COLOUR TRANSFORMATION ALGORITHM ON WEBSITE IMAGES FOR THE COLOUR BLIND USERS

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COLOUR TRANSFORMATION ALGORITHM ON WEBSITE IMAGES FOR THE COLOUR BLIND USERS

by

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DECLARATION

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TABLES OF CONTENTS

Chapter 3 Research Methodology

Chapter 4 Colour Transformation on Website Images

Chapter 5 Evaluation

Chapter 6 Conclusion

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

B	Blue
CMY	Cyan, Magenta, and Yellow
G	Green
H	Hue
HSV	Hue, Saturation, and Value
HTML	HyperText Markup Language
MIMOS	Malaysian Institute of Microelectronic Systems
R	Red
RGB	Red, Green, and Blue
SOM	Self-organising Map
URL	Uniform Resource Locator
USM	Universiti Sains Malaysia
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines

ALGORITMA TRANSFORMASI WARNA PADA IMEJ DI HALAMAN WEB UNTUK PENGGUNA YANG BUTA WARNA

ABSTRAK

Teknik penukaran daripada ruangan warna RGB ke ruangan warna HSV tertumpu pada warna merah lampu isyarat dan selalunya diterapkan pada pengenalan lampu isyarat. Algoritma tersebut menyebabkan kebingungan selepas penukaran warna apabila diuji pada imej yang kompleks dan mengandungi warna merah yang berbeza nilai dan kecerahan kerana warna ditukar kepada lebih daripada satu warna. Orang yang buta warna tidak dapat mengenalpasti warna tersebut dengan tepat. Kaedah penukaran warna organisasi sendiri berjalan dengan lancar meskipun diterapkan pada imej yang kompleks. Masalah utama kaedah ini ialah kebingungan warna pada imej di mana masalah tersebut sama seperti algorithma sebelum ini. Setakat ini tiada algoritma penukaran warna telah diterapkan pada aplikasi web. Orang yang buta warna menghadapi kesulitan apabila melihat imej di halaman web. Tujuan utama kajian ini adalah untuk memodifikasi algoritma penukaran daripada ruangan warna RGB ke ruangan warna HSV supaya warna merah dan hijau khususnya ditukar kepada warna kuning dan biru sahaja. Objektif lain adalah untuk melaksanakan pengubahsuaian algoritma transformasi warna pada halaman web supaya halaman web lebih mudah dicapai oleh orang buta warna dan meningkatkan kesedaran terhadap kesulitan yang dihadapi oleh orang yang buta warna. Manakala kesemua warna biru dikekalkan. Algoritma transformasi warna kemudian diuji oleh sekumpulan 35 orang yang buta warna melalui senarai soalan diedarkan kepda mereka.

COLOUR TRANSFORMATION ALGORITHM ON WEBSITE IMAGES FOR THE COLOUR BLIND USERS

ABSTRACT

The conversion technique from RGB colour space to HSV colour space focuses on the red colour of the traffic lights as it is mostly applied on traffic lights recognition. When tested with complex images which consist of different values and levels of brightness of red colour, it causes colour confusion after the colour is converted as the colours are transformed into more than one colour. The colour blind are unable to identify them specifically. The self-organising colour transformation method works well even when applied on complex images. The main problem with this method is that it causes colour confusion on the image, which is similar to the former transformation method. No colour transformation algorithm has yet been applied to website images. The colour blind face difficulty when looking on the images on the websites. The main objective of this research is to modify the conversion technique from RGB colour space to HSV colour space algorithm, so that red and green are specifically transformed into yellow and blue only. Other objective is to implement the modified colour transformation algorithm to websites to make the websites more accessible to the colour blind and to raise awareness of the problems that are faced by the colour blind. However, all the blue colours are maintained. The modified colour transformation algorithm is then tested on a group of 35 people who have colour blindness via a designed questionnaire handed out to them.

CHAPTER 1

INTRODUCTION

1.1 Introduction to Colour Transformation

Colour blindness is the inability to distinguish some colours from others under bright illumination (Kovalev, 2004). Even though colour works well for most of the people, there are around 8% of males and less than 1% of females having faulty colour perception from birth (Betsy, 2003; Huang *et al.*, 2007; Kovalev, 2004; Ma *et al.*, 2009; Ohkubo and Kobayashi, 2008). Many people think that those who are colour blind can only see black and white, just like during the old days, watching black and white movies (Kim *et al.*, 2007). This is not true because it only happens to people who are totally colour blind and, it is extremely rare for a person to be totally colour blind (Betsy, 2003).

A more accurate term for colour blindness should be colour vision deficiency. The most common category of colour vision deficiency is called red-green colour vision deficiency such as protanopia, protanomaly, deuteranopia and deuteranomaly (Betsy, 2003; Kovalev, 2004; Ma *et al.*, 2009; Mcdowell, 2008; Ohkubo and Kobayashi, 2008). However, it cannot be concluded that these groups of people cannot see red or green. They just have difficulty in differentiating between these two colours exactly, especially when their brightness are altered or they come in a mixture of colours. For example, these people can easily tell the difference between light green and dark red. But it would be confusing to them if the green colour is almost as dark as the red or vice versa. Another problem encountered by people who have red-green colour vision deficiency is that they view red and green colours as yellow, orange and beige (a light grayish-brown colour). Therefore, they will be confused whether the yellow, orange and beige that they see are its original colour or is it red or green. The least affected colour is the blue colour (Kim *et al.,* 2007).

Colour transformation means transforming the colour space of an image into another colour space that can be distinguished by the colour vision deficient, depending on the types of colour vision deficiency they have. There are two methods of colour transformation which are (1) the conversion technique from red, green, and blue (RGB) colour space to hue, saturation, and value (HSV) colour space and (2) the self-organising colour transformation method.

The RGB to HSV conversion technique converts the captured RGB colour space image into HSV colour space. After the conversion, the image is passed to the image processing unit for the hue values transformation. The hue value of the unrecognized colour is changed into a value that is recognized by the colour vision deficient. After the transformation, the image is converted back from HSV colour space to RGB colour space for the output purpose. The details of the conversion technique from RGB colour space to HSV colour space are further explained in Chapter 2.

The self-organising colour transformation method uses the redundancy of colour information, changing the colours of a scene into discernable ones for colour vision deficient. The self-organising map (SOM) is used to build a nonlinear colour map, maintaining the neighboring relations between colours. The colours are transformed according to the codebook vector created from the sampled pixels, which are taken from the original image. Each sampled pixel corresponds to one codebook vector. The details of self-organising colour transformation method are explained further in Chapter 2.

1.2 Background of the Problem

At the present time, there are several devices that have been designed to help the colour vision deficient. First, colour blind glasses, which are the main instrument prescribed for the colour vision deficient (Ma *et al*., 2009). These glasses have a very simple way of filtering the colours to help them differentiate certain specific colours such as red and green colour. It provides useful colour information to the user of the colour blind glasses. Although these glasses seem like can be easily helping them to see the colours, it can easily cause other colour confusion.

Secondly is Colour Vision Assist System which helps the colour blind in recognizing the colour of the traffic lights. The system consists of a small camera, an image processing unit and a wearable display which can monitor real-time like a single eye-glass (Ohkubo and Kobayashi, 2008). This device utilises the RGB to HSV technique. The red colour of the traffic lights is captured by the camera and the system converts the colour to magenta. Therefore, people with red-green deficiencies see the red light as blue, which helps them to know that the red colour light is on.

Thirdly, the Visual Auxiliary System by Lai and Chang (2009) undergoes a compensation processes such as linear or nonlinear image scaling, edge and contrast enhancement, colour coordinate transformation and histogram modification to enhance images for better and clearer viewing. For instance, it increases the contrast of the image appropriately to enhance colour discrimination.

However, a major problem that still persists among the colour vision deficient even with all these devices and methods is colour differentiation. This is due to the fact that the transformation usually distorts the borders between the colours. For example, when viewing an image with red-coloured text on green background, they cannot see the borders between that red and green area. Therefore, the image looks blur.

With this persisting problem, it is hard for colour vision deficients to view and differentiate the colours in an image perfectly, thus distorting their perception of its meaning. This is a crucial problem today because of the importance of the internet in our daily lives. The inability to correctly identify an image can cause a user to have a wrong perception of its meaning.

The main reason they face this difficulty is because colour vision deficiency is neglected by the public. A lot of people do not consider colour vision deficient as a serious problem (Kim *et al.*, 2007) because most of them think that even with their deficiency, they are still able to see everything perfectly. But in fact, colour vision deficiency is actually classed as a disability and they need much attention and aid.

Another reason is that people are more concerned about the safety of these groups of people rather than web accessibility. Most of the researches are done in the traffic lights applications because the colour vision deficient drives as normal people do, in their daily life. But so far, no research has yet been done on any other field besides fields to ensure their safety on the road. Hence, they face difficulty when accessing websites.

Furthermore, during the website development, developers are focused more on the design of the website rather than the disabled's accessibility. Websites are usually designed with a colourful interface in order to make it more attractive. They will always try to create a harmonized look rather than a contrasting look which is more accessible to the colour vision deficient. They seldom think about the problems faced by the colour vision deficient people.

1.3 Statement of the Problem

Based on the result of a survey on 35 people who have colour vision deficiency, it has been proven that the existing methods, the RGB to HSV technique and the self-organising technique, cause colour confusion. In this survey, the participants are asked to evaluate several images that are transformed using these existing colour transformation methods. The details of the survey done can be referred to in Appendix C. 28 (80.0%) experienced colour confusion, 2 (5.7%) had an accurate depiction of the transformed image and 5 (14.4%) were unsure.

After analysis of the data and evaluation of their responses, it can be concluded that these methods cause colour confusion because of the following reasons:

(1) RGB to HSV Conversion Technique

This algorithm adds a fixed constant ΔH to a colour with hue value H, thus changing it to a colour that is distinguishable to the colour deficient. However, an image has several thousand colours to be processed. There is a definite probability for several colours to have almost similar hue value, H, resulting in the transformed colours having almost similar colours.

For instance, this technique has been tested on an image of red flowers with green leaves. After the transformation, the colour of the flower and the leaves look almost the same. Therefore, the transformed image looks like a blur, thus confusing the colour vision deficient.

The RGB to HSV conversion technique is mostly applied on traffic lights recognition but not on website images. It only focuses on the high values of red in the traffic lights or any other images. When it is tested with lower values, it causes colour confusion as stated above.

(2) Self-Organising Technique

This algorithm selects sample pixels and creates a three-dimesional color space codebook vector. The three-dimensional color space is projected onto a two-dimensional plane or two intersecting planes with similar normal orientations. In other words, the colour clusters or dimensions are reduced, mainly the red and the green.

When the self-organizing colour transformation method is applied on images, it is found that it works fairly well even when applied to complex images. When the method is tested on the same image of red flowers on green field, the red and green colours are transformed to yellow and blue colours respectively. However, parts of the green field were transformed into yellow colour due to the different shades of green involved, thus causing colour confusion for the colour vision deficient. In addition, the colour transformation process enhances the local contrast in order to enable better precision of colour quantization. This can cause colour discontinuity for certain images. This is further explained in Section 2.10.

Until now, no colour transformation algorithm has yet been applied to websites. The colour vision deficient face difficulty when they look at images as they surf the internet. They are unable to see the images clearly, especially when the images consist of certain colours that are undistinguishable to them. Hence, this research aims to aid them in this area.

1.4 Research Objective

The main objective of this research is to modify the RGB to HSV conversion technique so that it produces the most suitable website images for the red-green colour vision deficient viewing. First, the flaws of the existing colour transformation algorithms are identified. Generally, the algorithms used in these transformations are based on general formulaes, ignoring the visibility factor for the colour vision deficient. Because of this ignorance, both red and green are transformed into the same shade of yellow. Secondly, the algorithm is modified so that red and green specifically transforms to yellow and blue. Finally, the algorithm is tested on several images that have previously caused colour confusion, by people with colour vision deficiency.

Another objective of this research is to implement the modified colour transformation algorithm to website images to allow greater accessibility to the colour vision deficient. The images are first extracted from the websites and then passed through the algorithm for transformation. This will allow people with colour vision deficiency to have total freedom in accessing whatever websites that they choose, without wasting any time in going through some websites, just to find out that they are unable to identify the images.

1.5 Significance of the Research

This research plays an important role in helping people with colour vision deficiencies to have better discrimination and perception of the colours and ultimately, every image on the websites. Initially, they would view the images of different colours as just an image consisting of only one colour, beige with different lightness. This colour transformation algorithm transforms the colours of the original image to colours that are visible and distinguishable to them. In addition, the image becomes more attractive as they can fully understand all the colours involved.

This research is also important as it gives the colour vision deficient a chance to surf the internet without any setbacks. The colour vision deficient, except for their disability in differentiating colours, are just like everyone else and they deserve this chance to surf the internet freely. Besides, it informs the public of the difficulty they face when dealing with colours especially when viewing images. Hopefully, this research also helps to remind website developers to keep those who are colour vision deficient in mind while developing their websites.

1.6 Contribution

The previous existing algorithm is modified to correct its faults, enhancing the users' perceptibility of the whole image. The modified colour transformation algorithm minimizes the colour confusion on the transformed images. The algorithm is implemented on website images to make the websites more accessible to the colour vision deficient. The images from the websites are extracted and passed through the algorithm, where each colour pixels are analysed and categorized respectively, before the transformation process.

In this algorithm, red is transformed to yellow using the RGB transformation, and green to blue using the HSV transformation. When dealing with RGB values, it is found that when the red (R) value is equal to the green (G) value, the resultant pixel is always yellow. In the red transformation, the G value is made equal to the R value. Hence, red is always transformed into yellow. For the green transformation, after the hue value of green is determined, the ratio of that particular green with respect to the whole green band is obtained and the ratio is used to transform the green into its respective blue based on its ratio in the blue band. The colour Blue of the original image is maintained. Further details of the colour transformation process of the modified algorithm are explained in Chapter 4.

1.7 Organization of Thesis

The literature reviews of the previous works are discussed in Chapter 2. Section 2.2 discussed the types of colour deficiency and the causes of colour vision deficiency are discussed in Section 2.3. The websites design and accessibility is discussed in Section 2.4 and followed by the web accessibility tools in Section 2.5. The automatic web information extraction is discussed in Section 2.6. The RGB colour space and HSV colour space are discussed in Section 2.7 and 2.8 respectively. The RGB to HSV conversion technique is discussed in Section 2.9. The self-organising colour transformation method is discussed in Section 2.10.

The research methodology is discussed in Chapter 3. The architecture of the colour transformation process is discussed in details in Section 3.2. Section 3.3 discussed the research design in details.

The colour transformation on website images is discussed in details in Chapter 4. The red to yellow colour transformation is discussed in Section 4.2 and the green to blue colour transformation is discussed in Section 4.3. Section 4.4 discussed about maintaining the blue colour of the images during the colour transformation. In Section 4.5, HSV to RGB colour space conversion is discussed.

The evaluation of the colour transformation algorithm is discussed in details in Chapter 5. The comparison among the existing colour transformation algorithms is discussed in Section 5.2. In this section, the original images, the transformed images by previous algorithms and the transformed images by modified colour transformation algorithms are compared and discussed. In Section 5.3, the results of the transformed images are discussed. The data collected from the questionnaire is analysis and discussed in Section 5.4. Further findings from the questionnaire are discussed in Section 5.5.

The whole research is concluded in Chapter 6. The contributions are discussed in details and summarized in Section 6.2. The limitations of the research are discussed in Section 6.3. Finally, the future works are discussed in Section 6.4.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are several types of colour vision deficiency such as protanopia, protanomaly, deuteranopia, deuteranomaly, tritanopia, tritanomaly and rod monochromacy. The colours affected by each groups are different. Therefore the colour images viewed by different groups are different. The details of colour vision deficiency are discussed in Section 2.2 and the causes of colour vision deficiency are discussed in Section 2.3.

There are several rules that have been set in the process of designing an accessible websites in order to help the disable user. These rules lead to the development of web accessibility tools, which measure the level of accessibility of websites. The details of the website design and accessibility are discussed in Section 2.4. Examples of web accessibility tool are discussed in Section 2.5.

The web information extraction program is used to extract the images from the websites before passing them to the colour transformation algorithm as the input images. There are several steps taken in order to complete the extraction process. The details of automatic web information extraction are discussed in Section 2.6.

The theory of the RGB colour space and HSV colour space are studied to know have a better understanding when dealing with the colour transformation algorithm. There are two existing colour transformation algorithm, which are the RGB to HSV conversion technique and the self-organising colour transformation method. The details are discussed in Section 2.7 to 2.10.

2.2 Types of Colour Deficiency

Figure 2.1 shows the original image and the simulation results of the colour vision dificient. The image on the left is the original colour image perceived by people with normal vision. The six images on the right are the simulation results for various types of colour vision deficiency.

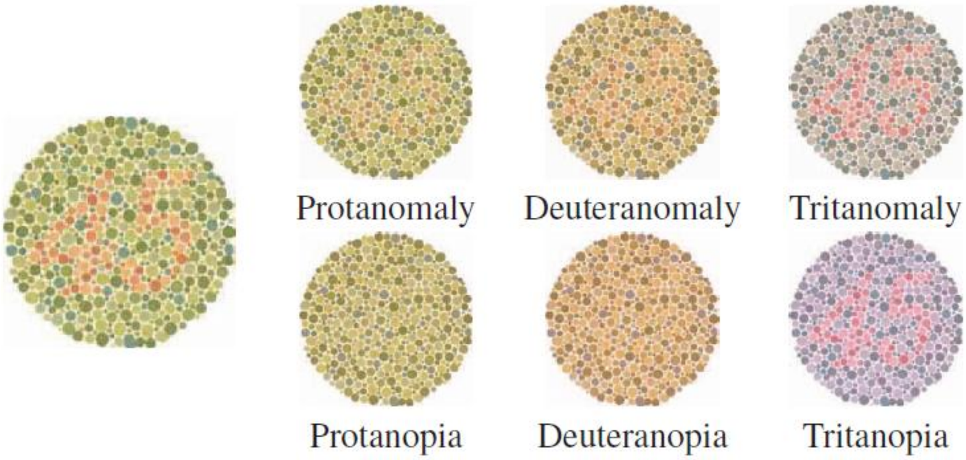

Figure 2.1: Original Colour Image and the Simulation Results for Various Types of Colour Vision Deficiency (Huang *et al.*, 2009)

2.2.1 Protanopia and Protanomaly

Protanopia is referred as 'red-absence' (Kim *et al.*, 2007). The color receptors in their eyes are not sensitive to long wavelengths colour which is the red colour. The red colour may be confused with black or dark gray, and red traffic lights may appear to be extinguished. The red colour they see looks like beige color. Beige colour also known as pale brown shades. They may learn to distinguish reds from yellows and from greens primarily on the basis of their apparent brightness, but not on any perceptible difference of hue. However, since the reddish components are so dimmed until they seem invisible, colours such as violet, lavender and purple are indistinguishable from various shades of blue.

Protanomaly is referred as ‘red-weakness’ (Kim *et al.*, 2007). Although they can distinguish some red and green color, they still cannot differentiate the color as people with normal vision. Any redness seen in a colour by normal eyes is seen more weakly by protanomalous eyes, both in terms of its saturation and its brightness. Colours such as red, orange, yellow, yellow-green and green appear shifted in hue towards green, and all appear paler than they do to normal eyes. The redness component that normal eyes see in violet or purple colours is so weakened for the protanomalous observer that the person may fail to detect it. Therefore, they see only the blue component. Hence, the violet or purple may appear to be a shade of blue to the colour vision deficient.

2.2.2 Deuteranopia and Deuteranomaly

Deuteranopia is referred as ‘green-absence’ (Kim *et al.*, 2007). The color receptors in their eyes are not sensitive to medium wavelengths color which is green color. Similar to protanopia, the green color tends to look almost the same as red color for them. Deuteranopia reduces discrimination between red, orange and yellow compared to normal. It also reduces discrimination between violet, lavender, purple and blue.

Deuteranomaly is referred as ‘green-weakness’ (Kim *et al.*, 2007). It is less serious than protanopia, protanomaly and deuteranopia. They are unable to distinguish between colours in red, orange, yellow and green region of the spectrum. These colours appear shifted towards red. Even though they cannot see red and green color in the same way as people with normal vision, they still can distinguish accurately between the shades of red and green color.

2.2.3 Tritanopia and Tritanomaly

Another type of colour vision deficiency is blue-yellow colour deficiency. Tritanopia is referred as ‘blue-absence’ (Huang *et al.*, 2007). The color receptors in their eyes are not sensitive to short wavelengths color which is blue. In general, they are confused between blue and green color. The yellow color is also affected. The yellow color they see will either disappear or appear as lighter shades of red.

Tritanomaly is very rare and its basis is unclear. It is having a mutated form of the short-wavelength (blue) pigment (Mcdowell, 2008). The short-wavelength pigment is shifted towards the green area of the spectrum. It is known that people affected by this condition have difficulty distinguishing between yellow and blue.

2.2.4 Rod monochromacy

Rod monochromacy or achromacy consists only of an extremely small minority even among the colour vision deficient (Betsy, 2003; Huang *et al.*, 2009; Mcdowell, 2008). The color receptors in their eyes cannot function at all. The receptor can only distinguish among light and dark. Therefore, this group of people cannot see any color at all. Everything that they see will be in grayscale.

2.3 Causes of Colour Vision Deficiency

Most colour vision deficiencies are caused genetically because of the sex-linked X chromosomes inheritance. They are inherited from parents and is present since birth. Colour vision deficiency is a recessive trait as opposed to normal vision which is a dominant trait. Females have two X chromosomes and males have one X chromosome and one Y chromosome. Therefore, males are almost exclusively the victim of colour vision deficiency because colour vision deficiency trait only affects X chromosome. Females have higher chance of being a carrier of colour vision deficient instead of being a colour vision deficient. According to Hood *et al.* (2006), approximately 15% of women are carriers of sex-linked X deficiency of colour vision. Figure 2.2 shows the affection of the sex-linked of parents to their kids in colour vision deficiency where

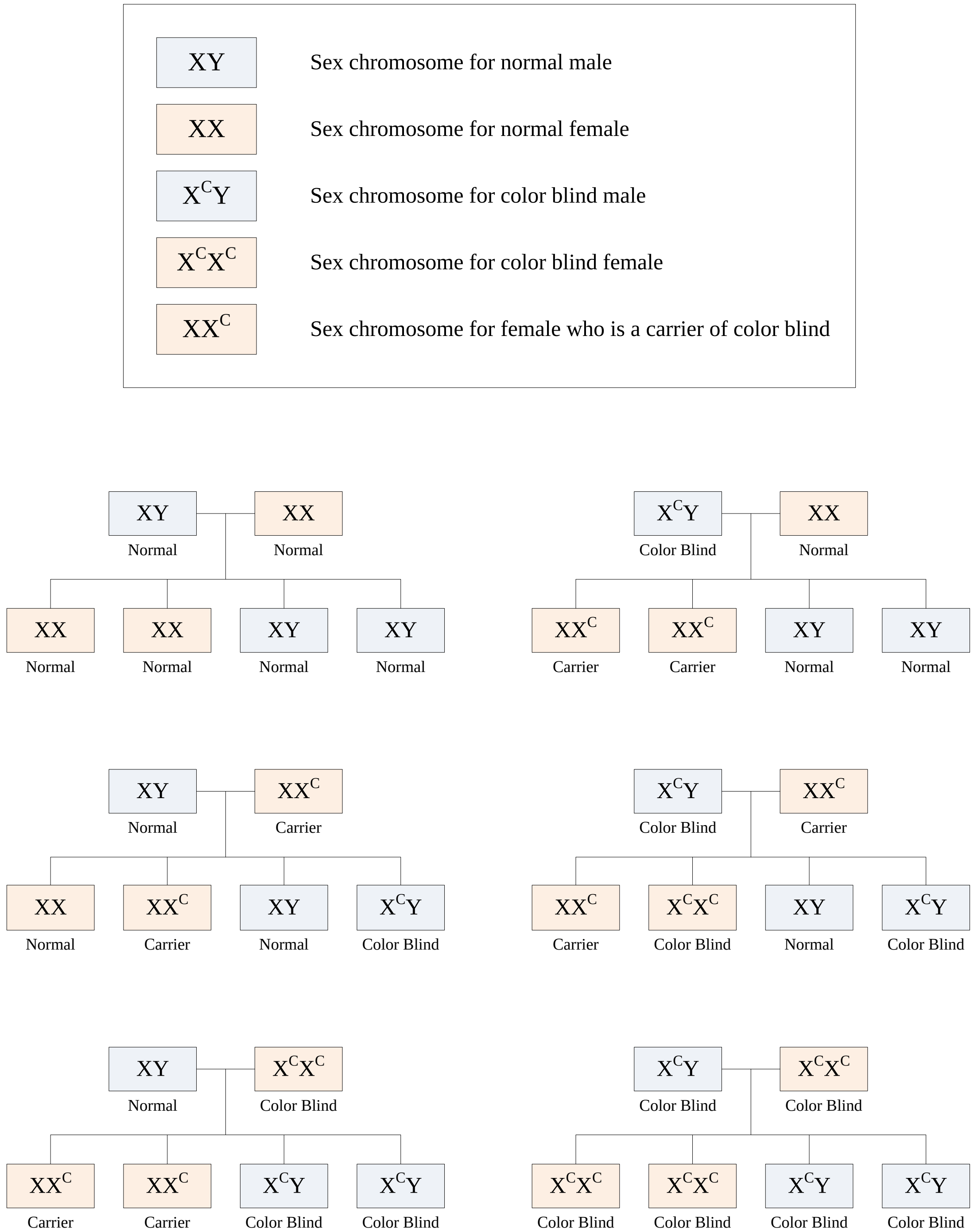

Figure 2.2: Cases of Sex-linked in Colour Vision Deficiency (Gerl and Morris, 2008)

Shaken Baby Syndrome is a form of child abuse that occurs when an abuser violently shakes an infant or small child. It causes damage on the retina and brain. Thus, the child ends up with colour vision deficiency. UV damage to the retina because of not wearing appropriate protection also leads to colour vision deficiency. Other causes of colour vision deficiency are aging problem, disease, complications cause by other eye disorders, optic nerve problems and side effects from certain medicines or medical treatments. If colour vision deficiency is caused by disease or injury, it is still possible to recover to normal vision through treatment. But if it is inherited genetically, there is no medical treatment that can cure it.

2.4 Websites Design and Accessibility

Nowadays the development of information technology and internet provides human a flood of information (Anse and Tabe, 2009; Park, 2006). The internet not only provides information, but also entertainment and news. It also can be used as a form of communication. Just by a click of a mouse, information from all around the world will be available instantly. Unfortunately, disabled people especially blind people have limitation in accessing information through the internet as many of the websites are not user friendly according to their need. According to Jati and Dominic (2008), in 2004, more than half of the websites run by disability organizations cannot meet the level of criteria set up by Web Content Accessibility Guidelines (WCAG). Loiacono and McCoy (2004) found that less than 20% of Fortune 100 websites meet the accessibility criteria according to the need of disabled people. This situation causes difficulty for disabled people as their needs on internet is no less than normal people. In terms of purpose, about 75% of them use internet to search for products and about 50% of the users access the internet to do online transaction (Loiacono and McCoy, 2004).

Website accessibility is the ability of the website to be accessed by users using all of the existing browser technology (Jati and Dominic, 2008). Website accessibility also refers to the capability of a user to understand all the information contained in the website and their ability to interact with the website if it is needed. Therefore, the World Wide Web Consortium (W3C) developed specification, rules, procedure, software and mechanism to increase the websites accessibility. The implemented rules should be followed by all the website developers. The W3C rules are divided into three priority levels. The first level is that websites must be developed so that they can be accessed by the blind (Williams, 2003). The second level includes several items that should be provided in the website so that disabled users are able to access more information on the website. Third level requires more items to be included than the second level so that the disabled user can completely access the information in the website. If the website fails to fulfill the first priority, then the disabled user will not have an opportunity to access it. If a website fails to satisfy second level, then the disabled user will encounter problems when accessing access the web. If the website satisfies the third level, then the disabled user will have a little difficulty to access the web (Loiacono and McCoy, 2004).

Researches are being done on the design of user interface for Malaysia's older adults. The major motivation for this research is the adoption of computer technology among older people in developing countries like Malaysia. Regardless of demographic and cultural characteristics, older people share similar age-related difficulties in perception, cognition and mobility which remarkably affects their daily activities including computer tasks (Hassan *et al.*, 2008). However, the problem is more apparent in Malaysia's older adults who are not only struggling with their age-related difficulties but at the same time dealing with poor user-interface design which was designed without considering their cultural preferences. According to Seman *et al.* (2009), researchers' current survey on the quality of websites shows that there are few websites that are highly usable. Approximately 75% of the websites are poorly designed (Angeli *et al.*, 2006; Sutcliffe, 2002).

Former Ministry of National Unit and Social Development in collaboration with the Malaysian Institute of Microelectronic Systems (MIMOS) in 2003 partly inspired Syariffanor to conduct a one year pilot study namely Warga Emas Networks and Eagle Nest targeted at Malaysian older adults (Hassan *et al.*, 2008). This pilot study was aimed at promoting societal inclusion and freelance employment with the use of computer and the internet among older people in Kuala Lumpur, Selangor and Kelantan. Positive results from this pilot study had initiated more research interests with regards to Malaysian older people and their interaction with computer.

2.5 Web Accessibility Tools

Since the W3C legislate its WCAG in 1997, a lot of automatic tools for web accessibility evaluation have been developed. The "Bobby" and "A-Prompt" are the most well known among them (Park, 2008). The Bobby checks the source codes that are liable to cause an accessibility problem based on WCAG, while testing the compatibility of a page. The A-Prompt developed by Toronto University Canada confirms and evaluates the accessibility based on WCAG 1.0 and provides the function of correcting an error. The "LIFT" developed by UsableNet has the strong point of simultaneously evaluating both web accessibility and web convenience.

2.6 Automatic Web Information Extraction

Web information extraction is a program that automatically extracts data and transforms it into another more structured format (Aumann *et al.*, 2006; Baumgartner *et al.,* 2005). There are three main steps in executing the information extraction process (Habegger, 2004). Step (1) is to browse into the targeted website and add the targeted information to create the extraction pattern. The rule generator remembers the extraction pattern and saved it for used of later applications (Chang *et al.*, 2003). Step (2) is to execute the extraction process to extract the information based on the extraction pattern created in step (1). The extraction process uses an automatic web information extractor called catch Crawler. It uses style sheet to extract interesting data on a target website. Style sheets are generally used for uniform presentation of website in a commercial site. In order to execute the catch Crawler, users have to let the catch Crawler know the interesting data area by clicking the data on a website. The catch Crawler automatically perceives the class of style sheet for the data and generates dataset from the whole website following the same style sheet class. Therefore, the catch Crawler automatically crawls the whole targeted website automatically to gather information from each webpage to present it to user (Shin and Jo, 2008). Step (3) is to continue to the "Next page" link and extract same type of information by using the same extraction pattern. Step (3) depends on the user's preference either to extract the next page information or not. If the user selects the "Next page" link, the process returned to step (2) until the end of the extraction and saved into the database. The whole extraction processes are simplified in Figure 2.3.

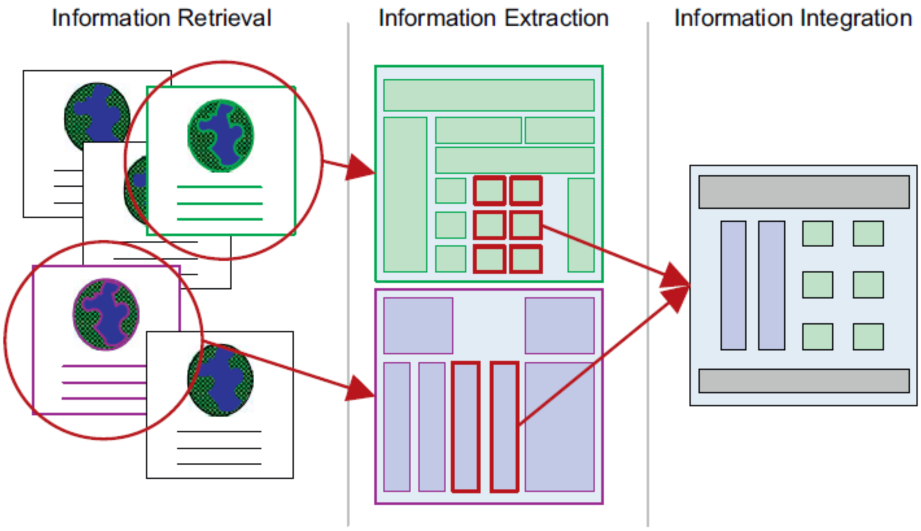

Figure 2.3: Web Information Acquisition Phases (Penna *et al.*, 2010)

2.7 RGB Colour Space

RGB are primary colousr while cyan, magenta, and yellow (CMY) are secondary colours. Primary colours are colours that no mixture of colours can result into. Secondary colour are colours made by mixing two primary colours. The mixture of same amount of each primary colour produces white colour and the mixture of same amount of each secondary colour produces black colour. Each pixel consists of three values that are red, green and blue value. These values are commonly specified using three integers between 0 and 255, representing red, green and blue intensities, in that order. For example, (0,0,0) is black, (255,255,255) is white, (255,0,0) is red, (0,255,0) is green, (0,0,255) is blue, (255,255,0) is yellow, (0,255,255) is cyan and (255,0,255) is magenta. The saturation of the red colour gets lower when the value getting nearer to 0 and vice versa. This condition also happens to green and blue colour. The descriptions of the RGB and CMY are summarized in Figures 2.4 and 2.5.

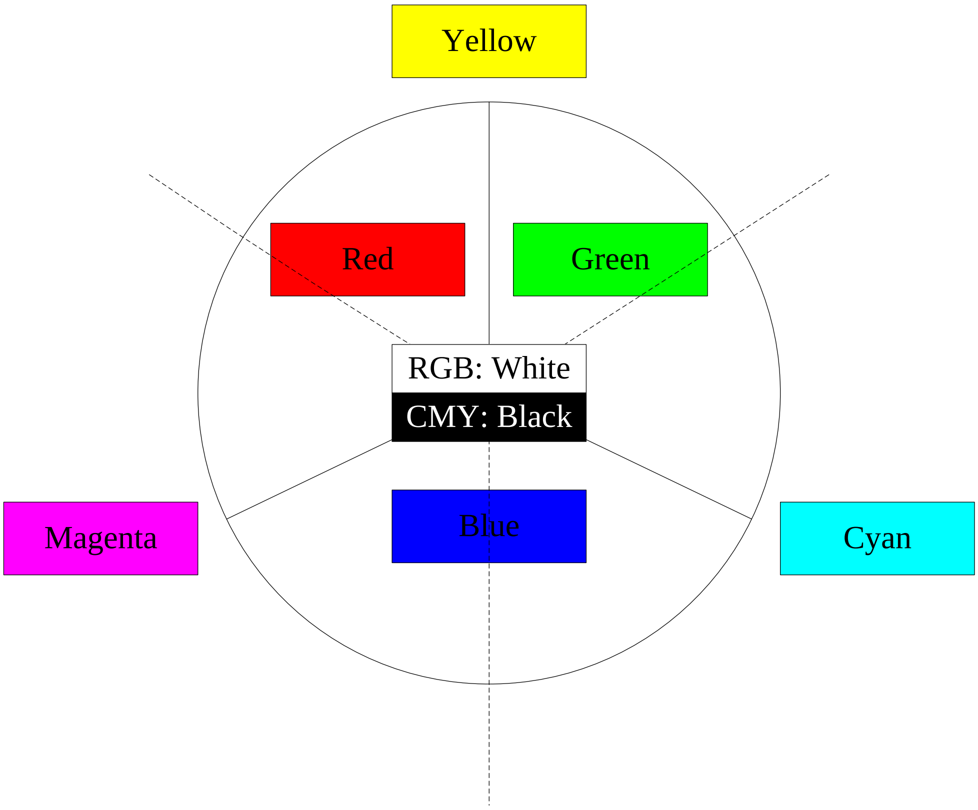

Figure 2.4: Colour Wheel of the RGB Colour Space

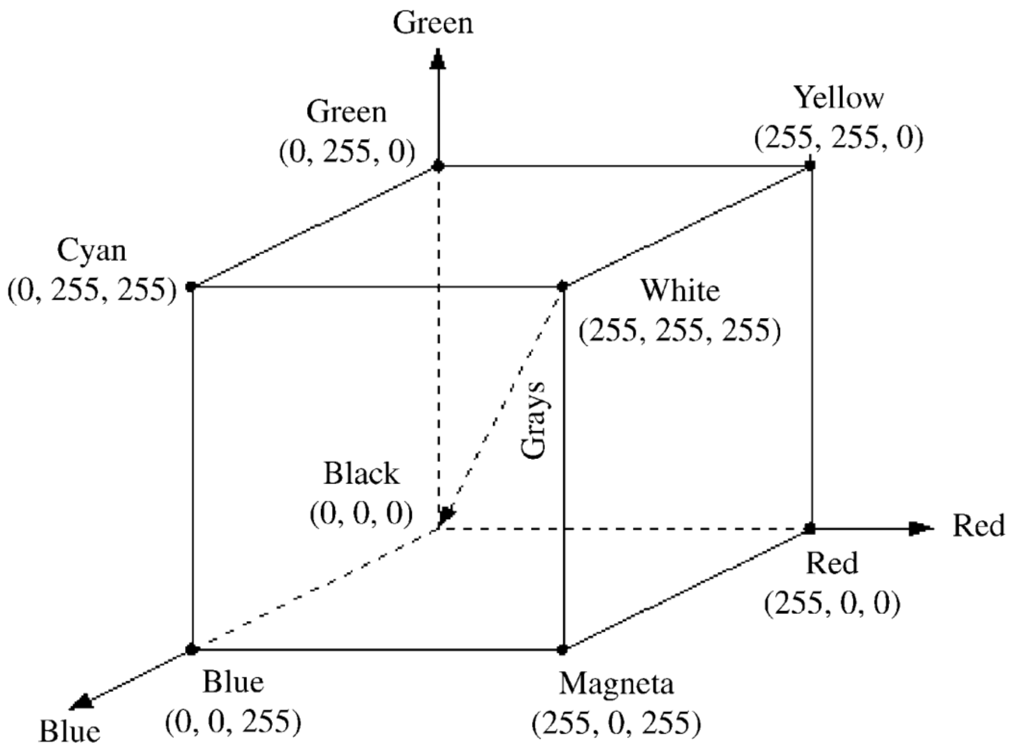

Figure 2.5: RGB Colour Space represented in a 3-dimensional Cube (Hoy, 1997)

2.8 HSV Colour Space

Figures 2.6 and 2.7 show the model of the HSV colour space. The intensity and the value in the models are referring to the brightness of the colour. In the cylinder, the angle around the central vertical axis corresponds to hue. The range of the hue value is from 0° to 360° (Cheng *et al.*, 2001). The distance from the axis corresponds to saturation. The distance along the axis corresponds to brightness. The value of saturation and brightness is between 0 and 240. The higher the value of saturation, the more saturated it is. The higher the value of the brightness, the more bright it is.

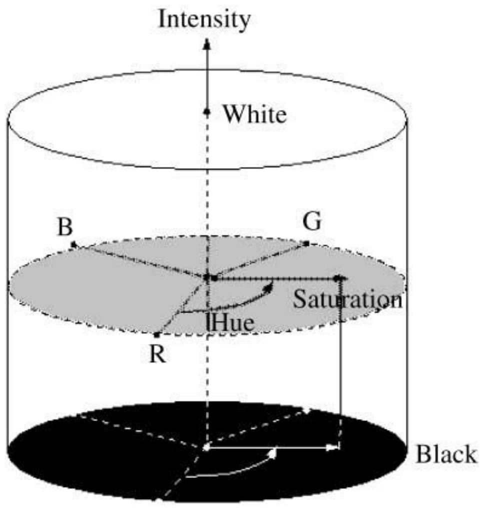

Figure 2.6: HSV Cylindrical Model (Hoy, 1997)

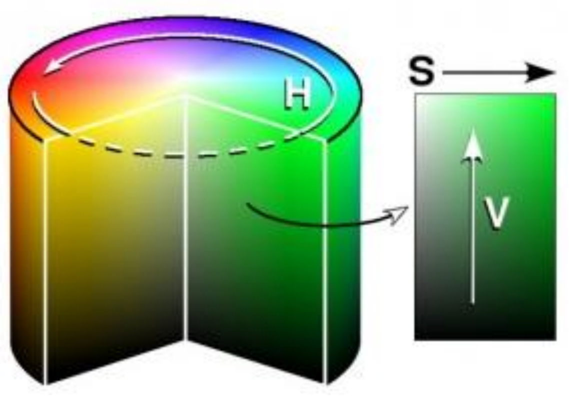

Figure 2.7: HSV Colour Space (http://www.factarchive.com/encyclopedia/HSV_color_space, Accessed 15th December 2009)

Figure 2.8 shows the degree of hue. The pure red colour falls in 0° or 360°, the pure green colour falls in 120° and the pure blue colour falls in 240°. Pure colour of RGB means that it contains 100% of that particular colour only. For example, the pure red colour consists of the red, green and blue colour with the value 255, 0 and 0 respectively. This same condition happens to the green and blue colour. The pure yellow colour falls in 60°, the pure cyan colour falls in 180° and the pure magenta colour falls in 300°.

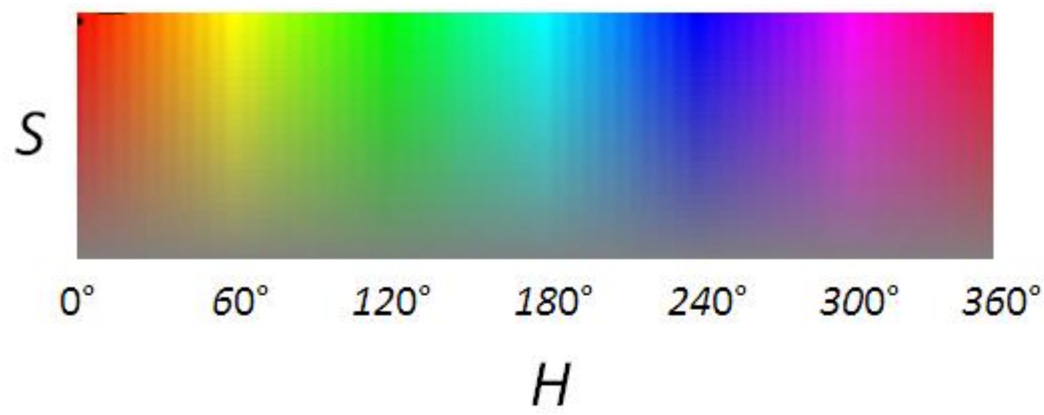

Figure 2.8: Degree of Hue

2.9 RGB to HSV Conversion Technique

Colour Vision Assist System by Ohkubo and Kobayashi (2008) and Visual Auxiliary System by Lai and Chang (2009) are developed in order to compensate color for color vision deficient. In both systems, the captured image in RGB colour space is converted to HSV colour space which enables the defective colour range to be avoided easily. The image is then passed to the image processing unit to transform the colours that are invisible for the color vision deficient. The colour transformation enhances the color difference depending on the defective color type. In the final step, the transformed image is then converted back to RGB colour space for the output purpose. Figure 2.9 shows a schematic diagram of the both system.

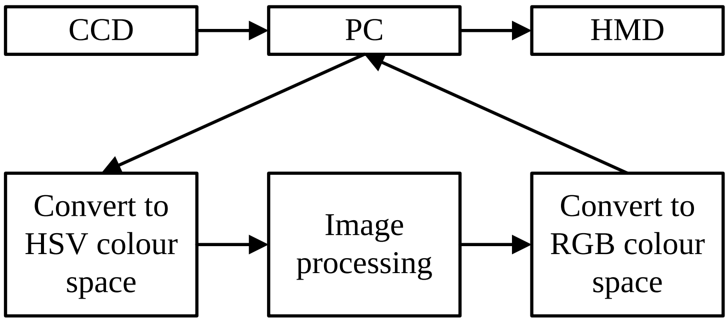

Figure 2.9: Block Diagram of System (Ohkubo and Kobayashi, 2008)

The image processing unit transforms all the colours into colours that the color vision deficient can identify. After the conversion from RGB colour space to HSV colour space, the hue value is adjusted to transform the colours that cannot be identified by the red-green color vision deficient into the colours that they can. The adjustment of hues by Lai and Chang (2009) and Yang and Ro (2003) is described as follows:

$$H' = H + \Delta H; \quad S' = S; \quad V' = V \qquad \text{Equation 2.1}$$

where H' indicates corrected hue

S' indicates corrected saturation

V' indicates brightness values

ΔH indicates hue displacement value

There are three areas of saturation, which are high-saturation colours, mid-saturation colours and low-saturation colours. The high-saturation area is reserved while the mid-saturation area is replaced with the originally mistaken saturation to