Automatic Hue Matching Cabinet for Textile Industry Using Raspberry Pi

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Abstract: Colour is one of the most important features of textile design that makes a major contribution to the overall visual impact of a completed fabric. Colour is the most important element in material development in most cases and is also vital to profitable success. Colour matching is an essential operation from the master standard to all subsequent manufacturing batches to ensure consistency of colour. Metamerism is one of the major problems in textile industries where two colored samples appear same in one source of light but vary when the source of light is modified. In existing method, textile industry uses software and spectrophotometers to test the colour of the yarn and the machine is of high cost. To overcome this we have designed a colour matching system based on Raspberry pi with low cost and greater accuracy to test the fabrics. The proposed system offers visual assessment of colour under 5 standard lights. The image of fabric is captured using camera. The captured image is compared with standard reference image of fabric requirement given by the customer and the comparison result is displayed using LCD display. Fabric dyeing plant, garment manufacturers and exporters use this cabinet as a lab instrument for checking yarn.

Index Terms- Colour Matching cabinet, Metamerism, Comparision.

1 INTRODUCTION

In the modern world, colour is extremely important. For certain cases, colour is an significant element in the manufacture of products, and is also essential to profitable success of the product. Clearly a simple colour calculation and colour control framework is much desired. An object's colour depends on many factors, including illumination, sample size, and context and ambient colours. Factors like texture and gloss are essential when considering the appearance of an object as well as its colour. Nearly all modern colour calculation is based on the colour classification framework of the CIE. Metamerism is the phenomenon where under one light source two coloured objects tend to be of the same colour but under a second source seems to be different shades. For eg, the slacks and socks that fit well at home under incandescent light but may not be a suitable match at the office under the fluorescent lighting. Physical samples will only match under all sources if precisely the same shape is in their spectral reflectance curves. If the reflectance curves of the samples have different shapes, which usually intersect at least three times, then they are likely to be a metameric pair. Under one light source, the two different colours have the same hue effect but look different under another light source. Metamerism is the contrast between the two-colour reflex curves that appear the same under a specified illumination system (e.g. electric bulb display, daylight). Only colours that show the same curves of remission (M=0) will be viewed under different light sources as being the same colour. Figure 1.1 shows colour matching process manual

Figure 1.1 Colour Matching process manual

2 LITERATURE SURVEY

In 1960, Billmeyer et al[2] defined the synthesis of trans parent colours with a digital computer; and in 1961, howe ver, Alderson et al[3]revealed the iterative methodology f or complex subtractive colour mixing, the first appropriat e theoretical analysis of the issue had been reported by Pa rk and Stearns[1] as early as 1944.

Such advances were accompanied in 1966 by the demonstration of Allen's [4] computer algorithms of computation. Because of Allen's algorithm's flexibility and applicability its use was popular. The algorithm is based on the Kubelka –Munk turbid media theory for a highly dispersing, dyed or pigmented opaque substratum. The instrumental colour formulation could be split into two groups, according to the intent of matching; spectrophotometric and colourimetric matching. Hart et al [11] developed a new design which is a simple but innovative stimulator that started a new area of patient recovery that is known as an FES system. The development of electrical stimulators produces stimulation by implantable electrodes and transcutaneous, cutaneous.

Bugao Xu and Sheng Lin [6] have developed a prototype technique for auto-organizing maps and gathering fuzzy c-means to instantly classify various printed textile colours. Their technique changes a colour image to a map of planar density indicating the pixel amounts of each main cluster of colours. The approach effectively results in naccurate classification of colour regions within a picture which provides for independent colour analyses. Despite the success of this process, the estimation of the quantity of foremost colour in the picture and the regular colour value of each cluster is thought mainly for.

Lou et al [16] developed a multi-spectral imaging technique to calculate colour and relate particular yarns without twisting where a particular yarn is divided into multispectral images through an updated k-means grouping method from a context. In this study, the averaging process and imaging framework describes multispectral picture reflection of the single yarn, called eye colour measurement (ICM), in order to evaluate their proposed procedure. Despite the technique's effectiveness, it was only intended to determine the color of particular single yarn threads before they were turned into fabric.

S.Gorji Kandi, M.Amani Tehran [10] published a paper on title "Colour Recipe Prediction by Genetic Algorithm" in 2006, in which data query color matching approach slowly switches to dyeing modeling work in the last few years. Genetic algorithms are applied to the analysis of color recettes. In 2007, Yoshinobu Nayatani, Hideki Sakai[11] published a paper entitled "Proposal for a New Color-Appearance Modeling Design" The improving method for In-CAM color matching model is done in this paper.

Maozu Guo, Yadong Wang, Xiaohong Su [5] published a paper "Research of Colour Method Based on BP Network" in 2000. In this the author put forward the method of matching the BP neural network colour. Huifeng Wang, Chunping Xie [7] published a paper "Colour Recognition Method Based on Artificial Neural Network in the Application of Colour Matching System in Wool" in 2006 in which the author introduced the concept of neural network color recognition when implementing wool color matching systems.

Tao Yang, Ningfang Liao, Weimin Wu[8] published in 2006 a paper entitled "Computer Color Matching of Paints Based on Neural Networks," in which he created the neural network machine paint matching method. Yáñez, Cornelio, Felipe Riveron[9] published in 2006 a novel entity entitled "A novel approach to automatic color matching, Improvement in pattern recognition, image analysis and applications," introducing an automatic color matching method that incorporated associative memories from Alpha-Beta.

Lau et al [13][15] stated that the spectrophotometer and DigiEye coordinates for fabrics have a robust correlation between colours and also innovated testing breakfronts and light cubicles with regular lights, so that products can be presented in invariable conditions when measuring colours against the norm.

Neda et al [14] conducted a study of two manufacturing spectrophotometers with separate computing geometries to investigate the uncertainty of the calculation of clothing items in the colour group.

3 Conceptual Background

Photo recovery is the process by which photographs are accessed, retrieved and restored from a large digital photo server. The photo archive of the web is rising bigger and complexer. It is a challenge to retrieve images from such large collections. One of the main issues they discussed was the difficulty of seeking the perfect picture in a large and varied collection. Although the desired image from a small collection can be found perfectly simply by searching, with collections containing thousands of objects, more successful techniques are needed. A user may provide query terms such as keyword, image file / link or click on a certain image to search for images and the system will return "similar" images to the query. The similarities used for search criteria may be meta tags, distribution of image colours, region / shape attributes, etc. Unfortunately, image retrieval systems have not kept up with the collections they search. Such systems' limitations are attributable to the image representations they use, as well as their methods of accessing such representations for image searching. Problems of image retrieval are becoming widely known and the search for solutions is becoming an increasingly active research and development field. With a large-scale collection of images, the need to provide an efficient method of image search and retrieval has evolved in recent years. It may minimize those activities in many use areas such as biomedicine, forensics, artificial intelligence, military, education, web-image scanning. Most of today's image recovery systems are text-based, where images are manually annotated using text-based keywords, and when we ask a keyword instead of digging into the content of the image, this approach compares the query to the keywords in the picture. This method has some drawbacks: (a) First, given the huge set of available images, it is not feasible to annotate them manually (b) Secondly; keywords cannot completely explain the rich features present in an image. Figure 3.1 shows the colour based image processing.

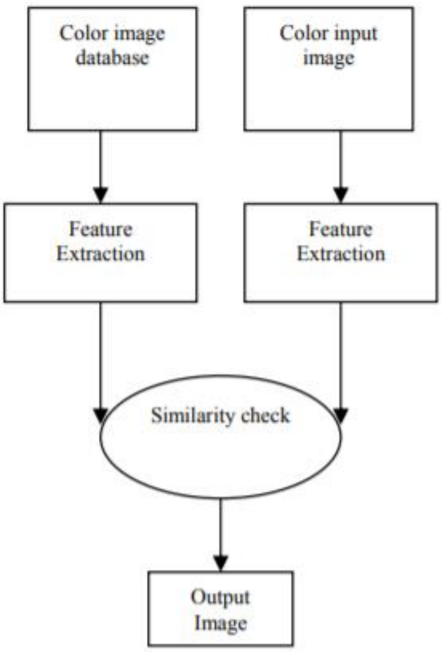

Figure 3.1 Colour based image processing

3.1 RGB COLOUR MODEL

The RGB display scheme consists of three basic colors: red, green, and blue. By combining these, we obtain all other colours. This pattern can be considered as a triangle, where three non-adjacent and perpendicular corners are R, G, and B.As can be seen when the mixing of black, red, and blue gives white, RGB is an additive color scheme. It is the most commonly used computer graphics color pattern because it fits the representation of the image in the display memory. Used for color patterns and a broad color class of color pattern corners, RGB color is three-point at the corners and a basic scale at. Magenta, green, and cyan have three points left at the corner. Black is at the source, and white is at the most distant. The color of the line dividing black and white is brown. All other colors are inside the cube in the form of points, and are expressed by vectors that extend from the center. The depth of pixels is the amount of pixels used to represent a pixel. The set of shades that can be used in place of whole colors is called subsets of colours. This is also called stable RGB colours

3.2 HSV COLOUR MODEL

The HSV is about Hue, Heat, and Saturation. We see the space of the hue-saturation-value (HSV) as a cone: for a given point (HSV), the position angular and radial coordinates on a radius vat height disk v are h and SV; both co-ordinates vary from 0 to 1. Its design decouples color and white degrees. This is the approach that provides awareness of the picture that is portrayed and understood quickly. To mind the way artists and graphic designers think about colors, the HIS color model has been created. Artists use terms such as saturation (pureness of a colour), hue (color itself), and intensity (brightness of the colour). That is exactly what the HSI color style reflects. The color space is unusual since it is not orthogonal, color is, as in the others, a vector in this domain of colour. H (hue) is the angle of the vector over the base triangle, beginning at the red (0 degrees). S (saturation) is the relative size of the vector projection over the simple triangle, and I (intensity) is the distance between the vector end and the origin triangle. The move from RGB to HIS is very complex.

3.3 COLOUR HISTOGRAM

The color histogram is created for an image by counting the number of pixels in each colour. In other words, a histogram of color is defined in an picture as a distribution of colour. A color histogram represents the number of pixels in each of a specified color spectrum ranges comprising shades for digital images. These cover the range of colors available in the color space of the image. A visual representation of the histogram of an image is a basic but useful device, since it defines the image in terms of brightness and contrast. To find the colour image histogram S = sum [sum {sum (√h1*√h2)}] Where s is similarity value between two colour image histogram, h1 is the query image histogram and h2 is the database image histogram. Figure 3.2 shows the colour matching using histogram.

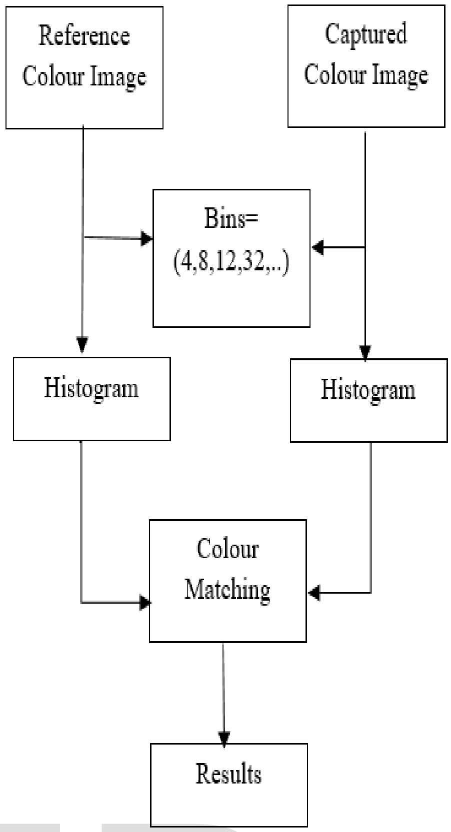

Figure 3.2 Colour matching using histogram

4 PROPOSED METHOD

In this research work, The device includes a huge inspecting part filled with several light sources or uplighters to detect the Metamerism effect, where samples tend to fit under one light source but are noticeably different under another. The fabric will progress through different light sources, such as artificial daylight, cool white light, tungsten filament light, ultraviolet light, triphosphorous fluorescent light, to achieve final approval. The sample to be tested are kept in the inspecting cavity. After switching on the D-65 Light the camera provided captures the image and the Raspberry Pi is programmed to closely compare the original specimen and the specimen to be tested and the result is displayed. The cabinet is built by Teakwood, Ply Board & Sun mica in strict compliance with international standards. Supplied with wide tube lights & bulbs for simple and exact color assessment. Equipped with Instant Start & Power Saving Electronic / Ballast to protect the costly & sensitive tube lights & vamps. No heat-up, no heat-emission, no turn, time Elapsed showing some source of light. Power effective lighting. Compact; high quality, competitiveness of the market. The block diagram for automatic hue matching cabinet for textile Industry using Raspberry Pi is shown in Figure 4.1.

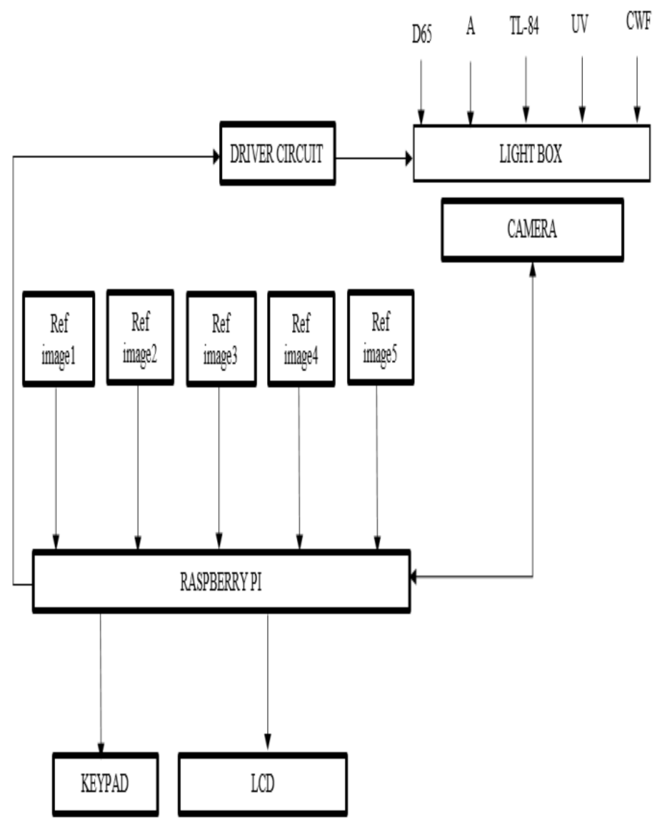

Figure 4.1 Proposed method

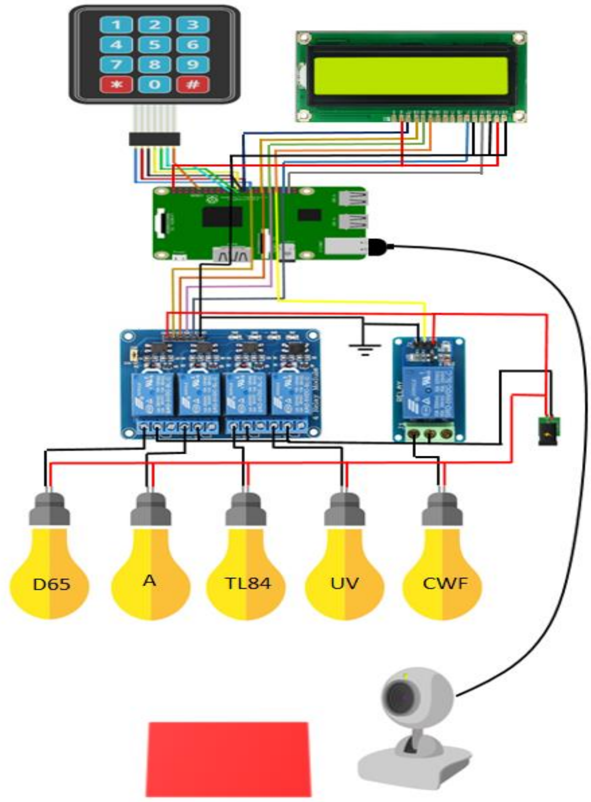

Figure 4.2 Schematic diagram of proposed method

The cabinet is activated by giving supply to it. The lights are fixed in the upper region of the cabinet. The lights are made to work with the help of one 4-channel relay module and one 1-channel relay module thus providing one relay for one light .By switching on the button in keypad the light is made ON and OFF. If button1 is pressed D65 light is switched ON and automatically web camera captures the image. Similarly images are captured in remaining four lights by pressing the button2, button3, button4, button5. All the five reference images captured are stored in raspberry pi. After capturing of reference image, the next process is capturing image of actual cloth produced. The same process is carried out while capturing of actual image. After taking the actual image it is compared with the reference image and the comparison result is displayed in LCD. When button1 is pressed the D65 light gets ON and automatically the camera clicks the image of the cloth and the result is displayed in LCD. If reference image and actual image is similar the LCD displays the result 1. If the result is 0.9 the images are approximately similar. If the result is 0 the images are no similar. Similarly the same process is carried in all sources of lights. Figure 4.2 shows Schematic diagram of proposed method.

5 HARDWARE AND EXPERIMENTAL RESULTS

The hardware setup consists of light sources, web camera, buttons, relay, LCD. The Cabinet is made up of Teakwood, Ply Board & Sun mica, adhering strictly to international specifications. It consists of relay which is used as a driver circuit to operate the light. Each light source uses one relay; and all the five relays are connected with raspberry pi. The button provided is connected with raspberry pi to switch on the light. A web camera is also connected with raspberry pi through USB. The LCD connected with raspberry pi displays the image comparison value. Figure 5.1 shows the complete hardware setup of automatic hue matching cabinet.

Figure 5.1 Complete hardware setup of automatic hue matching cabinet.

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In case if reference and produced cloth is of same colour. The reference cloth is placed below the light sources and camera. If button 1 is pressed D65 light switches on and captures the reference image of the reference cloth. Similarly the reference image of reference cloth is taken in all the lights through camera and stored in raspberry pi. Then the produced cloth is kept below the camera. If button 1 is pressed D65 light switches on and captures the image. The reference image is compared with captured image and displays the value 1 or "The images are matched". Likewise the same process is done in all light sources. Table 5.1 shows the comparision result of RGB triplet with same colour cloth. Figure 5.2, 5.3, 5.4, 5.5, 5.6 shows the comparison of same colour cloth under different light sources. Figure 5.7 shows results of images are matched.

Table 5.1 Comparison result of RGB triplet with similar colour cloth

COLOUR	COLOUR NAME	REFERENCE IMAGE RGB TRIPLET	CAPTURED IMAGE RGB TRIPLET
	RED	(255,0,0)	(255,0,0)
	BLUE	(0,0,255)	(0,0,255)
	YELLOW	(255,255,0)	(255,255,0)
	GREEN	(0,128,0)	(0,128,0)
	PURPLE	(128,0,128)	(128,0,128)
	ORANGE	(255,153,0)	(255,153,0)
	BLACK	(0,0,0)	(0,0,0)
	FUCHSIA	(255,0,255)	(255,0,255)
	WHITE	(255,255,255)	(255,255,255)

Figure 5.2 Comparison of similar colour cloth under Tungsten light

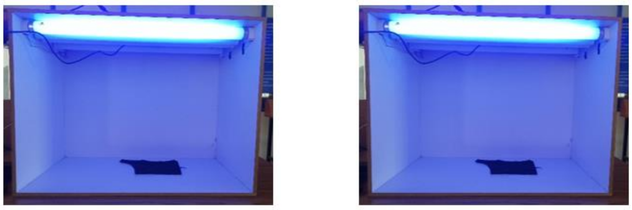

Figure 5.3 Comparison of similar colour cloth under UV light

Figure 5.4 Comparison of similar colour cloth under D65 light

Figure 5.5 Comparison of similar colour cloth under TL84 light

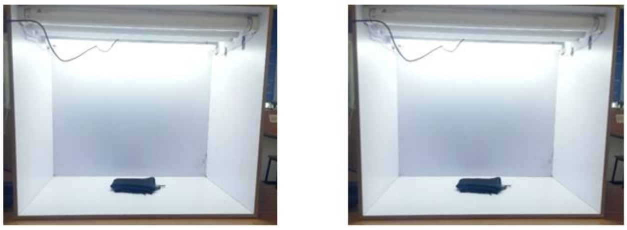

Figure 5.6 Comparison of similar colour cloth under CWF light

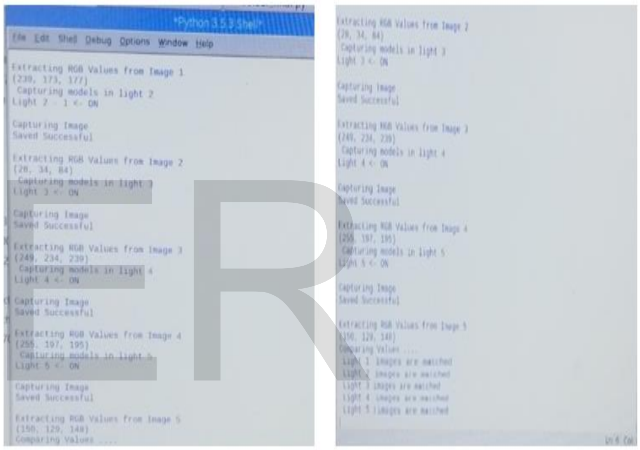

Figure 5.7 Result of images are matched

In case if reference and produced cloth is not of same colour. The reference cloth is placed below the light sources and camera. If button 1 is pressed D65 light switches on and captures the reference image of the reference cloth. Similarly the reference image of reference cloth is taken in all the lights through camera and stored in raspberry pi. Then the produced cloth is kept below the camera. If button 1 is pressed D65 light switches on and captures the image. The reference image is compared with captured image and displays the value 0 or "The images are not matched". Likewise the same process is done in all light sources. Table 5.2 shows the comparision result of RGB triplet with different colour cloth. . Figure 5.8, 5.9, 5.10, 5.11, 5.12 shows the comparison of different colour cloth under different light sources. Figure 5.13 shows results of images are not matched.

Table 5.2 Comparison result of RGB triplet with different colour cloth

COLOUR	COLOUR NAME	REFERENCE IMAGE RGB TRIPLET	CAPTURED IMAGE RGB TRIPLET
	RED	(255,0,0)	(245,0,0)
	BLUE	(0,0,255)	(0,0,230)
	YELLOW	(255,255,0)	(226,226,0)
	GREEN	(0,128,0)	(0,115,0)
	PURPLE	(128,0,128)	(132,0,132)
	ORANGE	(255,153,0)	(243,122,0)
	BLACK	(0,0,0)	(0,0,0)
	FUCHSIA	(255,0,255)	(231,0,226)
	WHITE	(255,255,255)	(215,220,224)

Figure 5.8 Comparison of different colour cloth under Tungsten light

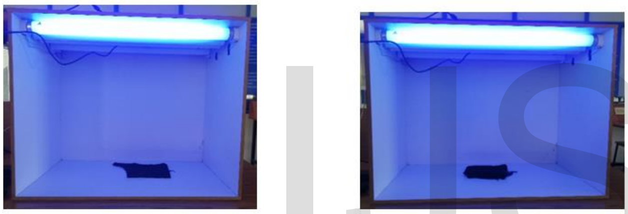

Figure 5.9 Comparison of different colour cloth under UV light

Figure 5.10 Comparison of different colour cloth under D65 light

Figure 5.11 Comparison of different colour cloth under TL84 light

Figure 5.12 Comparison of different colour cloth under CWF light

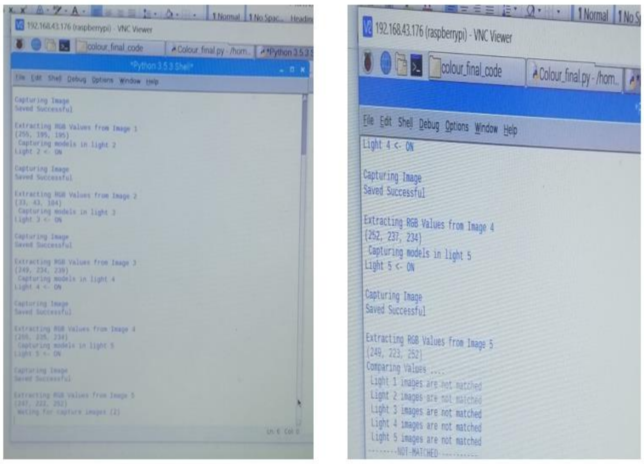

Figure 5.13 Result of images are not matched

6 Conclusion

In this project, the automatic hue matching cabinet for textile industry using raspberry pi to check the fabric metamerism was proposed. The proposed system is designed by teakwood, ply board and sun mica, specifically consistent with international standards. It comes with wide tube lights and bulbs for fast and accurate color evaluation. The cabinet is fitted with electronic / ballast immediate start and power saving to secure the costly and prone tube lights and amps. Does not heat-up, heat-emission is not present, Elapsed time displays each source of light. Not much Energy is used. It is compact compared with other colour matching cabinet. It is of high quality and competitive pricing. The fabrics are tested under different light source, so that the effect of metamerism can be detected. The camera provided captures the image of cloth to be tested. The colour matching is done using algorithm where the captured image is compared with reference image. The raspberry pi is programmed, so that it can compare and display the results in LCD. This project can be extended by sending the result to the customer through SMS and by adding several light sources to check the cloth. Thus this proposed method is low cost compared to software used.

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