] > 100.0 THEN
            SIGNAL InvalidInput
              SET MESSAGE_TEXT =
                'incorrect color histogram feature specification';
        END IF;
        SET i = i + 1;
    END WHILE;
    RETURN SELF.
    SI_ColorsList (colors).
    SI_FrequenciesList (frequencies);
END

```

Definitional Rules

- 1) *SI_MaxHistogramLength* is the implementation-defined maximum number of color/frequency pairs that are admissible in an *SI_ColorHistogram* feature value.

Description

- 1) The method *SI_ColorHistogram(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.
- 2) If any of the following is *True* for an invocation of the method *SI_ColorHistogram(SI_StillImage)*, then an exception condition is raised: *SQL/MM Still Image exception – bad input image; color histogram feature cannot be determined*.
 - a) *sourceImage* is the null value.
 - b) *sourceImage.SI_content* is the null value and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value.
 - c) *SI_ColorHistogram* feature is not supported for *sourceImage*.

- 3) The method *SI_ColorHistogram(SI_StillImage)* derives an *SI_ColorHistogram* value from the parameter *sourceImage*. To that end, the color space is divided into an implementation-dependent number *N* of areas *A_i*, each of which is represented by some color *C_i*. For *i* ranging from 1 (one) to *N*, let *F_i* be frequency values that are initially all 0 (zero). For each point in the reference grid of *sourceImage*, *F_i* is increased by 1 (one) if the color of that point in the reference grid represents one of the colors of *A_i*. Let *F* be the value that is obtained by summing up all *F_i* values. The final result is effectively a sequence of pairs (*C_i*, (*F_i* / *F*) * 100).

NOTE 6 If the *sourceImage.SI_retainFeatures* attribute value is set to 1 (one), then the implementation-dependent attribute that represents the color histogram feature value in the parameter *sourceImage* may be used to construct the *SI_ColorHistogram* value.

- 4) The method *SI_ColorHistogram(SI_Color, DOUBLE PRECISION)* takes the following input parameters:
- a) an *SI_Color* value *firstColor*,
 - b) a DOUBLE PRECISION value *frequency*.
- 5) If any of the parameters of the method *SI_ColorHistogram(SI_Color, DOUBLE PRECISION)* is the null value, or if the frequency value is less than 0 (zero) or greater than 100, then an exception condition is raised: *SQL/MM Still Image exception – incorrect color histogram feature specification*.
- 6) The method *SI_ColorHistogram(SI_Color ARRAY, DOUBLE PRECISION ARRAY)* takes the following input parameters:
- a) an *SI_Color* ARRAY value *colors*,
 - b) a DOUBLE PRECISION ARRAY value *frequencies*.
- 7) If any of the parameters of the method *SI_ColorHistogram(SI_Color ARRAY, DOUBLE PRECISION ARRAY)* is the null value, or if a frequency value is less than 0 (zero) or greater than 100, or if the cardinalities of the arrays *colors* and *frequencies* are different, then an exception condition is raised: *SQL/MM Still Image exception – incorrect color histogram feature specification*.

6.2.3 SI_Append Method

Purpose

Extend an *SI_ColorHistogram* value by another (*SI_Color*, DOUBLE PRECISION) pair.

Definition

```
CREATE METHOD SI_Append
  (color SI_Color,
   frequency DOUBLE PRECISION)
RETURNS SI_ColorHistogram
FOR SI_ColorHistogram
BEGIN
  DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF03';

  IF CARDINALITY(SELF.SI_ColorsList) = SI_MaxHistogramLength OR
     color IS NULL OR
     frequency IS NULL OR
     frequency < 0.0 OR frequency > 100.0 THEN
    SIGNAL InvalidInput
      SET MESSAGE_TEXT =
        'incorrect color histogram feature specification';
  END IF;
  SET SELF.SI_ColorsList =
    SELF.SI_ColorsList || ARRAY[color];
  SET SELF.SI_FrequenciesList =
    SELF.SI_FrequenciesList || ARRAY[frequency];
  RETURN SELF;
END
```

Definitional Rules

- 1) *SI_MaxHistogramLength* is the implementation-defined maximum number of color/frequency pairs that are admissible in an *SI_ColorHistogram* feature value.

Description

- 1) The method *SI_Append(SI_Color, DOUBLE PRECISION)* takes the following input parameters:
 - a) an *SI_Color* value *color*,
 - b) a DOUBLE PRECISION value *frequency*.
- 2) If the maximum number of color/frequency pairs is already reached, or if any of the parameters is the null value, or if the frequency value is less than 0 (zero) or greater than 100, then an exception condition is raised: *SQL/MM Still Image exception – incorrect color histogram feature specification*.

6.2.4 SI_Score Method**Purpose**

Determine and return the score of an *SI_StillImage* value to a given *SI_ColorHistogram* value.

Definition

```
CREATE METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  FOR SI_ColorHistogram
  BEGIN
    --
    -- !! See Description
    --
  END
```

Description

- 1) The method *SI_Score(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 2) The method *SI_Score(SI_StillImage)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better the color histogram of *image* is characterized by the color histogram represented by the *SI_ColorHistogram* value used for scoring *image*.

Case:

- a) If SELF or *image* is the null value or if *image.SI_content* and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value, or if the color histogram feature is not supported for *image*, then the null value is returned.
- b) Otherwise, the exact relationship between the values of *SI_ColorHistogram*, *SI_StillImage*, and the result of *SI_Score(SI_StillImage)* is implementation-dependent.

6.2.5 SI_findClrHstgr Function**Purpose**

Return the *SI_ColorHistogram* value from an *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_findClrHstgr
  (sourceImage SI_StillImage)
  RETURNS SI_ColorHistogram
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  STATIC DISPATCH
  RETURN NEW SI_ColorHistogram(sourceImage)
```

Description

- 1) The function *SI_findClrHstgr(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.

6.2.6 SI_mkClrHstgr Function

Purpose

Return a specified *SI_ColorHistogram* value.

Definition

```
CREATE FUNCTION SI_mkClrHstgr
    (firstColor SI_Color,
     frequency DOUBLE PRECISION)
RETURNS SI_ColorHistogram
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN NEW SI_ColorHistogram(firstColor, frequency)
```

Description

- 1) The function *SI_mkClrHstgr(SI_Color, DOUBLE PRECISION)* takes the following input parameters:
 - a) an *SI_Color* value *firstColor*,
 - b) a DOUBLE PRECISION value *frequency*.

6.2.7 SI_arrayClrHstgr Function

Purpose

Return a specified *SI_ColorHistogram* value.

Definition

```
CREATE FUNCTION SI_arrayClrHstgr
    (colors SI_Color ARRAY[SI_MaxHistogramLength],
     frequencies DOUBLE PRECISION ARRAY[SI_MaxHistogramLength])
RETURNS SI_ColorHistogram
DETERMINISTIC
READS SQL DATA
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN NEW SI_ColorHistogram(colors, frequencies)
```

Definitional Rules

- 1) *SI_MaxHistogramLength* is the implementation-defined maximum number of color/frequency pairs that are admissible in an *SI_ColorHistogram* feature value.

Description

- 1) The function *SI_arrayClrHstgr(SI_Color ARRAY, DOUBLE PRECISION ARRAY)* takes the following input parameters:
 - a) an *SI_Color ARRAY* value *colors*,
 - b) a DOUBLE PRECISION ARRAY value *frequencies*.

6.2.8 SI_appendClrHstgr Function

Purpose

Extend an *SI_ColorHistogram* value by another (*SI_Color*, DOUBLE PRECISION) pair.

Definition

```
CREATE FUNCTION SI_appendClrHstgr
  (colorHistogram SI_ColorHistogram,
   color SI_Color,
   frequency DOUBLE PRECISION)
RETURNS SI_ColorHistogram
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN colorHistogram.SI_Append(color, frequency)
```

Description

- 1) The function *SI_appendClrHstgr*(*SI_ColorHistogram*, *SI_Color*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_ColorHistogram* value *colorHistogram*,
 - b) an *SI_Color* value *color*,
 - c) a *DOUBLE PRECISION* value *frequency*.

6.2.9 SI_ScoreByClrHstgr Function**Purpose**

Determine and return the score of an *SI_StillImage* value to a given *SI_ColorHistogram* value.

Definition

```
CREATE FUNCTION SI_ScoreByClrHstgr
  (feature SI_ColorHistogram,
   image SI_StillImage)
RETURNS DOUBLE PRECISION
DETERMINISTIC
READS SQL DATA
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN feature.SI_Score(image)
```

Description

- 1) The function *SI_ScoreByClrHstgr*(*SI_ColorHistogram*, *SI_StillImage*) takes the following input parameters:
 - a) an *SI_ColorHistogram* value *feature*,
 - b) an *SI_StillImage* value *image*.

6.3 SI_PositionalColor Type and Routines**6.3.1 SI_PositionalColor Type****Purpose**

Provide the definition of the feature type *SI_PositionalColor* and facilities for scoring *SI_StillImage* values using values of the *SI_PositionalColor* type.

Definition

```
CREATE TYPE SI_PositionalColor
AS (
  SI_ColorPositions
  SI_Color ARRAY[SI_NumberSections]
)
INSTANTIABLE
NOT FINAL
```

```

CONSTRUCTOR METHOD SI_PositionalColor
  (sourceImage SI_StillImage)
  RETURNS SI_PositionalColor
  SELF AS RESULT
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT,

METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT

```

Definitional Rules

- 1) *SI_NumberSections* is the implementation-defined number of *SI_AverageColor* values that are represented by an *SI_PositionalColor* value.
- 2) The attribute *SI_ColorPositions* is not for public use. There are no GRANT statements granting EXECUTE privilege on the observer and mutator functions for the attribute *SI_ColorPositions*.

Description

- 1) The *SI_PositionalColor* type provides for public use:
 - a) a method *SI_PositionalColor(SI_StillImage)*,
 - b) a method *SI_Score(SI_StillImage)*,
 - c) a function *SI_findPstnlClr(SI_StillImage)*,
 - d) a function *SI_ScoreByPstnlClr(SI_PositionalColor, SI_StillImage)*.
- 2) The *SI_PositionalColor* type represents lists of *SI_Color* values using the attribute:
 - a) an *SI_Color* ARRAY value *SI_ColorPositions*.

6.3.2 SI_PositionalColor Method

Purpose

Return the *SI_PositionalColor* value from an *SI_StillImage* value.

Definition

```

CREATE CONSTRUCTOR METHOD SI_PositionalColor
  (sourceImage SI_StillImage)
  RETURNS SI_PositionalColor
  FOR SI_PositionalColor
  BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF07';

    IF sourceImage IS NULL OR
       (sourceImage.SI_content IS NULL AND
        SI_getDLContent(sourceImage.SI_reference) IS NULL) OR
       NOT
         SI_supportedFeature('SI_PositionalColor', sourceImage) = 1 THEN
      SIGNAL InvalidInput
      SET MESSAGE_TEXT =
        'bad input image; positional color feature cannot be
         determined';
    END IF;
    --
    -- !! See Description
    --
  END
END

```

Description

- 1) The method *SI_PositionalColor(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.
- 2) If any of the following is *True* for an invocation of the method *SI_PositionalColor(SI_StillImage)*, then an exception condition is raised: *SQL/MM Still Image exception – bad input image; positional color feature cannot be determined*.
 - a) *sourceImage* is the null value.
 - b) *sourceImage.SI_content* is the null value and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value.
 - c) *SI_PositionalColor* feature is not supported for *sourceImage*.
- 3) The method *SI_PositionalColor(SI_StillImage)* derives an *SI_PositionalColor* value from the parameter *sourceImage*. To that end, *sourceImage* is effectively divided into *n* by *m* rectangles, such that the product of *n* and *m* equals *SI_NumberSections*. For each rectangle, the most significant color is implementation-defined. The array, thus computed, of color values which represent the most significant colors is the *SI_ColorPositions* value of the returned *SI_PositionalColor* value. Further details on the relationship between *sourceImage* and the resulting *SI_PositionalColor* value, such as the values *n* and *m*, are implementation-dependent.

NOTE 7 If the *sourceImage.SI_retainFeatures* attribute value is set to 1 (one), then the implementation-dependent attribute that represents the positional color feature value in the parameter *sourceImage* may be used to construct the *SI_PositionalColor* value.

NOTE 8 The color histograms, from which the color values representing the most significant color for each rectangle are derived, are determined as described in Subclause 6.2.2, "SI_ColorHistogram Methods" Description 3), for the method *SI_ColorHistogram(SI_StillImage)*.

6.3.3 SI_Score Method

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_PositionalColor* value.

Definition

```
CREATE METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  FOR SI_PositionalColor
  BEGIN
    --
    -- !! See Description
    --
  END
```

Description

- 1) The method *SI_Score(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 2) The method *SI_Score(SI_StillImage)* returns a value greater than or equal to 0 (zero). For scoring *image*, that still image is effectively divided into *n* by *m* rectangles, such that the product of *n* and *m* equals *SI_NumberSections*. For each rectangle, the most significant color is implementation-defined. The lower the returned value, the better the *n* by *m* most significant colors of *image* are characterized by the most significant colors represented by the *SI_PositionalColor* value used for scoring *image*.

NOTE 9 The way in which *image* is divided into *SI_NumberSections* of rectangles is implementation-dependent, as well *n* and *m* itself. However, the division shall be performed in the same fashion for the *SI_Score* method and the method *SI_PositionalColor(SI_StillImage)*.

Case:

- a) If SELF or *image* is the null value, or if *image.SI_content* and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value, or if the positional color feature is not supported for *image*, then the null value is returned.
- b) Otherwise, the exact relationship between the values of *SI_PositionalColor*, *SI_StillImage* and the result of *SI_Score(SI_StillImage)* is implementation-dependent.

6.3.4 SI_findPstnlClr Function

Purpose

Return the *SI_PositionalColor* value from an *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_findPstnlClr
  (sourceImage SI_StillImage)
  RETURNS SI_PositionalColor
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  STATIC DISPATCH
  RETURN NEW SI_PositionalColor(sourceImage)
```

Description

- 1) The function *SI_findPstnlClr(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.

6.3.5 SI_ScoreByPstnlClr Function

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_PositionalColor* value.

Definition

```
CREATE FUNCTION SI_ScoreByPstnlClr
  (feature SI_PositionalColor,
   image SI_StillImage)
  RETURNS DOUBLE PRECISION
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN feature.SI_Score(image)
```

Description

- 1) The function *SI_ScoreByPstnlClr(SI_PositionalColor, SI_StillImage)* takes the following input parameters:
 - a) an *SI_PositionalColor* value *feature*,
 - b) an *SI_StillImage* value *image*.

6.4 SI_Texture Type and Routines

6.4.1 SI_Texture Type

Purpose

Provide the definition of the feature type *SI_Texture* and facilities for scoring *SI_StillImage* values using values of the *SI_Texture* type.

Definition

```

CREATE TYPE SI_Texture
AS (
    SI_TextureEncoding CHARACTER VARYING(SI_MaxTextureLength)
)
INSTANTIABLE
NOT FINAL

CONSTRUCTOR METHOD SI_Texture
    (sourceImage SI_StillImage)
    RETURNS SI_Texture
    SELF AS RESULT
    LANGUAGE SQL
    DETERMINISTIC
    READS SQL DATA
    CALLED ON NULL INPUT,

METHOD SI_Score
    (image SI_StillImage)
    RETURNS DOUBLE PRECISION
    LANGUAGE SQL
    DETERMINISTIC
    READS SQL DATA
    RETURNS NULL ON NULL INPUT

```

Definitional Rules

- 1) *SI_MaxTextureLength* is the implementation-defined number of bytes needed for the implementation-defined encoded representation of an *SI_Texture*.
- 2) The attribute *SI_TextureEncoding* is not for public use. There are no GRANT statements granting EXECUTE privilege on the observer and mutator functions for the attribute *SI_TextureEncoding*.

Description

- 1) The *SI_Texture* type provides for public use:
 - a) a method *SI_Texture(SI_StillImage)*,
 - b) a method *SI_Score(SI_StillImage)*,
 - c) a function *SI_findTexture(SI_StillImage)*,
 - d) a function *SI_ScoreByTexture(feature SI_Texture, image SI_StillImage)*.
- 2) The *SI_Texture* type provides for the representation of image textures using the attribute:
 - a) a CHARACTER VARYING value *SI_TextureEncoding*, the values of which represents image texture characteristics such as coarseness, contrast, and directionality in an implementation-dependent fashion.

6.4.2 SI_Texture Method**Purpose**

Return the *SI_Texture* value from an *SI_StillImage* value.

Definition

```

CREATE CONSTRUCTOR METHOD SI_Texture
    (sourceImage SI_StillImage)
    RETURNS SI_Texture
    FOR SI_Texture
    BEGIN
        DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF09';

```

```

IF sourceImage IS NULL OR
  (sourceImage.SI_content IS NULL AND
   SI_getDLContent(sourceImage.SI_reference) IS NULL) OR
  NOT SI_supportedFeature('SI_Texture', sourceImage) = 1 THEN
  SIGNAL InvalidInput
    SET MESSAGE_TEXT =
      'bad input image; texture feature cannot be determined';
END IF;
--
-- !! See Description
--
END

```

Definition

- 1) The method *SI_Texture(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.
- 2) If any of the following is *True* for an invocation of the method *SI_Texture(SI_StillImage)*, then an exception condition is raised: *SQL/MM Still Image exception – bad input image; texture feature cannot be determined*.
 - a) *sourceImage* is the null value.
 - b) *sourceImage.SI_content* is the null value and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value.
 - c) *SI_Texture* feature is not supported for *sourceImage*.
- 3) The method *SI_Texture(SI_StillImage)* derives an *SI_Texture* value from the parameter *sourceImage*. The relationship between *sourceImage* and the resulting *SI_Texture* value is implementation-dependent.

NOTE 10 If the *sourceImage.SI_retainFeatures* attribute value is set to 1 (one), then the implementation-dependent attribute that represents the texture feature value in the parameter *sourceImage* may be used to construct the *SI_Texture* value.

6.4.3 SI_Score Method

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_Texture* value.

Definition

```

CREATE METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  FOR SI_Texture
  BEGIN
    --
    -- !! See Description
    --
  END

```

Description

- 1) The method *SI_Score(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 2) The method *SI_Score(SI_StillImage)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better the texture of *image* is characterized by the *SI_Texture* value used for scoring *image*.

Case:

- a) If SELF or *image* is the null value, or if *image.SI_content* and the result of the function invocation *SI_getDLContent(image.SI_reference)* is the null value, or if the texture feature is not supported for *image*, then the null value is returned.

- b) Otherwise, the exact relationship between the values of *SI_Texture*, *SI_StillImage* and the result of *SI_Score(SI_StillImage)* is implementation-dependent.

6.4.4 SI_findTexture Function

Purpose

Return the *SI_Texture* value from an *SI_StillImage* value.

Definition

```
CREATE FUNCTION SI_findTexture
  (sourceImage SI_StillImage)
  RETURNS SI_Texture
  DETERMINISTIC
  READS SQL DATA
  CALLED ON NULL INPUT
  STATIC DISPATCH
  RETURN NEW SI_Texture(sourceImage)
```

Description

- 1) The function *SI_findTexture(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *sourceImage*.

6.4.5 SI_ScoreByTexture Function

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_Texture* value.

Definition

```
CREATE FUNCTION SI_ScoreByTexture
  (feature SI_Texture,
   image SI_StillImage)
  RETURNS DOUBLE PRECISION
  DETERMINISTIC
  READS SQL DATA
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN feature.SI_Score(image)
```

Description

- 1) The function *SI_ScoreByTexture(SI_Texture, SI_StillImage)* takes the following input parameters:
 - a) an *SI_Texture* value *feature*,
 - b) an *SI_StillImage* value *image*.

6.5 SI_FeatureList Type and Routines

6.5.1 SI_FeatureList Type

Purpose

Provide the definition of the type *SI_FeatureList* and facilities for scoring *SI_StillImage* values using values of the *SI_FeatureList* type.

Definition

```
CREATE TYPE SI_FeatureList
  AS (
    SI_AvgClrFtr SI_AverageColor,
    SI_AvgClrFtrWght DOUBLE PRECISION DEFAULT 0.0,
    SI_ClrHstgrFtr SI_ColorHistogram,
    SI_ClrHstgrFtrWght DOUBLE PRECISION DEFAULT 0.0,
```

```

    SI_PstnlClrFtr SI_PositionalColor,
    SI_PstnlClrFtrWght DOUBLE PRECISION DEFAULT 0.0,
    SI_TextureFtr SI_Texture,
    SI_TextureFtrWght DOUBLE PRECISION DEFAULT 0.0
)
INSTANTIABLE
NOT FINAL

CONSTRUCTOR METHOD SI_FeatureList
(averageColorFeature SI_AverageColor,
 averageColorFeatureWeight DOUBLE PRECISION,
 colorHistogramFeature SI_ColorHistogram,
 colorHistogramFeatureWeight DOUBLE PRECISION,
 positionalColorFeature SI_PositionalColor,
 positionalColorFeatureWeight DOUBLE PRECISION,
 textureFeature SI_Texture,
 textureFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_setFeature
(averageColorFeature SI_AverageColor,
 averageColorFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_setFeature
(colorHistogramFeature SI_ColorHistogram,
 colorHistogramFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_setFeature
(positionalColorFeature SI_PositionalColor,
 positionalColorFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

METHOD SI_setFeature
(textureFeature SI_Texture,
 textureFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT,

```

```

METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  LANGUAGE SQL
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT

```

Definitional Rules

- 1) There are no GRANT statements granting EXECUTE privilege on the mutator functions for the attributes *SI_AvgClrFtr*, *SI_AvgClrFtrWght*, *SI_ClrHstgrFtr*, *SI_ClrHstgrFtrWght*, *SI_PstnlClrFtr*, *SI_PstnlClrFtrWght*, *SI_TextureFtr*, and *SI_TextureFtrWght*.

Description

- 1) The *SI_FeatureList* type provides for public use:
 - a) a method *SI_FeatureList*(*SI_AverageColor*, DOUBLE PRECISION, *SI_ColorHistogram*, DOUBLE PRECISION, *SI_PositionalColor*, DOUBLE PRECISION, *SI_Texture*, DOUBLE PRECISION),
 - b) a method *SI_setFeature*(*SI_AverageColor*, DOUBLE PRECISION),
 - c) a method *SI_setFeature*(*SI_ColorHistogram*, DOUBLE PRECISION),
 - d) a method *SI_setFeature*(*SI_PositionalColor*, DOUBLE PRECISION),
 - e) a method *SI_setFeature*(*SI_Texture*, DOUBLE PRECISION),
 - f) a method *SI_Score*(*SI_StillImage*),
 - g) a function *SI_mkFtrList*(*SI_AverageColor*, DOUBLE PRECISION, *SI_ColorHistogram*, DOUBLE PRECISION, *SI_PositionalColor*, DOUBLE PRECISION, *SI_Texture*, DOUBLE PRECISION),
 - h) a function *SI_setAvgClrFtr*(*SI_FeatureList*, *SI_AverageColor*, DOUBLE PRECISION),
 - i) a function *SI_setClrHstgrFtr*(*SI_FeatureList*, *SI_ColorHistogram*, DOUBLE PRECISION),
 - j) a function *SI_setPstnlClrFtr*(*SI_FeatureList*, *SI_PositionalColor*, DOUBLE PRECISION),
 - k) a function *SI_setTextureFtr*(*SI_FeatureList*, *SI_Texture*, DOUBLE PRECISION),
 - l) a function *SI_ScoreByFtrList*(*SI_FeatureList*, *SI_StillImage*).
- 2) The *SI_FeatureList* type represents a list of weighted features using the attributes:
 - a) an *SI_AverageColor* value *SI_AvgClrFtr*,
 - b) a DOUBLE PRECISION value *SI_AvgClrFtrWght*,
 - c) an *SI_ColorHistogram* value *SI_ClrHstgrFtr*,
 - d) a DOUBLE PRECISION value *SI_ClrHstgrFtrWght*,
 - e) an *SI_PositionalColor* value *SI_PstnlClrFtr*,
 - f) a DOUBLE PRECISION value *SI_PstnlClrFtrWght*,
 - g) an *SI_Texture* value *SI_TextureFtr*,
 - h) a DOUBLE PRECISION value *SI_TextureFtrWght*.

6.5.2 SI_FeatureList Method

Purpose

Return a specified *SI_FeatureList* value.

Definition

```

CREATE CONSTRUCTOR METHOD SI_FeatureList
  (averageColorFeature SI_AverageColor,
   averageColorFeatureWeight DOUBLE PRECISION,
   colorHistogramFeature SI_ColorHistogram,

```

```

colorHistogramFeatureWeight DOUBLE PRECISION,
positionalColorFeature SI_PositionalColor,
positionalColorFeatureWeight DOUBLE PRECISION,
textureFeature SI_Texture,
textureFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
FOR SI_FeatureList
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF04';
    IF averageColorFeature IS NOT NULL AND
        (averageColorFeatureWeight IS NULL OR
         averageColorFeatureWeight < 0.0) OR
        colorHistogramFeature IS NOT NULL AND
        (colorHistogramFeatureWeight IS NULL OR
         colorHistogramFeatureWeight < 0.0) OR
        positionalColorFeature IS NOT NULL AND
        (positionalColorFeatureWeight IS NULL OR
         positionalColorFeatureWeight < 0.0) OR
        textureFeature IS NOT NULL AND
        (textureFeatureWeight IS NULL OR
         textureFeatureWeight < 0.0) THEN
        SIGNAL InvalidInput
        SET MESSAGE_TEXT = 'incorrect feature list specification';
    END IF;
    RETURN SELF.
    SI_AvgClrFtr(averageColorFeature).
    SI_AvgClrFtrWght(
        CASE
            WHEN averageColorFeature IS NULL THEN 0.0
            ELSE averageColorFeatureWeight
        END).
    SI_ClrHstgrFtr(colorHistogramFeature).
    SI_ClrHstgrFtrWght(
        CASE
            WHEN colorHistogramFeature IS NULL THEN 0.0
            ELSE colorHistogramFeatureWeight
        END).
    SI_PstnlClrFtr(positionalColorFeature).
    SI_PstnlClrFtrWght(
        CASE
            WHEN positionalColorFeature IS NULL THEN 0.0
            ELSE positionalColorFeatureWeight
        END).
    SI_TextureFtr(textureFeature).
    SI_TextureFtrWght(
        CASE
            WHEN textureFeature IS NULL THEN 0.0
            ELSE textureFeatureWeight
        END);
END

```

Description

- 1) The method *SI_FeatureList*(*SI_AverageColor*, *DOUBLE PRECISION*, *SI_ColorHistogram*, *DOUBLE PRECISION*, *SI_PositionalColor*, *DOUBLE PRECISION*, *SI_Texture*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_AverageColor* value *averageColorFeature*,
 - b) a *DOUBLE PRECISION* value *averageColorFeatureWeight*,
 - c) an *SI_ColorHistogram* value *colorHistogramFeature*,

- d) a DOUBLE PRECISION value *colorHistogramFeatureWeight*,
 - e) an *SI_PositionalColor* value *positionalColorFeature*,
 - f) a DOUBLE PRECISION value *positionalColorFeatureWeight*,
 - g) an *SI_Texture* value *textureFeature*,
 - h) a DOUBLE PRECISION value *textureFeatureWeight*.
- 2) If any of the parameters *averageColorFeature*, *colorHistogramFeature*, *positionalColorFeature*, or *textureFeature* is not the null value and any of the corresponding parameters *averageColorFeatureWeight*, *colorHistogramFeatureWeight*, *positionalColorFeatureWeight*, or *textureFeatureWeight* is the null value or less than 0 (zero), then an exception condition is raised: *SQL/MM Still Image exception – incorrect feature list specification*.
- 3) If any of the parameters *averageColorFeature*, *colorHistogramFeature*, *positionalColorFeature*, or *textureFeature* is the null value, then the attribute value of *SI_AvgClrFtrWght*, *SI_ClrHstgFtrWght*, *SI_PstnlClrFtrWght*, or *SI_TextureFtrWght*, respectively, is set to 0 (zero), disregarding the value of the respective parameter *averageColorFeatureWeight*, *colorHistogramFeatureWeight*, *positionalColorFeatureWeight*, or *textureFeatureWeight*.

6.5.3 SI_setFeature Methods

Purpose

Modify a designated feature attribute and the corresponding weight attribute of an *SI_FeatureList* value.

Definition

```
CREATE METHOD SI_setFeature
(averageColorFeature SI_AverageColor,
 averageColorFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
FOR SI_FeatureList
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF04';

    IF averageColorFeature IS NOT NULL AND
        (averageColorFeatureWeight IS NULL OR
         averageColorFeatureWeight < 0.0) THEN
        SIGNAL InvalidInput
            SET MESSAGE_TEXT = 'incorrect feature list specification';
    END IF;
    RETURN SELF.
        SI_AvgClrFtr(averageColorFeature).
        SI_AvgClrFtrWght(
            CASE
                WHEN averageColorFeature IS NULL THEN 0.0
                ELSE averageColorFeatureWeight
            END);
END

CREATE METHOD SI_setFeature
(colorHistogramFeature SI_ColorHistogram,
 colorHistogramFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
FOR SI_FeatureList
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF04';

    IF colorHistogramFeature IS NOT NULL AND
        (colorHistogramFeatureWeight IS NULL OR
         colorHistogramFeatureWeight < 0.0) THEN
        SIGNAL InvalidInput
            SET MESSAGE_TEXT = 'incorrect feature list specification';
```

```

END IF;
RETURN SELF.
    SI_ClrHstgrFtr(colorHistogramFeature).
    SI_ClrHstgrFtrWght(
        CASE
            WHEN colorHistogramFeature IS NULL THEN 0.0
            ELSE colorHistogramFeatureWeight
        END);
END

CREATE METHOD SI_setFeature
    (positionalColorFeature SI_PositionalColor,
     positionalColorFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
FOR SI_FeatureList
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF04';

    IF positionalColorFeature IS NOT NULL AND
       (positionalColorFeatureWeight IS NULL OR
        positionalColorFeatureWeight < 0.0) THEN
        SIGNAL InvalidInput
        SET MESSAGE_TEXT = 'incorrect feature list specification';
    END IF;
    RETURN SELF.
    SI_ClrHstgrFtr(positionalColorFeature).
    SI_ClrHstgrFtrWght(
        CASE
            WHEN positionalColorFeature IS NULL THEN 0.0
            ELSE positionalColorFeatureWeight
        END);
END

CREATE METHOD SI_setFeature
    (textureFeature SI_Texture,
     textureFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
FOR SI_FeatureList
BEGIN
    DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF04';

    IF textureFeature IS NOT NULL AND
       (textureFeatureWeight IS NULL OR
        textureFeatureWeight < 0.0) THEN
        SIGNAL InvalidInput
        SET MESSAGE_TEXT = 'incorrect feature list specification';
    END IF;
    RETURN SELF.
    SI_ClrHstgrFtr(textureFeature).
    SI_ClrHstgrFtrWght(
        CASE
            WHEN textureFeature IS NULL THEN 0.0
            ELSE textureFeatureWeight
        END);
END

```

Description

- 1) The method *SI_setFeature(SI_AverageColor, DOUBLE PRECISION)* takes the following input parameters:
 - a) an *SI_AverageColor* value *averageColorFeature*,
 - b) a DOUBLE PRECISION value *averageColorFeatureWeight*.

2) For the method *SI_setFeature(SI_AverageColor, DOUBLE PRECISION)*:

Case:

- a) If the parameter *averageColorFeature* is not the null value and the parameter *averageColorFeatureWeight* is the null value or less than 0 (zero), then an exception condition is raised: *SQL/MM Still Image exception – incorrect feature list specification*.
- b) If the parameter *averageColorFeature* is the null value, then the attribute value of *SI_AvgClrFtrWght* is set to 0 (zero), disregarding the value of the parameter *averageColorFeatureWeight*.

3) The method *SI_setFeature(SI_ColorHistogram, DOUBLE PRECISION)* takes the following input parameters:

- a) an *SI_ColorHistogram* value *colorHistogramFeature*,
- b) a DOUBLE PRECISION value *colorHistogramFeatureWeight*.

4) For the method *SI_setFeature(SI_ColorHistogram, DOUBLE PRECISION)*:

Case:

- a) If the parameter *colorHistogramFeature* is not the null value and the parameter *colorHistogramFeatureWeight* is the null value or less than 0 (zero), then an exception condition is raised: *SQL/MM Still Image exception – incorrect feature list specification*.
- b) If the parameter *colorHistogramFeature* is the null value, then the attribute value of *SI_ClrHstgrFtrWght* is set to 0 (zero), disregarding the value of the parameter *colorHistogramFeatureWeight*.

5) The method *SI_setFeature(SI_PositionalColor, DOUBLE PRECISION)* takes the following input parameters:

- a) an *SI_PositionalColor* value *positionalColorFeature*,
- b) a DOUBLE PRECISION value *positionalColorFeatureWeight*.

6) For the method *SI_setFeature(SI_PositionalColor, DOUBLE PRECISION)*:

Case:

- a) If the parameter *positionalColorFeature* is not the null value and the parameter *positionalColorFeatureWeight* is the null value or is less than 0 (zero), then an exception condition is raised: *SQL/MM Still Image exception – incorrect feature list specification*.
- b) If the parameter *positionalColorFeature* is the null value, then the attribute value of *SI_PstnlClrFtrWght* is set to 0 (zero), disregarding the value of the parameter *positionalColorFeatureWeight*.

7) The method *SI_setFeature(SI_Texture, DOUBLE PRECISION)* takes the following input parameters:

- a) an *SI_Texture* value *textureFeature*,
- b) a DOUBLE PRECISION value *textureFeatureWeight*.

8) For the method *SI_setFeature(SI_Texture, DOUBLE PRECISION)*:

Case:

- a) If the parameter *textureFeature* is not the null value and the parameter *textureFeatureWeight* is the null value or less than 0 (zero), then an exception condition is raised: *SQL/MM Still Image exception – incorrect feature list specification*.
- b) If the parameter *textureFeature* is the null value, then the attribute value of *SI_TextureFtrWght* is set to 0 (zero), disregarding the value of the parameter *textureFeatureWeight*.

6.5.4 SI_Score Method

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_FeatureList* value.

Definition

```

CREATE METHOD SI_Score
  (image SI_StillImage)
  RETURNS DOUBLE PRECISION
  FOR SI_FeatureList
  BEGIN
    DECLARE totalWeight DOUBLE PRECISION;
    DECLARE scoreResult DOUBLE PRECISION;

    IF SELF.SI_AvgClrFtr IS NULL AND
       SELF.SI_ClrHstgrFtr IS NULL AND
       SELF.SI_PstnlClrFtr IS NULL AND
       SELF.SI_TextureFtr IS NULL THEN
      RETURN CAST (NULL AS DOUBLE PRECISION);
    END IF;
    SET totalWeight = SI_AvgClrFtrWght + SI_ClrHstgrFtrWght +
      SI_PstnlClrFtrWght + SI_TextureFtrWght;
    IF totalWeight = 0.0 THEN
      RETURN CAST (NULL AS DOUBLE PRECISION);
    END IF;
    SET scoreResult = 0.0;
    IF SELF.SI_AvgClrFtr IS NOT NULL THEN
      SET scoreResult = scoreResult +
        SELF.SI_AvgClrFtr.SI_Score(image) * SI_AvgClrFtrWght;
    END IF;
    IF SELF.SI_ClrHstgrFtr IS NOT NULL THEN
      SET scoreResult = scoreResult +
        SELF.ClrHstgrFtr.SI_Score(image) * SI_ClrHstgrFtrWght;
    END IF;
    IF SELF.SI_PstnlClrFtr IS NOT NULL THEN
      SET scoreResult = scoreResult +
        SELF.PstnlClrFtr.SI_Score(image) * SI_PstnlClrFtrWght;
    END IF;
    IF SELF.SI_TextureFtr IS NOT NULL THEN
      SET scoreResult = scoreResult +
        SELF.TextureFtr.SI_Score(image) * SI_TextureFtrWght;
    END IF;
    RETURN scoreResult/totalWeight;
  END

```

Description

- 1) The method *SI_Score(SI_StillImage)* takes the following input parameter:
 - a) an *SI_StillImage* value *image*.
- 2) The method *SI_Score(SI_StillImage)* returns the null value if one of the following is true:
 - a) SELF is the null value.
 - b) *image* is the null value.
 - c) The values *SELF.SI_AvgClrFtr*, *SELF.SI_ClrHstgrFtr*, *SELF.SI_PstnlClrFtr*, and *SELF.SI_TextureFtr* are all the null value.
 - d) The sum of *SELF.SI_AvgClrFtrWght*, *SELF.SI_ClrHstgrFtrWght*, *SELF.SI_PstnlClrFtrWght*, and *SELF.SI_TextureFtrWght* is 0 (zero).
- 3) The method *SI_Score(SI_StillImage)* returns a value greater than or equal to 0 (zero). The lower the returned value, the better *image* is characterized by the *SI_FeatureList* value used for scoring *image*. Let *N* be the number of feature attributes of SELF that are not the null value. For *i* ranging from 1 (one) to *N*, let *F_i* be the value of that attribute, and *W_i* the value of the corresponding weight attribute. Then the result is:

$$\frac{\sum_{i=1}^N F_i \cdot SI_Score(image) \cdot W_i}{\sum_{i=1}^N W_i}$$

6.5.5 SI_mkFtrList Function

Purpose

Return a specified *SI_FeatureList* value.

Definition

```
CREATE FUNCTION SI_mkFtrList
(
    averageColorFeature SI_AverageColor,
    averageColorFeatureWeight DOUBLE PRECISION,
    colorHistogramFeature SI_ColorHistogram,
    colorHistogramFeatureWeight DOUBLE PRECISION,
    positionalColorFeature SI_PositionalColor,
    positionalColorFeatureWeight DOUBLE PRECISION,
    textureFeature SI_Texture,
    textureFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN NEW SI_FeatureList
(
    averageColorFeature, averageColorFeatureWeight,
    colorHistogramFeature, colorHistogramFeatureWeight,
    positionalColorFeature, positionalColorFeatureWeight,
    textureFeature, textureFeatureWeight)
```

Description

- 1) The function *SI_mkFtrList*(*SI_AverageColor*, *DOUBLE PRECISION*, *SI_ColorHistogram*, *DOUBLE PRECISION*, *SI_PositionalColor*, *DOUBLE PRECISION*, *SI_Texture*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_AverageColor* value *averageColorFeature*,
 - b) a *DOUBLE PRECISION* value *averageColorFeatureWeight*,
 - c) an *SI_ColorHistogram* value *colorHistogramFeature*,
 - d) a *DOUBLE PRECISION* value *colorHistogramFeatureWeight*,
 - e) an *SI_PositionalColor* value *positionalColorFeature*,
 - f) a *DOUBLE PRECISION* value *positionalColorFeatureWeight*,
 - g) an *SI_Texture* value *textureFeature*,
 - h) a *DOUBLE PRECISION* value *textureFeatureWeight*.

6.5.6 SI_ScoreByFtrList Function

Purpose

Determine and return the score of an *SI_StillImage* value to a given *SI_FeatureList* value.

Definition

```
CREATE FUNCTION SI_ScoreByFtrList
(
    feature SI_FeatureList,
    image SI_StillImage)
RETURNS DOUBLE PRECISION
DETERMINISTIC
CONTAINS SQL
RETURNS NULL ON NULL INPUT
STATIC DISPATCH
RETURN feature.SI_Score(image)
```

Description

1) The function *SI_ScoreByFtrList*(*SI_FeatureList*, *SI_StillImage*) takes the following input parameters:

- a) an *SI_FeatureList* value *feature*,
- b) an *SI_StillImage* value *image*.

6.5.7 Regular Functions Complementing SI_setFeature Methods**Purpose**

Modify a designated feature attribute and the corresponding weight attribute of an *SI_FeatureList* value.

Definition

```
CREATE FUNCTION SI_setAvgClrFtr
  (featureList SI_FeatureList,
   averageColorFeature SI_AverageColor,
   averageColorFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN featureList.
    SI_setFeature(averageColorFeature, averageColorFeatureWeight)

CREATE FUNCTION SI_setClrHstgrFtr
  (featureList SI_FeatureList,
   colorHistogramFeature SI_ColorHistogram,
   colorHistogramFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN featureList.
    SI_setFeature(colorHistogramFeature, colorHistogramFeatureWeight)

CREATE FUNCTION SI_setPstnlClrFtr
  (featureList SI_FeatureList,
   positionalColorFeature SI_PositionalColor,
   positionalColorFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN featureList.
    SI_setFeature(positionalColorFeature, positionalColorFeatureWeight)

CREATE FUNCTION SI_setTextureFtr
  (featureList SI_FeatureList,
   textureFeature SI_Texture,
   textureFeatureWeight DOUBLE PRECISION)
RETURNS SI_FeatureList
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
STATIC DISPATCH
RETURN featureList.
    SI_setFeature(textureFeature, textureFeatureWeight)
```

Description

- 1) The function *SI_setAvgClrFtr*(*SI_FeatureList*, *SI_AverageColor*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_FeatureList* value *featureList*,
 - b) an *SI_AverageColor* value *averageColorFeature*,
 - c) a *DOUBLE PRECISION* value *averageColorFeatureWeight*.
- 2) The function *SI_setClrHstgrFtr*(*SI_FeatureList*, *SI_ColorHistogram*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_FeatureList* value *featureList*,
 - b) an *SI_ColorHistogram* value *colorHistogramFeature*,
 - c) a *DOUBLE PRECISION* value *colorHistogramFeatureWeight*.
- 3) The function *SI_setPstnlClrW*(*SI_FeatureList*, *SI_PositionalColor*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_FeatureList* value *featureList*,
 - b) an *SI_PositionalColor* value *positionalColorFeature*,
 - c) a *DOUBLE PRECISION* value *positionalColorFeatureWeight*.
- 4) The function *SI_setTextureW*(*SI_FeatureList*, *SI_Texture*, *DOUBLE PRECISION*) takes the following input parameters:
 - a) an *SI_FeatureList* value *featureList*,
 - b) an *SI_Texture* value *textureFeature*,
 - c) a *DOUBLE PRECISION* value *textureFeatureWeight*.

6.5.8 Regular Functions Complementing Observer Functions of type SI_FeatureList**Purpose**

Obtain the value of a designated attribute from an *SI_FeatureList* value.

Definition

```

CREATE FUNCTION SI_getAvgClrFtr
  (featureList SI_FeatureList)
  RETURNS SI_AverageColor
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_AvgClrFtr

CREATE FUNCTION SI_getAvgClrFtrW
  (featureList SI_FeatureList)
  RETURNS DOUBLE PRECISION
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_AvgClrFtrWght

CREATE FUNCTION SI_getClrHstgrFtr
  (featureList SI_FeatureList)
  RETURNS SI_ColorHistogram
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_ClrHstgrFtr

```

```

CREATE FUNCTION SI_getClrHstgrFtrW
  (featureList SI_FeatureList)
  RETURNS DOUBLE PRECISION
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_ClrHstgrFtrWght

CREATE FUNCTION SI_getPstnlClrFtr
  (featureList SI_FeatureList)
  RETURNS SI_PositionalColor
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_PstnlClrFtr

CREATE FUNCTION SI_getPstnlClrFtrW
  (featureList SI_FeatureList)
  RETURNS DOUBLE PRECISION
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_PstnlClrFtrWght

CREATE FUNCTION SI_getTextureFtr
  (featureList SI_FeatureList)
  RETURNS SI_Texture
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_TextureFtr

CREATE FUNCTION SI_getTextureFtrW
  (featureList SI_FeatureList)
  RETURNS DOUBLE PRECISION
  DETERMINISTIC
  CONTAINS SQL
  RETURNS NULL ON NULL INPUT
  STATIC DISPATCH
  RETURN featureList.SI_TextureFtrWght

```

Description

- 1) The function *SI_getAvgClrFtr(SI_FeatureList)* takes the following input parameter:
 - a) an *SI_FeatureList* value *featureList*.
- 2) The function *SI_getAvgClrFtrW(SI_FeatureList)* takes the following input parameter:
 - a) an *SI_FeatureList* value *featureList*.
- 3) The function *SI_getClrHstgrFtr(SI_FeatureList)* takes the following input parameter:
 - a) an *SI_FeatureList* value *featureList*.
- 4) The function *SI_getClrHstgrFtrW(SI_FeatureList)* takes the following input parameter:
 - a) an *SI_FeatureList* value *featureList*.
- 5) The function *SI_getPstnlClrFtr(SI_FeatureList)* takes the following input parameter:
 - a) an *SI_FeatureList* value *featureList*.

- 6) The function *SI_getPstnlClrFtrW(SI_FeatureList)* takes the following input parameter:
- a) an *SI_FeatureList* value *featureList*.
- 7) The function *SI_getTextureFtr(SI_FeatureList)* takes the following input parameter:
- a) an *SI_FeatureList* value *featureList*.
- 8) The function *SI_getTextureFtrW(SI_FeatureList)* takes the following input parameter:
- a) an *SI_FeatureList* value *featureList*.

6.6 Auxiliary Types and Routines

6.6.1 SI_Color Type

Purpose

Provide the definition of the type *SI_Color* and facilities for constructing values of this type.

Definition

```
CREATE TYPE SI_Color
AS (
    --
    -- !! See Description
    --
)
INSTANTIABLE
NOT FINAL

METHOD SI_RGBColor
(redValue INTEGER,
 greenValue INTEGER,
 blueValue INTEGER)
RETURNS SI_Color
SELF AS RESULT
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
```

Definitional Rules

- 1) The implementation-dependent attributes are not for public use. There are no GRANT statements granting EXECUTE privilege on the observer and mutator functions for the implementation-dependent set of attributes.

Description

- 1) The *SI_Color* type provides for public use:
 - a) a method *SI_RGBColor(INTEGER, INTEGER, INTEGER)*,
 - b) a function *SI_mkRGBClr(INTEGER, INTEGER, INTEGER)*.

NOTE 11 An implementation may provide additional methods or functions to construct *SI_Color* values using the representation of color values in other color spaces beside RGB.

- 2) The *SI_Color* type represents color values using an implementation-dependent set of attributes.
- 3) Values of the *SI_Color* type represent color values using an implementation-dependent color space.

6.6.2 SI_RGBColor Method

Purpose

Construct a specified *SI_Color* value using the representation of colors in the RGB color space.

Definition

```

CREATE METHOD SI_RGBColor
  (redValue INTEGER,
   greenValue INTEGER,
   blueValue INTEGER)
RETURNS SI_Color
FOR SI_Color
BEGIN
  DECLARE InvalidInput CONDITION FOR SQLSTATE '2FF05';

  IF redValue IS NULL OR
     greenValue IS NULL OR
     blueValue IS NULL OR
     redValue < 0 OR redValue > SI_MaxRGBColor OR
     greenValue < 0 OR greenValue > SI_MaxRGBColor OR
     blueValue < 0 OR blueValue > SI_MaxRGBColor THEN
    SIGNAL InvalidInput
      SET MESSAGE_TEXT = 'incorrect color specification';
  END IF;
  --
  -- !! See Description
  --
END

```

Definitional Rules

- 1) *SI_MaxRGBColor* is the implementation-defined maximum value for each red, green, and blue values that define the representation of a color value in the RGB color space.

Description

- 1) The method *SI_RGBColor*(*INTEGER*, *INTEGER*, *INTEGER*) takes the following input parameters:
 - a) an *INTEGER* value *redValue*,
 - b) an *INTEGER* value *greenValue*,
 - c) an *INTEGER* value *blueValue*.
- 2) If any of the parameters is the null value, or if any of the input values are less than 0 (zero) or greater than *SI_MaxRGBColor*, then an exception condition is raised: *SQL/MM Still Image exception – incorrect color specification*.
- 3) It is implementation-dependent how the color value in the RGB color space, specified by its red, green, and blue values, is represented by the implementation-dependent set of attributes of the *SI_Color* type.

6.6.3 SI_mkRGBClr Function**Purpose**

Construct a specified *SI_Color* value using the representation of colors in the RGB color space.

Definition

```

CREATE FUNCTION SI_mkRGBClr
  (redValue INTEGER,
   greenValue INTEGER,
   blueValue INTEGER)
RETURNS SI_Color
LANGUAGE SQL
DETERMINISTIC
CONTAINS SQL
CALLED ON NULL INPUT
RETURN NEW SI_RGBColor(redValue, greenValue, blueValue)

```

Description

- 1) The function *SI_mkRGBClr*(*INTEGER*, *INTEGER*, *INTEGER*) takes the following input parameters:
 - a) an *INTEGER* value *redValue*,
 - b) an *INTEGER* value *greenValue*,
 - c) an *INTEGER* value *blueValue*.

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7 SQL/MM Still Image Information Schema

7.1 Introduction

The SQL/MM Still Image Information Schema views are defined as being in a schema named *SI_INFORMTN_SCHEMA* enabling these views to be accessed in the same way as any other tables in any other schema. SELECT privilege on all of these views is granted to PUBLIC WITH GRANT OPTION so that they can be queried by any user and so that SELECT privilege can be further granted on views that reference these Information Schema views. No other privilege is granted on them so they cannot be updated.

In order to provide access to the same information that is available via the *SI_INFORMTN_SCHEMA* to an SQL-Agent in an SQL-environment where the SQL-implementation does not support Feature F391, "Long identifiers" of Part 2 of ISO/IEC 9075, alternative views are provided that use only short identifiers.

An implementation may define objects that are associated with *SI_INFORMTN_SCHEMA* that are not defined in this Clause. An implementation may also add columns to tables that are defined in this Clause.

7.2 SI_FEATURES view

Purpose

Identify the supported features.

Definition

```
CREATE VIEW SI_FEATURES AS
  SELECT SI_FEATURENAME, SI_FEATUREVALUE
  FROM SI_DEFINITION_SCHEMA.SI_FEATURES
```

7.3 SI_IMAGE_FORMATS view

Purpose

Identify the supported image formats and the supported functionality for images with these formats.

Definition

```
CREATE VIEW SI_IMAGE_FORMATS AS
  SELECT SI_FORMAT, SI_SCALE, SI_RESIZE, SI_ROTATE
  FROM SI_DEFINITION_SCHEMA.SI_IMAGE_FORMATS
```

7.4 SI_IMAGE_FORMAT_CONVERSIONS view

Purpose

Identify the source and target image formats for which an image format conversion is supported and the supported functionality for images with these formats.

Definition

```
CREATE VIEW SI_IMAGE_FORMAT_CONVERSIONS AS
  SELECT SI_SOURCE_FORMAT, SI_TARGET_FORMAT
  FROM SI_DEFINITION_SCHEMA.SI_IMAGE_FORMAT_CONVERSIONS
```

7.5 SI_IMAGE_FORMAT_FEATURES view

Purpose

Identify the image formats for which a certain basic feature is supported.

Definition

```
CREATE VIEW SI_IMAGE_FORMAT_FEATURES AS
  SELECT SI_FORMAT, SI_FEATURE_NAME
  FROM SI_DEFINITION_SCHEMA.SI_IMAGE_FORMAT_FEATURES
```

7.6 SI_THUMBNAIL_FORMATS view

Purpose

Identify the image formats from which thumbnails can be derived.

Definition

```
CREATE VIEW SI_THUMBNAIL_FORMATS AS
  SELECT SI_FORMAT
    FROM SI_DEFINITION_SCHEMA.SI_THUMBNAIL_FORMATS
```

7.7 SI_VALUES view

Purpose

List the implementation-defined meta-variables and their values.

Definition

```
CREATE VIEW SI_VALUES AS
  SELECT SI_VALUE, SI_SUPPORTED_VALUE
    FROM SI_DEFINITION_SCHEMA.SI_VALUES
```

7.8 Short name views

Purpose

Provide alternative views that use only identifiers that do not require Feature F391, "Long identifiers", of Part 2 of ISO/IEC 9075.

Definition

```
CREATE VIEW SI_FORMAT_CONVRSNS AS
  SELECT SI_SOURCE_FORMAT, SI_TARGET_FORMAT
    FROM SI_DEFINITION_SCHEMA.SI_IMAGE_FORMAT_CONVERSIONS

CREATE VIEW SI_IMAGE_FRMT_FTRS AS
  SELECT SI_FORMAT, SI_FEATURE_NAME
    FROM SI_DEFINITION_SCHEMA.SI_IMAGE_FORMAT_FEATURES

CREATE VIEW SI_THUMBNAIL_FRMTS AS
  SELECT SI_FORMAT
    FROM SI_DEFINITION_SCHEMA.SI_THUMBNAIL_FORMATS
```

8 SQL/MM Still Image Definition Schema

8.1 Introduction

The only purpose of the SQL/MM Still Image Definition Schema is to provide a data model to support the *SI_INFORMTN_SCHEMA* and to assist understanding.

The base tables of the SQL/MM Still Image Definition Schema are defined as being in a schema named *SI_DEFINITION_SCHEMA*. The table definitions are as complete as the definitional power of ISO/IEC 9075 allows. The table definitions are supplemented with assertions where appropriate. Each description comprises three parts:

1. The function of the definition is stated.
2. The SQL definition of the object is presented as a <table definition>.
3. An explanation of the object.

The specification provides only a model of the base tables that are required, and does not imply that an implementation shall provide the functionality in the manner described in this clause.

8.2 SI_FEATURES base table

Purpose

Identify the supported features.

Definition

```
CREATE TABLE SI_FEATURES
(
  SI_FEATURENAME CHARACTER VARYING(SI_MaxFeatureNameLength),
  SI_FEATUREVALUE CHARACTER VARYING(256) NOT NULL,

  CONSTRAINT SI_FEATURES_PRIMARY_KEY PRIMARY KEY(SI_FEATURENAME),
  CONSTRAINT SI_FEATURES_CHECK CHECK
    (CASE SI_FEATURENAME
      WHEN 'SI_AverageColor' THEN
        (SI_FEATUREVALUE IN ('YES'))
      WHEN 'SI_ColorHistogram' THEN
        (SI_FEATUREVALUE IN ('YES'))
      WHEN 'SI_PositionalColor' THEN
        (SI_FEATUREVALUE IN ('YES'))
      WHEN 'SI_Texture' THEN
        (SI_FEATUREVALUE IN ('YES'))
      WHEN 'SI_Interface' THEN
        (SI_FEATUREVALUE IN ('METHOD', 'FUNCTION'))
      ELSE
        UNKNOWN
    )
)

INSERT INTO SI_FEATURES ( SI_FEATURENAME, SI_FEATUREVALUE ) VALUES
( 'SI_AverageColor', 'YES' ),
( 'SI_ColorHistogram', 'YES' ),
( 'SI_PositionalColor', 'YES' ),
( 'SI_Texture', 'YES' )
```

Definitional Rules

NOTE 12 The <else clause> in the <case expression> of the check constraint SI_FEATURES_CHECK allows implementation-defined features to be included in this table.

- 1) *SI_MaxFeatureNameLength* is the implementation-defined maximum length of a basic feature name.

Description

- 1) The value of *SI_FEATURENAME* is a character representation of a feature that is supported by an implementation.
- 2) If the value of *SI_FEATURENAME* is 'SI_AverageColor', the value of *SI_FEATUREVALUE* has the following meaning:
 YES The implementation supports the *SI_AverageColor* Feature.
- 3) If the value of *SI_FEATURENAME* is 'SI_ColorHistogram', the value of *SI_FEATUREVALUE* has the following meaning:
 YES The implementation supports the *SI_ColorHistogram* Feature.
- 4) If the value of *SI_FEATURENAME* is 'SI_PositionalColor', the value of *SI_FEATUREVALUE* has the following meaning:
 YES The implementation supports the *SI_PositionalColor* Feature.
- 5) If the value of *SI_FEATURENAME* is 'SI_Texture', the value of *SI_FEATUREVALUE* has the following meaning:
 YES The implementation supports the *SI_Texture* Feature.
- 6) If the value of *SI_FEATURENAME* is 'SI_Interface', then the values of *SI_FEATUREVALUE* have the following meanings:
 METHOD The implementation supports the Method oriented approach according to item 1) in Subclause 10.1, "Requirements for conformance".
 FUNCTION The implementation supports the Function oriented approach according to item 2) in Subclause 10.1, "Requirements for conformance".

8.3 SI_IMAGE_FORMATS base table**Purpose**

Identify the supported image formats and the supported functionality for images with these formats.

Definition

```
CREATE TABLE SI_IMAGE_FORMATS
(
  SI_FORMAT CHARACTER VARYING(SI_MaxFormatLength) NOT NULL,
  SI_SCALE CHARACTER VARYING(3),
  SI_RESIZE CHARACTER VARYING(3),
  SI_ROTATE CHARACTER VARYING(3),

  CONSTRAINT SI_FORMATS_PRIMARY_KEY PRIMARY KEY(SI_FORMAT),
  CONSTRAINT SI_FORMATS_SCALE_VALUES
    CHECK ( SI_SCALE IN ( 'YES', 'NO' ) ),
  CONSTRAINT SI_FORMATS_RESIZE_VALUES
    CHECK ( SI_RESIZE IN ( 'YES', 'NO' ) ),
  CONSTRAINT SI_FORMATS_ROTATE_VALUES
    CHECK ( SI_ROTATE IN ( 'YES', 'NO' ) )
)
```

Definitional Rules

- 1) *SI_MaxFormatLength* is the implementation-defined maximum length for the character representation of an image format indication.

Description

- 1) The value of *SI_FORMAT* is a character representation of an image format that is supported by an implementation. For an *SI_StillImage* value whose *SI_format* value indicates a supported image format that image format is derivable from its *SI_content* value.