Title: THREE DIMENSIONAL SHADE CARD GENERATOR

Abstract: A color measurement instrument is used as a shade card generator and printer. Spectral geometries of D/8, D/0, 45/0, 0/45, D(hemisphere)/8, D(hemisphere)/0 or others are applied. The light spectrum of the illumination source (2) lies in the range of 350 - 1100 nm. An integrating sphere (3) is used in the case of D/8 geometry. A detector (7.5) and an optical assembly (7.2, 7.3, 7.4) using a variable sample aperture are between the light source (2) and the sample.
Three Dimensional Shade Card Generator

Description of the invention:

Color Measurement Instrument to be used as a Shade Card Generator and Printer machine for the following Industries, of the type three dimensional shade cards, the three dimensional objects for color render being objects of the users choice. The Shade card can be viewed under any one of the following Illuminating condition/ Source of light of the user's choice. The user can introduce his own source of light also.

Background:

Shade Card Making done conventionally is a required in all color related industries.

Conventional shade cards are being made by a process that is intensive in following aspects:
1. Material.
2. Labor
4. Requires to spending money.
5. Requires lots of Space for storage of Colorants/Lacquers / card etc.

The Shade card making process is required to be repeated time and again, as the shade cards are distributed and finished.

Conventional Shade Cards are subject to:
1. Soiling
2. Fading.
4. Handling etc.

No shade card conventional is a three-dimensional shade card.

Prior Art:

The information that is required to create the Shade card is available. However, nobody has thought of exploiting the technology for the unique application of creation of shade card. So, the process being patented here is a unique process for the creation, distribution and circulation of shade cards that all the Color Industries require.

Over all design:

Spectrophotometer specifications:

Spectrophotometer type - Bench top

Spectral range: 350-1 100 nm. (Top of the line.)

Wavelength Interval: 1,5,10 nm, user selectable.

Source: Pulsed Xenon, with D65 filters or any other source.

Measurement Mode: % Reflectance and % Transmission.
Geometry: D/8,

Integrating Sphere: 6 Inch or 1.5 Inch or 2 Inch or any other size Diameter. Coated inside with BaSO4/ White Teflon.

Measurement principle: Double Beam./Single Beam.

Photometric Range: 0-200%.

Photometric Accuracy: 0.01% Reflectance. Or Transmission.

Measurement Apertures: 3 mm, 10 mm, and 24 mm.(1 inch diameter)

Calibration: White Tile, Black trap.

SCI/SCE: Motorized.

UV filter: Motorized.

Spectra Geometry: This can be D/8, D/0, 45/0, 0/45, D(hemisphere)/8, D(hemisphere)/O

Invention patent applies to all the above geometries.

Algorithm/ Equations:

The color to be added to the three dimensional shade cards is measured by spectrophotometer for % Reflectance values. The Tristimulus values calculations for CIE 1964 10° observer for the primary illuminant D 65 are done as under,

The Reflectance of the color to be added to the shade card is converted in to tristimulus values employing D65 Illuminant and Standard Observer of CIE 1964.

We employ the D65 CIE tables from the technical Bulletin of CIE for Energy Distribution of D65 Illuminant. The CIE D65 table are 5 nm based. We do a Lagrange interpolation and calculate the data at 1 nm, from 5 nm, and store in the tables, for 1 nm interval.

The xbar, ybar, zbar table for 10° observer 1964 are taken from Wyszecki Stiles book at 1 nm interval.

We then use sRGB color space for X Y Z to R G B conversion. This is done using the XYZ to RGB conversion by ICC color profiles for sRGB. The R G B calculated is scaled to 255.

R= R unitary X 255
G= G unitary X 255
B= B unitary X 255

The above R G B we employ for creation of three-dimensional shade card, in addition of two dimensional shade cards.

Note: the X Y Z to R G B can be done as per various. RGB Color Spaces like:
Adobe
Apple
Best RGB
Beta RGB
Bruce RGB
NTSC
CIE
ColorMatch.
DonRGB4
ECI
Ekta Space PC5
PAL/SECAM
Prophoto,
SMPTE-C.
Widegamut.

The gamma value for each RGB COLOR space is given below. The Illuminant column gives with respect to which Illuminant the specific Color Space does the X Y Z Tristimulus calculations, for further calculations in to R G B.

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<th>Gamma</th>
<th>Illuminant</th>
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<td>D65</td>
</tr>
<tr>
<td>Apple RGB</td>
<td>1.8</td>
<td>D65</td>
</tr>
<tr>
<td>Best RGB</td>
<td>2.2</td>
<td>D50</td>
</tr>
<tr>
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<td>2.2</td>
<td>D50</td>
</tr>
<tr>
<td>Bruce RGB</td>
<td>2.2</td>
<td>D65</td>
</tr>
<tr>
<td>CIE RGB</td>
<td>2.2</td>
<td>E</td>
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<td>D50</td>
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<tr>
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<tr>
<td>PAL/SECAM RGB</td>
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<td>SMPTE-C RGB</td>
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<td>D65</td>
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<tr>
<td>sRGB</td>
<td>2.2</td>
<td>D65</td>
</tr>
<tr>
<td>Wide Gamut RGB</td>
<td>2.2</td>
<td>D50</td>
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</tbody>
</table>

Transforming the X Y Z from one Illuminant to another Illuminant.
The above is done employing Bradford’s Chromatic adaptation Transform algorithm, and employing the R G B cone responses of source illuminant and destination illuminant.

So you get a value each for

\[ P_{Source} \gamma_{Source} \]  
\[ \beta_{Source} \]  

So you get a value each for

\[ P_{Destination} \gamma_{Destination} \]  
\[ \beta_{Destination} \]  

Now we do

\[ P_{Destination} / P_{Source} \]  
\[ \gamma_{Destination} / \gamma_{Source} \]  
\[ \beta_{Destination} / \beta_{Source} \]  

Thus by making the measurement in D65/10 degree, we can do the Chromatic Adaptation transform to any other Illuminant /Source.

This chromatic adaptation Transformed values of X Y Z of the destination are then used to calculate the R G B values as Chromatic Adaptation transformed R G B.

This enables us to depict the three-dimensional shade card in any user switched on illuminant.

Rendering algorithm on three dimensional objects of the user’s choice:

User is given a choice for the three-dimensional objects of his choice on which the color is to be rendered on.

Like:

1. Interior of an apartment.
2. Chair for upholstery
3. Sofa.
4. Apparel.
5. Plastic Chair.
6. Ceramic Tiles.
7. As Printed Matter for Graphic arts.
10. Telephones.
11. Curtains/Drapes.
12. Leather Purse, Valet.
13. Car.
15. Any user desired object and so on

Note: The X Y Z to R G B conversion can be done under the following RGB Color Spaces. A library of such object is made as BMP, JPG files. The above objects in the library are converted in to gray images and the library is kept as library of gray images, of the type three-dimensional type. So we have a large library of three dimensional BMP, or JPG images that are gray.

Rendering algorithm:

Once the object is selected say Chair for upholstery. The programme scans the gray image for the individual pixels of the gray image

The gray image consists of pixels where R=G=B, or R and G and B are equal at various levels from 0 to 255.

For example, the scan may find 80% population of pixels where R=123 G=123 and B=123

10% population where R= 75 G=75 and B= 75, and so on.

So, we have to find out which group of pixels with the same R G B is in majority.

We assign the R G B of the color to be rendered to this group of pixels, which are in the majority in the three dimensional object.

Now, the gray group with R G B higher will get R+(difference in R), G +(Difference in G), and B +(Difference in B) to give a lighter color to the group.

Now, the gray group with R G B lower will get R-(difference in R), G -(Difference in G), and B -(Difference in B) to give a darker color to the group.

Any group of pixels R and G and B > 255 R and G and B =255.

Also, any group of pixels R and G and B < 0 R and G and B = 0

Thus the whole three dimensional object will be at various pixels shades darker and lighter of the same color to produce the dimensional color render of the R G B to be rendered.

Any suitable render algorithm, other than the above may be used for the purpose of creating shade cards.

Shade Card now has:
1. Color Shade names,  
2. R G B of each color shade.  
3. Various gray objects of the three dimensional type to render.  
4. Various shapes, brush marks etc. for two-dimensional flat depiction of the color also.  
5. Square, Rectangle, Pentagon, Hexagon, Triangle, Brush mark, Alphabet, Circle, Ellipse, Oval, 

% Reflectance of each Shade in case required for matching etc. 

On a high fidelity photographic printer the three-dimensional shade card can also be printed with true color reproduction. 

The three dimensional shade cards on the choice of user's own objects can be thus made. Each color shade is shown as a three-dimensional color rendered on the object of user's choice of the size as desired by the user. 

Utility value:  
The process being patented here is as under for the user. 

Just by measuring by spectrophotometer, all the color shades to be included in the shade card can be incorporated in the Electronic Shade Card. 

Using a high fidelity printer, the shade cards can be printed. 

Further, the shade cards can be made as three dimensional shade cards on the object of the user's choice. 

The algorithm explained in various lighting conditions/sources can view the shade cards. A users' own light source can also be used. 

- Measure by spectra and by patented process make it into shade card.  
- Shade card can be flat two dimensional, in various shapes like square, rectangle, brush mark, alphabet, circle, oval, triangle, hexagon, polygon etc.  
- Shade card is free from soilng and handling effect, does not age and fade.  
- Shade card can be three dimensional on the object of users choice.  
- Shade card can be viewed in all possible lighting conditions, illuminants.  
- Shade card can be used to paint the interior of a flat, building etc.  
- Shade card in textiles can be used to make apparel design.  
- Shade card can be sent across on CD, or emailed.  

Tangible/Intangible benefits.  

- A shade Card once made can be made into n number of copies and thus saving the cost of shade card making. A conventional shade card making is cost, labour and material intensive, and needs to be made time and again.  
- This shade card can be three dimensional, unlike a conventional shade card.  
- Free from handling and soilng.
Operating Platforms: Apple/Mackintosh, PC with Windows operating system, Linux, or any other operating system with 24 bit or 32 bit true color.

1. Industries,
2. Paints,
3. Plastics,
4. Textiles Dyeing/Printing,
5. Suiting,
6. Blended fabric,
7. Yarn,
8. Thread,
9. Carpets,
10. Paper,
11. Melange Fibers,
12. Rubber,
13. Glass,
14. Carpets,
15. Apparels,
16. Printing Inks / Graphic Arts,
17. Dyes,
18. Pigments,
19. Soft Drink Concentrates,
20. Automobiles.

Brief Description of Drawings

Fig1 gives the schematic of the optical measurement instrument used for the above application.

Description of Preferred Embodiment

1. Lamp/Diode Array Power Supply: It is used to switch on and off the xenon flash lamp and diode array.

2. Xenon Flash Lamp: They are convenient source for UV and visible light. These lamps are compact and generate a minimal amount of heat and are available in sizes ranging from 5 to 60 watts. The amount of output light, pulse width and repetition rate can be easily controlled.

3. Integrating Sphere:
   3.1: Entrance port of the light source into the integrating sphere
   3.2 and 3.3: Baffles to avoid direct light from the xenon source to fall on the sample, so that the sample receives purely diffused light.
   3.4: Sample port
   3.5: SCI/SCE: Specular component included or excluded. It is a lid hinged out and in to be used as a specular trap.
3.6: Exit port of the sphere

4. **Sample Position**: The liquid or the solid sample (from standard or batch) is placed here.

5. **Collecting Optics**: It receives radiation reflected from the sample 8° normal to the sample surface, with the angular collection tolerances specified by CIE and ASTM, DIN and focuses on the fiber couple.

6. **Fiber coupling**: It receives the focused light and transferred to the spectrum analyzer.

7. **Spectrum Analyzer**:
   - 7.1: Entrance slit of the spectrum analyzer and exit port of the fiber optic probe
   - 7.2: **Mirror**: Collimating concave mirror that collects the signal from the entrance slit to the grating.
   - 7.3: **Grating**: Plane reflection grating of 300/600 lines/mm used for dispersion of light into respective colors.
   - 7.4: **Mirror2**: De collimating concave mirror grating to diode array.
   - 7.5: **Diode array detectors**: It consists of individual photodiodes with number of pixels defined, so as to have the specific band of wavelengths. Band pass - 1 nm. The photodiodes convert the light signal to electrical signal. Strength of the electrical signal is proportional to the light intensity.

8. **I/O Card**: It has a necessary interfacing circuitry for CMOS linear image sensor and communicates with PC via USB

9. **PC**: Used for collecting and analyzing the data through the software developed for the application.
We claim,

1. An color measurement instrument to be used as a shade card generator and printer machine with D/8, D/0, 45/0, 0/45, D(hemisphere)/8, D(hemisphere)/0 or any other spectral geometry in the range of 350-1 100 nm or with any wavelength combinations in visible region of user's choice with the illumination source, integrating sphere (in case of D8), detector with an optical assembly between source and the sample & the sample and the detector for proper optical focusing using a variable sample aperture.

2. An instrument according to claim 1, wherein has a wavelength interval of <1nm, 1 nm, 5 nm, 10 nm, 20 nm or user selectable and measurement principle is single/double beam and is also preferred to as color spectrophotometer.

3. An instrument according to claim 1, wherein generates all the color shades to be included in the shade card, which can be incorporated in the electronic shade card, just by measurement by the instrument as above claimed,

4. An instrument according to claim 1, generates shade cards, which can be flat, two dimensional, in various shapes like but not limited to square, rectangle, brush mark, alphabet, circle, oval, triangle, hexagon, polygon.

5. An instrument according to claim 1, generates shade cards which are free from but not limited to soiling, fading, handling, aging.

6. An instrument according to claim 1, generates a three-dimensional shade card, unlike the conventional shade cards, on the object of the user's choice.

7. An instrument according to claim 1, generates a shade card that can be viewed in all possible lighting conditions and illuminants.

8. An instrument according to claim 1, generates a shade card that can be used to but not limited to paint the interior of a flat, building.

9. An instrument according to claim 1, generates a shade card, that can be used in but not limited to textiles to make apparel design.

10. An instrument according to claim 1, generates a shade card that can be sent across on CD or e-mailed.

11. An instrument according to claim 1, can be connected to a high fidelity photographic printer as to print out the shade cars with true color reproduction.

12. An instrument according to claim 1, generates a shade card as in claim 3, which can be viewed even by transforming the color from one illuminant to another illuminant.

13. An instrument according to claim 1, generates a shade card which can be made into n number of copies and thus saving the cost of shade card making.
14. An instrument according to claim 1, generates a shade card under any operating platform like apple/Mackintosh, windows, linux or any other platform with 24 and above bit true color.
INTERNATIONAL SEARCH REPORT

International application No
PCT/IN 2007/000092

A CLASSIFICATION OF SUBJECT MATTER
IPC®: GOU 3/52 (2006.01)
According to International Patent Classification (IPC) or to both national classification and IPC

B FIELDS SEARCHED
Minimun documentation searched (classification system followed by classification symbols)
IPC®: GOU

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPOQUE Fulltext, WPI

C DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>WO 2005/050150 A1 (CIBA SC HOLDING AG); 2 June 2005 (02.06.2005) page 2, line 23 - page 4, line 28;</td>
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<td>A</td>
<td>US 5 764 352 A (KAPPEL et al.), 9 June 1998 (09 06 1998) column 1, line 66 - column 4, line 5; fig. 1, 2</td>
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D Further documents are listed in the continuation of Box C

* Special categories of cited documents
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"Sc" document member of the same patent family

Date of the actual completion of the international search
20 July 2007 (20.07.2007)

Date of mailing of the international search report
1 August 2007 (01.08.2007)

Name and mailing address of the ISA/AT
Austrian Patent Office
Dresdner Straße 87, A-1200 Vienna

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Form PCT/ISA/2 10 (second sheet) (January 2004)
Continuation of first sheet

Continuation No. II:

Observations where certain claims were found unsearchable

(Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. With regard to any nucleotide and/or amino acid sequence disclosed in the international application and necessary to the claimed invention, the international search was carried out on the basis of:

Claims Nos.: 5 - 10, 12, 13 because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

claims 5 to 10, 12 and 13 do not reveal any concrete technical features
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