



A survey paper on Biometric based Face detection techniques

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Abstract: As continual research is being conducted in the area of Biometrics, one of the most practical applications under strong development is in the construction of a face detection system. a comprehensive description of biometric recognition based on the most popular human biometric traits is provided. The term Biometrics is becoming highly important in computer security world. The human physical characteristics like fingerprints, face, hand geometry, voice and iris are known as biometrics. We present a comprehensive and critical survey of face detection algorithms. Face detection is a necessary first-step in face recognition systems, with the purpose of localizing and extracting the face region from the background. It also has several applications in areas such as content-based image retrieval, video coding, video conferencing, crowd surveillance, and intelligent human-computer interfaces. However, it was not until recently that the face detection problem received considerable attention among researchers. The human face is a dynamic object and has a high degree of variability in its appearance, which makes face detection a difficult problem in computer vision. A great emphasis was placed on the face characteristics, particularly on the state of the art of the component-based face detection. While the problem of recognizing faces under gross variations remains largely unsolved, a demonstration system as proof of concept that such systems are now becoming practical have been developed. A system capable of reliable detection, with reduced constraints in regards to the facial position and expression of the face and the illumination variation and background of the image has been implemented. In this paper, an attempt is made to compare existing face detection algorithms which are widely used and subject of interest.

Keywords: Biometric, Face detection, Feature based, Color space model, YCbCr method.

I. Introduction

J. Prakash, and K. Rajesh V et. al [1] The term Biometrics is becoming highly important in computer security world. The human physical characteristics like fingerprints, face, hand geometry, voice and iris are known as biometrics. These features are used to provide an authentication for computer based security systems. The existing computer security systems used at various places like banking, passport, credit cards, smart cards, PIN , access control and network security are using username and passwords for person identification. The username and password can be replaced and/or provide double authentication by using any one of the biometric features. Biometrics refers to technologies used to detect and recognize human physical characteristics.

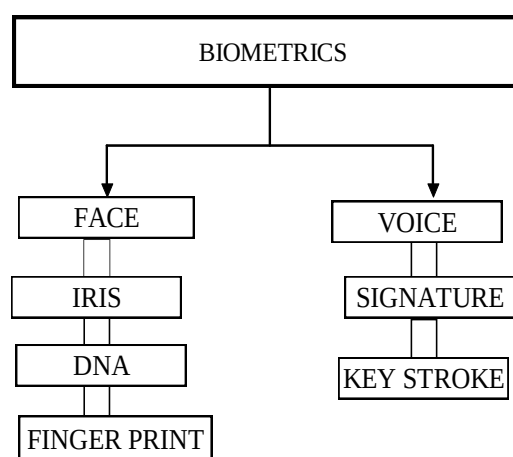


Figure 1. Biometrics model

In the IT world, biometrics is often synonymous with "biometric authentication," a type of security authorization based on biometric input. There are several types of biometric authentication. Common examples include fingerprint scanning, retinal scanning, facial recognition, and voice analysis. A facial recognition system, for instance, uses a camera to capture an image of a person's face. The photograph is then recorded and processed using biometrics software. The software attempts to match the scanned image with an image from a database of

users' photos. If the scan is close enough to a specific user, the person will receive authorization to continue. Biometric is automated methods of identifying a person or verifying the identity of a person based on a physiological or behavioural characteristic. Examples of physiological characteristics include hand or finger images, facial characteristics. Behavioural characteristics are traits that are learned or acquired. Dynamic signature verification, speaker verification and keystroke dynamics are examples of behavioural characteristics. Biometric authentication requires comparing a registered or enrolled biometrics sample against a newly captured biometric sample for example, a fingerprint captured during a login. During enrolment a sample of the biometric trait is captured, processed by a computer, and stored for later comparison. This is also called —one-to-one matching. In most computer access or network access environments, verification mode would be used. A user enters an account, user name, or inserts a token such as a smart card, but instead of entering a password, a simple touch with a finger or a glance at a camera is enough to authenticate the user. In some computers have a finger scanner that allows you to authenticate yourself by swiping your finger across a sensor. Instead of entering a username and password, the finger scan provides your authorization. Some retail outlets now use finger scanners to verify people's identity as an alternative to entering a unique pin number. High-security government and office buildings may even require of retinal scans in order to access certain areas of the building. In some cases, a key card, pass code, or login is required in addition to a biometric scan in order to provide extra security. Tanmoy Mondal, Anupam Nath, V. et. al [2] recognition is a field of biometrics together with fingerprint recognition, iris recognition, and speech recognition and so on. Automatic extraction of human head and face boundaries and facial features are critical in the areas of face recognition, criminal identification, security, surveillance systems.

II. Physiological

Physiological biometrics is based on data derived from direct measurements of parts of the human body. Fingerprints, iris scans, retina scans, hand geometry, and facial recognition are leading physiological biometrics.

A. Face

Sulochana Sonkamble, Dr. Ravindra Thool, Balwant Sonkamble et. al [3] The face is the commonly used biometric characteristics for person recognition. The most popular approaches to face recognition are based on shape of facial attributes, such as eyes, eyebrows, nose, lips, chin and the relationships of these attributes. As this technique involves many facial elements; these systems have difficulty in matching face images. The face recognition systems which are used currently impose number of restrictions on how facial images are obtained. This face recognition system automatically detects the correct face image and is able to recognize the face.

B. Iris

The iris is biological feature of a human. It is a unique structure of human which remains stable over a person's lifetime. The iris is the annular region of the eye. The left and right irises of an individual can be treated as separate unique identifiers. There is a very low false acceptance rate as compared to other biometrics like finger print, face, hand geometry and voice. Iris and retinal scans are two completely different methods of identification.



C. DNA

The biometric authentication technologies, typified by fingerprint, face recognition and iris scanning, have been making rapid progress. Retinal scanning, voice dynamics and handwriting recognition are also being developed. These methods have been commercialized and are being incorporated into systems that require accurate on-site personal authentication. However, these methods are based on the measurement of similarity of feature-points. This introduces an element of inaccuracy that renders existing technologies unsuitable for a universal ID system. Among the various possible types of biometric personal identification system, deoxyribonucleic acid (DNA) provides the most reliable personal identification. It is intrinsically digital, and does not change during a person's life or after his/her death.



D. Finger print

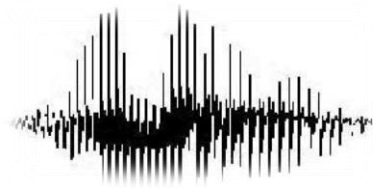
This method is traditional and it gives accuracy for currently available Fingerprint Recognition Systems for authentication. This fingerprint recognition system is becoming affordable in a large number of applications like banking, Passport etc.

III. Behavioural characteristics

Behavioural characters are based on a person's actions. Behavioral biometrics, in turn, are based on measurements and data derived from an action, thus indirectly measuring characteristics of the human body. Voice recognition, keystroke scans, and signature/sign scans are leading behavioral biometric technologies. One of the defining characteristics of a behavioral biometric is the incorporation of time as a metric, i.e., the measured behavior has a beginning, middle, and an end. Although behavioural biometrics are based on an individual's actions, those actions are in turn influenced by physiological attributes such as the size of a person's hand (in a signature scan) or the shape of their vocal chords (in voice recognition).

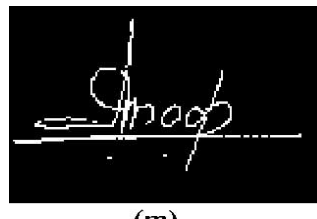
A. Voice

The voice recognition systems have been currently used in various applications. Voice is combination of physical and behavioural biometrics. The features of person voice are based on the vocal tracts, mouth, nasal activities and lips movement that are used synthesis of sound. These physical characteristics of human speech are invariant for individuals.



B. Signature

Biometric signature technology uses the dynamic analysis of a signature to authenticate a person. The technology is based on measuring speed, pressure and angle used by the person when a signature is produced. One focus for this technology has been e-business applications and other applications where signature is an accepted method of personal authentication.



IV. Application of biometric

- Information security
- Access management
- Biometrics
- Personal security
- Entertainment leisure
- Commercial
- Government

V. Biometric Advantages

- No more forgotten or stolen passwords.
- Positive and accurate Identification
- Highest level of security

- Offers mobility
- Impossible to forge

VI. Face detection

The face is the commonly used biometric characteristics for person recognition. The most popular approaches to face recognition are based on shape of facial attributes, such as eyes, eye brows, nose, lips, chin and the relationships of these attributes. All these attributes of the face image are shown in figure .As this technique involves many facial elements; these systems have difficulty in matching face images. The face recognition systems which are used currently impose a number of restrictions on how facial images are obtained. This face recognition system automatically detects the correct face image and is able to recognize the person. Detection of the human face is an essential step in many computer vision and biometric applications such as automatic face recognition, video surveillance, human computer interaction (HCI) and large-scale face image retrieval systems. The first step in any of these face processing systems is the detection of the presence and subsequently the position of human faces in an image or video. The main challenge in face detection is to cope with a wide variety of variations in the human face such as face pose and scale, face orientation, facial expression, ethnicity and skin color. External factors such as occlusion, complex backgrounds, inconsistent illumination conditions and quality of the image may also contribute significantly to the overall problem. Sania Arjomand Inalou *et al.* [4] Ada-Boost classifier was then used to choose a small number of important features and combines them in a cascade structure to decide whether an image is a face or a non-face fast and robust face detection issues under the illumination change and complex scenes by introducing human skin color detection and the modified census transform MCT. Xinyu Wang *et al.* [5] The identification of a person by their facial image can be done in a number of different ways such as by capturing an image of the face in the visible spectrum using an inexpensive camera or by using the infrared patterns of facial heat emission. Facial recognition in visible light typically model key features from the central portion of a facial image. Several approaches to modelling facial images in the visible spectrum are Principal Component Analysis, Local Feature Analysis, neural networks, elastic graph theory, and multi-resolution analysis.

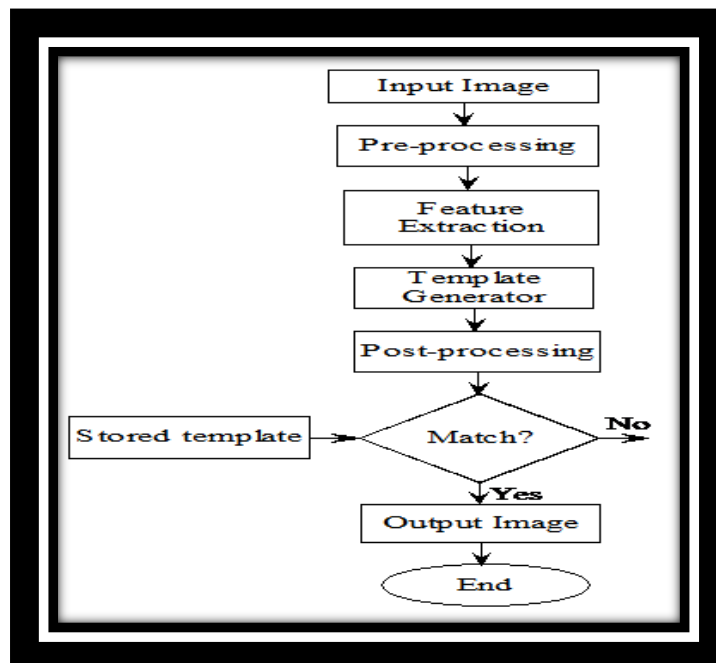


Figure 2 Flow chart of Face detection

VII. Face Detection: challenges

- Out-of-Plane Rotation: frontal, 45 degree, profile, upside down
- Presence of beard, mustache, glasses etc
- Facial Expressions
- Occlusions by long hair, hand
- Image conditions
- Lighting condition
- Distortion

VIII. Types of Face detection

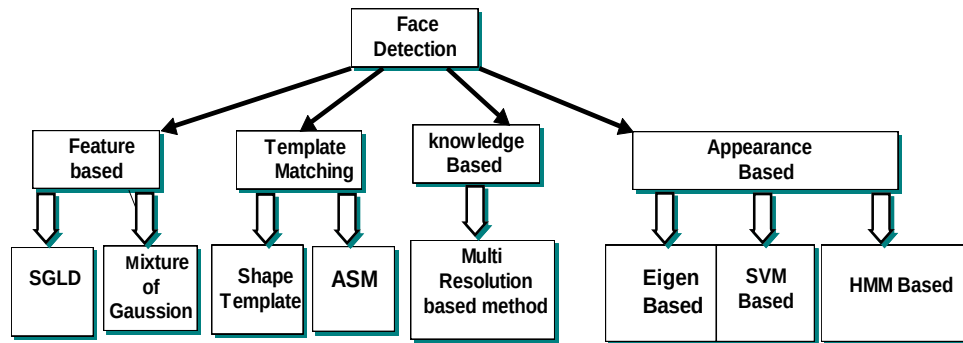


fig.2 Type of Face Detection

A. Knowledge based

Encode The problem of face detection in still images is more challenging and difficult when compared to the problem of face detection in video or real time applications since motion information can lead to probable. S.P.Khandait, R.C.Thool V et. al [6] This approach depends on using rules about human facial features to detect faces. Human facial features for examples as two eyes that are symmetric to each other, a nose and mouth, and features relative distances represent features relationships. After detecting features, a verification process is done to reduce false detection. This approach is good for frontal images and the difficulty of it is to translate human knowledge into known rules and to detect faces in different poses.

B. Appearance based

The third method on appearance based Techniques which includes neural networks, linear subspace methods like Eigen faces, fisher faces, Eigen faces with background learning and statistical approaches like support vector machines, higher order statistics, distribution based and information theoretical approaches.

- ❖ Neural network
- ❖ Multilayer Perceptions
- ❖ Principal Component Analysis (PCA), Factor Analysis
- ❖ Support vector machine (SVM)
- ❖ Mixture of PCA, Mixture of factor analyzers
- ❖ Distribution Distribution-based method
- ❖ Naïve Bayes classifier
- ❖

C. Template matching

The fourth method is based on Template matching, which use predefined templates such as Shape templates, Deformable template like Active shape model etc.

- ❖ Store a template
- ❖ Predefined: based on edges or regions
- ❖ Deformable: based on facial contours (e.g., Snakes)
- ❖ Templates are hand-coded (not learned)
- ❖ Use correlation to locate faces
- ❖

D. Feature based

The development of the feature-based approach can be further divided into three areas. Given a typical face detection problem in locating a face in a cluttered scene, low-level analysis first deals with the segmentation of visual features using pixel properties such as gray-scale and colour. Because of the low-level nature, features

generated from this analysis are ambiguous. In feature analysis, visual features are organized into a more global concept of face and facial features using information of face geometry. Erik Helms, Boon Kee Low *et al.* [7] The development of the feature-based approach can be further divided into three areas. Given a typical face detection problem in locating a face in a cluttered scene, low-level analysis first deals with the segmentation of visual features using pixel properties such as gray-scale and colour.

IX. Types of Face detection

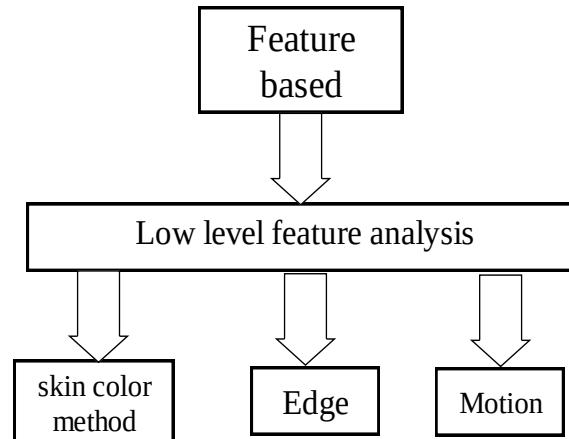


Figure 4 Feature based methods

Feature-based techniques depend on feature derivation and analysis to gain the required knowledge about faces. Features may be skin colour, face shape, or facial features like eyes, nose, etc. Feature methods are preferred for real time systems where the multi-resolution window scanning used by image based methods are not applicable method.

- ❖ Bottom-up approach: Detect facial features (eyes, nose, mouth, etc) first
- ❖ Facial features: edge, intensity, shape, texture, color, etc
- ❖ Aim to detect invariant features
- ❖ Group features into candidates and verify them
- ❖ Bottom-up approach: Detect facial features (eyes, nose, mouth, etc) first
- ❖ Facial features: edge, intensity, shape, texture, color, etc
- ❖ Aim to detect invariant features
- ❖ Group features into candidates and verify them

Szabolcs Sergyán *et al.* [8] Among the different stages use of colour in face detection is probably the most obvious. It is generally used to select the skin-like colorations. Then, simple refining procedures can be launched to discriminate the faces from other skin-like regions, such as hands, wood, etc. Thus, much faster face detectors are generally obtained when the colour cue is considered. Using the fact that some facial features, such as eyes, are darker than their surrounding regions, holes should then appear in the face area when labelling the skin pixels.

A. Edge detection

[7] Few techniques exist for an edge-based correspondence analysis in colour stereo images. This can lie first in the fact that an edge generally contains no colour information, or second, that edge-based techniques are frequently selected for reasons of reducing computation time. As a rule, the analysis of colour images needs, more computation time than a corresponding analysis of gray-level images. Furthermore, due to the correlation between the colour channels, at least 90% of the edges are identical in gray-level and colour images. Exceptions arise when neighbouring objects in the scene demonstrate the same brightness but differing hues. In these cases no edges can be detected in the gray-level image. By using a "good" colour edge finder, the number of edges found can increase up to 10%. Since only edges that were detected can be matched, a certain improvement of the results is to be expected. Gnanatheja Rakesh V, T Sreenivasulu Reddy *et al.* [9] Edge detection is an important image processing tool that is used as a fundamental pre-processing step in many image processing applications. Edges map have a significant role in application such as image categorization, image registration, feature extraction, and pattern recognition. An edge detector can be defined as a mathematical operator that responds to

the spatial change and discontinuities in gray levels of pixels set in an image with the help of detectors, we can find the edges of skin, which is useful for face detection.

B. Motion based

[7] Motion information is a convenient way of locating moving objects when a video sequence is provided. Using this information the face searching area can be narrowed. If the use of a video sequence is available, motion information is convenient means of locating moving objects. A straightforward way to achieve motion segmentation is by frame difference analysis. This approach, whilst simple, is able to discern moving foreground efficiently regardless of the background content. If the use of a video sequence is available, motion information is convenient means of locating moving objects. A straightforward way to achieve motion segmentation is by frame difference analysis. This approach, whilst simple, is able to discern moving foreground efficiently regardless of the background content. In moving silhouettes that include face and body parts are extracted by thresholding accumulated frame difference. Besides face region, also employ frame difference to locate facial features. The existence of an eye-pair is hypothesized by measuring the horizontal and the vertical displacements between two adjacent candidate regions obtained from frame difference. Another way of measuring visual motion is through the estimation of moving image contours. Compared to frame difference, results generated from moving contours are always more reliable, especially when the motion is in significant. Optical flow reflects the image changes due to motion during a time intervals. Optical flow calculation is a prerequisite for higher level processing which can solve motion problems. There are different ways to calculating optical flow. Usman Qayyum *et. al* [10] In mostly surveillance applications, background subtraction is commonly used class of techniques for segmenting out objects of interest in a scene. It involves comparison of an observed frame of video with an estimate of the image (background model) with no object of interest. Colour cue combined with motion detection results in improvement of skin region classification whereas enforcing the constraint of static background.

C. Skin colour method

Tarek M. Mahmud *et. al* [7] skin detection is a very popular and useful technique for detecting and tracking human-body parts. It receives much attention mainly because of its wide range of applications such as, face detection and tracking, naked people detection, hand detection and tracking, people retrieval in databases and Internet, etc. The main goal of skin colour detection or classification is to build a decision rule that will discriminate between skin and non-skin pixels. Identifying skin colour pixels involves finding the range of values for which most skin pixels would fall in a given colour space. In general, a good skin colour model must have a high detection rate and allow false positive rate. That is, it must detect most skin pixels while minimizing the amount of non-skin pixels classified as skin. Commonly used skin detection algorithms can detect skin regions accurately. daily life, Andreas Koschan and Mongi[11] our vision and actions are influenced by an abundance of geometry and colour information. When crossing a street, we identify a technical apparatus by its geometry as a traffic light. However, only by analyzing colour information do we subsequently decide whether we are to continue, if the light is green, or stop, if the light is red. A camera-assisted driving information system should be able to evaluate similar information and either passes the information onto the driver of a vehicle or directly influence the behaviour of the vehicle. The latter is of importance, for example, for the guidance of an autonomous vehicle on a public road. Something similar to this applies to traffic signs, which can be classified as prohibitive, regulatory, or informative signs based on colour and geometric. These techniques are denoted as physics-based vision techniques. The invariant extraction of colour information in relation to varying lighting conditions and description of image characteristics represents another problem in computer vision. Here promising vector-valued techniques for so-called colour constancy can make an important contribution. Xue-wu ZHANG, Ling-yan LIANG Low *et. al* [12] Research shows that: even though of different races, different ages and different gender, the difference in color chrominance is far less than the difference in the brightness. Skin distribution shows clustering distribution in the skin-color space without luminance influence. The research of a large number of color pixels shows that skin-color cluster a very small range of YCbCr color space.

X. Types of color space model

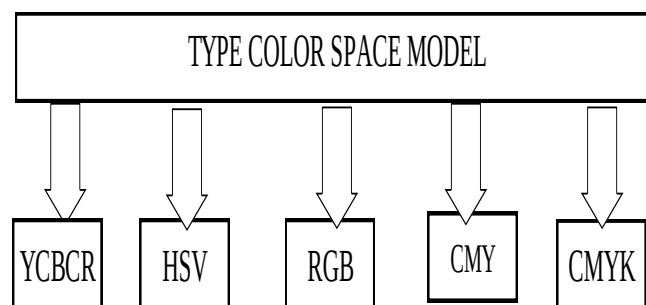


Figure 5 Types of Color Space model

A. YCbCr color model

YCbCr Mode. Swapnil V Tathe and Sandipan P Narote v et. al [13] The mostly used colour space is YCbCr where Y is luminance component, Cb is blue chrominance and Cries red chrominance. The chrome component is represented only by blue and reads the sum of chromo value of red, green and blue component is always constant. The separate luma and chrome component makes this model illumination invariant. The conversion from RGB to YCbCr is done.

Using following equations:

$$Y = 0.299R + 0.587G + 0.114B$$

$$Cb = 128 (-0.169R + 0.331G + 0.5B)$$

$$Cr = 128(0.5R + 0.419G + 0.081B)$$

Smita Tripathi, Varsha Sharma, Sanjeev Sharma v et. al [14] The skin colour detection is an important role in the face detection. It can be used to detect the skin region or non- skin region in the images. First we can choose the suitable colour spaces in the skin colour detection. There are various colour spaces such as, RGB (Red Green Blue), NTSC, YCbCr, HSV, CMY, HIS, YUV, CIE-Lab etc. In the NTSC colour space, the main advantages of this colour space are that gray-scale information is separate from colour data. It can consist the three components such as luminance (Y), hue (I), and saturation (Q). The YCbCr colour space is widely used in the digital images and the digital videos. In the YCbCr, Y is the luminance information of the component, and colour information is stored as two colour difference components, Cb and Cr. Cb is the difference between the blue component and a reference value and Cr is the difference between the red component and a reference value. The HSV (Hue Saturation Value) colour space is one of several colour systems used by people to select colours. The CMY (Cyan Magenta Yellow) colour space. The HSI (Hue Saturation Intensity) colour space, it is widely used in skin colour detection. YIQ and YUV are an along spaces, while YCbCr is a digital colour system. versa Powar Aditi jahagirdar, sumedha sirsikar v et. al [15] the YCbCr space was chosen for following reasons:

- ❖ Bitmap images used the R-G-B planes directly to represent colour images. But medical research proved that the human eye has different sensitivity to colour and brightness. Thus there came about the transformation of RGB to YCbCr.
- ❖ The luminance component (Y) of YCbCr is independent of the colour, so can be adopted to solve the illumination variation problem and it is easy to program.

B. HSV based method

The HSV (Hue, Saturation, and Value) model, also called HSB (Hue, Saturation, and Brightness), defines a colour space in terms of three components: Hue (H), the colour type (such as red, green). It ranges from 0 to 360 degree, with red at 0 degree, green at 120 degree, blue at 240 degree and so on. Saturation (S) of the colour ranges from 0 to 100%. Also sometimes it called the "purity". The lower the saturation of a colour, the more "greyness" is present and the more faded the colour will appear. Value (V), the Brightness (B) of the colour ranges from 0 to 100%. It is a nonlinear transformation of the RGB colour space. Note that HSV and HSB are the same. Some applications use also other kinds of this model. For instance, S and B/V with can vary from 0 up to 1, H may be normalized to 0-100%, or all three parameters can vary from 0 up to 255. Just Colour Picker uses the [degree, percent, percent] notation. It is sometimes preferable in working with art materials, digitized images, or other media, to use the HSV or HSL colour model over alternative models such as RGB or CMYK, because of differences in the ways the models emulate how humans perceive colour. RGB and CMYK are additive and subtractive models, respectively, modelling the way that primary colour lights or pigments (respectively) combine to form new colours when mixed.

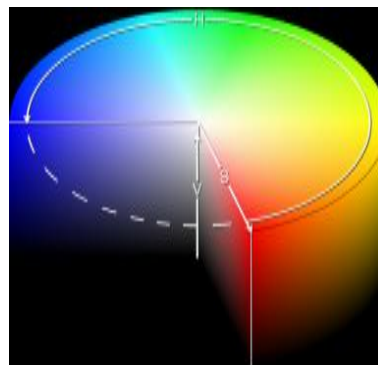


Figure 6 HSV Colour Model

C. RGB Colour Model

An RGB colour space is any additive colour space based on the RGB colour model. A particular RGB colour space is defined by the three chromaticity's of the red, green, and blue additive primaries, and can produce any chromaticity that is the triangle defined by those primary colours. The complete specification of an RGB colour space also requires a white point chromaticity and a gamma correction curve. RGB is an abbreviation for red–green–blue. An RGB colour space can be easily understood by thinking of it as "all possible colours" that can be made from three colorants for red, green and blue. Imagine, for example, shining three lights together onto a white wall: one red light, one green light, and one blue light, each with dimmer switches. If only the red light is on, the wall will look red. If only the green light is on, the wall will look green. If the red and green lights are on together, the wall will look yellow. Dim the red light and the wall will become more of a yellow-green. Dim the green light instead, and the wall will become more orange. Bringing up the blue light a bit will cause the orange to become less saturated and more whitish. In all, each setting of the three dimmer switches will produce a different result, either in colour or in brightness or both. The set of all possible results is the gamut defined by those particular colour lamps. Swap the red lamp for one of a different brand that is slightly more orange, and there will be slightly different, and more limited gamut, since the set of all colours that can be produced with the three lights will be changed.

D. CMY&CMYK Colour Model

The CMY and CMYK color spaces are often used in color printing. A CMY color space uses cyan, magenta, and yellow (CMY) as its primary colors. Red, green, and blue are the secondary color. The following figure is color representations of the CMY color space. The CMY color space is normalized.

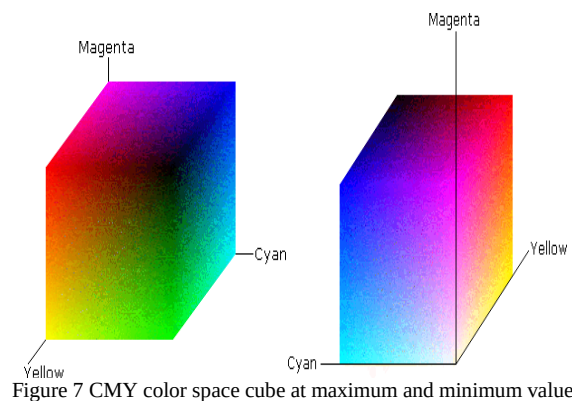


Figure 7 CMY color space cube at maximum and minimum value

The CMY color space is subtractive. Therefore, white is at (0.0, 0.0, 0.0) and black is at (1.0, 1.0, 1.0). If you start with white and subtract no colors, you get white. If you start with white and subtract all colors equally, you get black. The CMYK color space is a variation on the CMY model. It adds black (Cyan, Magenta, Yellow, and black). The CMYK color space closes the gap between theory and practice. In theory, the extra black component is not needed. However, experience with various types of inks and papers has shown that when equal components of cyan, magenta, and yellow inks are mixed, the result is usually a dark brown, not black. Adding black ink to the mix solves this problem. The CMY and CMYK colors spaces can be device independent, but most often they are used in reference to a specific device.

XI. Conclusion

Face detection is an emerging field which can have great impact in making security systems more reliable and developing HCI applications. This paper presents different methods of face detection techniques. Basically for Face detection we have summarized different techniques that how face are detected with the help of those techniques such as for skin detection we have different techniques like HSV, YCbCr, CMY, CMYK, HCI etc. In which we identified skin and non-skin pixels for various skin colours from white to black and other colours. YCbCr method for face detection is simplest methods because it gives better result comparison to other techniques. Skin colour based method proposed in this paper is resistive to pose and illumination variation and requires less computation time. We also implement these methods in real time application.

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