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Face Recognition using Content Based Image Retrieval for Intelligent Security

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Abstract**—** *This paper try to construct an intelligent security system based on face recognition. The data used in this research are frontal face images and without obstacles, and facial images with obstacles. In this research, we used Content Based Image Retrieval or CBIR method. Approximately 10,000 images used in this work which is collected from internet, police department office, and shooting directly as primary data. Facial image data are stored in the database object-based files through process of identification and facial recognition. Consequently, facial images are retrieved using facial similarity techniques. In this stage of identification , an application can specify shape of the front face, performs feature extraction, and running intelligent Similarity (matching face data) which open the door automatically . This system can be used to minimize the occurrence of criminality occurs nowadays. This system can be used such as for house door security, office doors, and airport gates. The experiments result show that our algorithm quite good in face detection and recognition to open the door.*

Keywords**— Face recognition; CBIR; intelligent: security system; criminal; similarity.**

I. INTRODUCTION

. The development of face recognition techniques is quite difficult because human faces are complex, multidimensional, and often change according to circumstances and situations. Therefore, the creation of an automatic facial recognition and / or facial expression system is a challenge for experts to date. Biometrics is a self-recognition technology using body parts or human behavior. Some of them are fingerprint, retina, iris, patterns of the face [1]. One of the most widely used in recently research face detection and face recognition [2],[3]. Meanwhile [4] states that face recognition systems been recognized almost 50 years ago, it is a branch of the field of pattern recognition and computer vision. Face recognition is also a branch of the nature of human biometrics. [5] ,[6] . Recently, higher number of criminal occurs, causing the security system to be absolute tightly applied. It is required a security system device that keep full time protection for assets and privacy. Therefore, with this security system application able to provide a sense of safety and comfort for us. In addition to this it may reduces criminal rates which occur in the community.

Door is an example of the utmost importance in home security, company, government offices, and other important buildings and houses. The existence of door security systems installation is an automation as a positive impact of technology developments. Automation will replace of the human role by a tool or machine, since basically the gate will open itself when a password is entered correctly. In the future a door should not be kept constantly by humans because the system is also equipped with alarms when the door is forcibly opened by unauthorized person. An Intelligent system was built in this research using Content Based Image Retrieval method. This intelligent system is targeted to replace a text-based conventional security system that is so easy to be "hacked" by unauthorized people.

In this paper will explore face recognition to build intelligent system to access and open doors or gate automatically. In section 2 will present related works of the research, section 3 provides methods of the work, while section 4 will provide the results as well as discussion of it, finally section will provide the conclusion and future works of the research,

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II. RELATED WORKS

2.1. Face recognition

According to [7] face recognition system is a computer application for automatically identifying or verifying a person from a digital image or a single frame from a video source. This can be carried out by comparing selected facial characteristics of the likeness and a facial database. It performs that by matching the face of the retrieving user with a database of faces formerly stored in memory. Face recognition offerings a interesting issues in the area of image analysis and computer vision, and it has acknowledged a great deal of interest over the last few years since of its applications in different areas. There are many issues occur due to many factors that can affect the images. When processing images one must take into account the variations in frivolous, image quality, the individuals pose and facial expressions along with others. Whilst, [8] stated that different types of facial images are taken for face detection. The images that are collected in a semi-controlled situation are used as a query. Images were taken in uncontrolled indoor location and different facial expressions (such as open / closed eyes, smiling / not smiling) or formations (such as w/glasses, center-light, happy, left-light, normal, right-light, w/no glasses, unhappy, sleepy, surprised, and flash). The images are taken by changing the lighting and facial minutiae (glasses / no glasses) at different times and are used as input. It showed different results and performance algorithm.

An essential problem in image recognition and computer vision is defining the distance between two images. Significant efforts have been made to outline image distances that provide automatically reasonable results [4, 16, 1, 10]. Among others, two representative measures are the tangent distance [16] and the generalized Hausdorff distance [4]. Tangent distance is locally invariant with reverence to some chosen alterations, and has been extensively used in handwritten digit recognition. The generalized Hausdorff distance is not only robust to noise but also allows portions of one image to be compared with another, and has become a typical tool for comparing shapes. [11].

Face recognition is one of the challenging aspect in the field of image analysis and computer vision. The focus towards the face recognition has been increased in the last few years leads to encouraging results but still we are unable to find the face recognition technique which is able to perform efficiently in the various situations commonly encountered in daily due to its enormous applications in different domains. The research conducted in this field for the past four decades life. The algorithms related to face recognition technique are thoroughly studied taking a number of test images and varying the conditions and variables. Proposed Genetic algorithm based method is applied on three different benchmarked databases: ORL (Olivetti Research Laboratory), UMIST and Indbase. The ultimate objective of the research work is to improve the recognition rate. The proposed method gives better recognition rate as com-pared to existing PCA and LDA methods. It has been observed that the proposed Genetic algorithm based method has achieved the 98.57 % face recognition rate with ORL database, 100 % recognition rate with UMIST database and 98.33 % recognition rateIndbase database which is far better than the existing techniques PCA and LDA. The proposed work can further be improved using other optimization algorithms and can also be applied on other benchmarked databases [9]. The main goal of face recognition technology is to match a given face image against the stored database of images. Face recognition technique uses several other disciplines such as image processing, computer vision, pattern recognition, neural networks and psychology. With the current perceived world security situations, governments as well as businesses require reliable methods to accurately identify individuals, without overly infringing on rights to privacy or requiring significant compliance on the part of the individual being recognized.

2.2. Content Based Image Retrieval

Stated by [10] that Content Based Image Retrieval (CBIR) is the process of searching and retrieving images from a database on the basis of features that are extracted from the image themselves. In this paper image classes are used such as Africa, beaches, buildings, buses, dinosaurs, elephants, flowers, foods, horses and mountains. Features are extracted from the entire image database and the feature vectors have been stored. Furthermore they said that a new hybrid feature scheme is proposed for efficient CBIR in this paper based on spatial, frequency, CEDD and BSIF feature descriptors. In addition to spatial features such as color auto-correlogram, moments, and HSV histogram features and frequency domain features like SWT moments, Gabor wavelet transform features, CEDD and BSIF features are used to increase precision of the presented approach. Using spatial domain features lowest precision results were obtained whereas frequency domain features resulted in better precision as compared to spatial domain features. Finally, in order to improve the precision we extracted CEDD and BSIF descriptors, which resulted in highest precision. Both global and local features are combined to obtain higher retrieval rate. Experimental results obtained using the proposed approach are better compared to existing methods. Currently we are working

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on techniques for reducing the feature vector size which will further reduce the execution time.

2.3. Content Based Image Retrieval

New approach has been proposed for an image retrieval system based on region growing segmentation on DCT compress domain. It is presented as a different way to develop image indexing by using of DCT descriptors. The method has been carried out for compressed images database to verify its performance in JPEG standard stream line.

The proposed method of region growing segmentation on DC images offers huge storage and time saving for Image indexing and retrieving. From this work, it could be concluded that segmentation, while imperfect, is an essential step and very useful in building indexing keys. In summary, this indexing key method is a promising method for image retrieval on segmented image on compress domain. This new approach could be used for image indexing by other segmentation methods. For the near future, it will be used another segmentation approaches such as Support Vector Machine, Fuzzy logic, and Split Merge to improve speed of image indexing and Retrieval [12].

According to [10] stated that semantics in general terms describe about the denotation of something. In programming, semantics tells about the meaning and format of syntaxes written in the program code, in the same manner when discussed in the field of image processing, semantics tells about the interpretation of images from the user level perspective. In CBIR features are extracted which do not justify the user's perspective and his critical thinking properly. This loophole is called semantic gap as discussed earlier in the starting of paper. So to bridge this gap, researchers proposed methods by which retrieval based on High Level semantics was possible.

Meanwhile [14] gives a comprehensive summary about content based image retrieval, semantic gap, Low Level features and High Level semantics. A literature review of work done in CBIR is also given. CBIR is still an immature technique which needs more enhancements for better retrieval results. Researchers are still working on the main issue of CBIR which is the reduction of semantic gap. Though a lot of work has been done in this domain, but still a generic approach is not yet developed for image retrieval which uses High Level semantic parameters. As there is no proper technique available which reduces semantic gap fully, future research directions are suggested

2.3 Intelligent System

Recently, the necessity of home surveillance security system is turning out to be extremely important and it is oftentimes utilized in the house or residence [3], business firms [4- 6], robotics [7-9] and also for traffic monitoring systems [10]. The purpose of home surveillance security system is essentially used to screen the activities, behavior or other changes in information in order to manage or protect personal belongings. These days, this surveillance system is being installed at home to monitor and avoid any unwanted activities to occur. Thus, the owner can quickly take necessary actions in case of any aggravations [13]. As house break-in cases increasingly rapidly, there is multiple intelligent home security system that is being developed with many necessary features. Moreover [13] defined that one of the fundamental reasons that bring about the increase in the rate of this case is the failure in intruder confirmations. In fact, these failures lead to prolonged crimes. A smart alarm system is developed in this paper to be installed in the locker to overcome the intruder confirmation issues. The development works in a way that when an object's movement or action passes through infrared radiation and blocks it.

III. METHODS

3.1. Research Steps

Research is conducted in two phases, first phase involves the collection of facial image of more than 10,000 facial images. In this first phase, activities will be focused on activities and face features extraction. Figure 1 describes the flow of activities which constitute the face extraction. To stage face recognition , this works use to implement image retrieval by image query into the system, which an implementation of image retrieval based on face detection feature. Database used in this study is a combination or mixture of some facial expressions such as facial was mediocre, angry face, smiling, shouting, and laughing, while also used illumination (some variation of radiation from the left side, right side, and radiation from both sides).

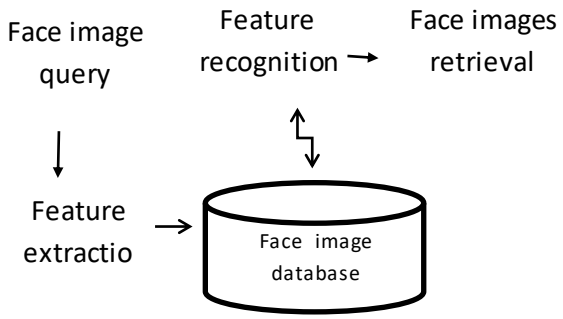

Fig.1: Diagram of face recognition retrieval system

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Database used in this study is a combination or mixture of some facial expressions such as facial was mediocre, angry face, smiling, shouting, and laughing, while also used illumination (some variation of radiation from the left side, right side, and radiation from both sides). As for calculating effectiveness (effectives) of facial images used search precision and recall parameters that can be written as follows [8].

$$\text{Precision} = \frac{\sum \text{relevant images retrieved}}{\sum \text{images retrieved}}$$

$$\text{Recall} = \frac{\sum \text{relevant image retrieved}}{\sum \text{relevant image in category in the database}}$$

The greater the value of precision and recall, the more effective methods or techniques used by search, precision has a maximum value 1 and minimum 0.

3.2. Face Searching Algorithm

The algorithm of the method applied in this study is to explore the features available in the DCT coefficients, where each coefficient is a vector containing the energy to build a histogram in the process of matching during the search process and the introduction of facial images from the database. Sequence or algorithm of this technique can be explained as follows:

1. *Input face image*

2. Convert RGB Image into YCbCr and HVS component, get face candidate

Generate Key Indexing from DCT coefficient of 2D matrix image calculate

I(query Image) as follow:

H(i)= {h0,h1,…,h63), and hi=

Q(u,v) is DCT coefficient at row u, and column v

Similar step 3 for iamge in the database.

H(i) = { h0,h1,h2,…,h63},andn

hi = d(u,v) is DCT coefficient at row u and column v.

2. *Calculate similarity between image query and image in the database using this formula:*

Have

$$D(Iq, Id) = \sum_{i=0}^{N} \frac{(I_{qi} - I_{di}).(I_{qi} - I_{di})}{N}$$

where D is distance between Iq vector Id vector (face in the database). Whilst N is number of block of related face image. D value has range 0 and 1, if D=0 then image query is exactly the sane to image retrieved from the database.

4. Range face image retrieved based D value calculated as ascending order.

For Number_of_block = 1 to N

For u = 0 to 63

For v = 0 to 63

D((Iq(u,v),Id(u,v)));

End

End

End

5. Display 20 images similar retrieved

6. For next image query, repeat steps 1 to 6.

3.3. Evaluation of Face Image Searching

To measure the similarity or degree of similarity between the query face image (the reference face) with facial image is in the database, then used the Euclidean distance formula which can be defined as follows [9]:

$$\Delta d = \sqrt{\sum_{i=1}^{n} (|Q_i - D_i|)^2}$$

The method of application development used in this work is Waterfall model. It includes implementation, testing, and maintenance [10]. Whilst, for process system model is described in with form of system development life cycle. It consists of requirements, analysis, design, and flowchart of general process model. [11], [12] stated that analysis is done to determine the problems occurred ,and an automatic security on the door by recognizing the face through the technique of Content Based Image Retrieval (CBIR).

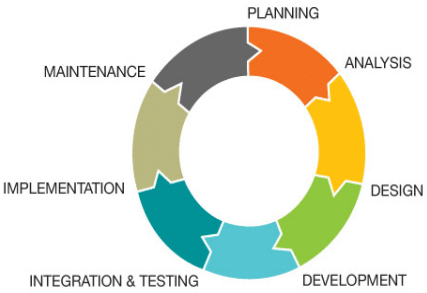

Fig.2: System development steps

The system development system as illustrates in figure 2 can be explained as follow, [12]:

- Planning step deliveries estimating as well as scheduling and tracking the application,
- Analysis step, face image data analysis and design of face recognition and application

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- Development step , in this step coding application and was carried out as well as feed back also be finished
- Integration and testing step , integration each modul such as face detection , recognition, graphics user interface were integrated,
- Implementation, as all steps carried out the application system is ready to deploy in real word.

3.4. Application System Design and Development

The development of intelligent doors system by using CBIR method can be described at figure 3.

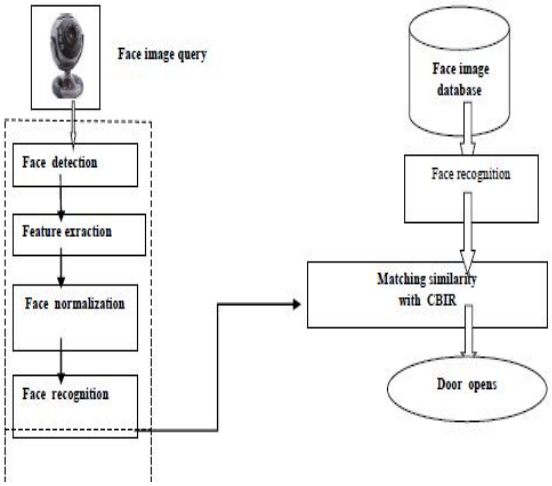

Fig.3: Face recognition to open the doors automatically using CBIR method

In this step we applied ground truth not less than 10,000 face images with variant pose and expression. The database consist of face with normal pose or without obstacles forward at front and face with obstacles such as wearing hat, glasses, and hijab. Face images were collected from many sources such as from: internet, police office, county offices, and from the site.

3.5 Haar Classified Facial Tracking method

Haar Cascade is considered as technique using square features which identify particular object on image. Haar algorithm using statistical method to detect a face. It used statically model in face detection, the method carried out by using Haar-like features sample. Value of Haar –like feature can be considered as the difference between grey scale level pixel values and white box regions. The formula of Haar-like feature might be written as f(x) = SumBlack rectangle - SumWhite rectangle, where f(x) is Haar-like value, SumBlack rectangle is number of black pixel gray level and SumWhite rectangle is the sum of white pixel on gray level [13-16], .

3.6 Evaluation of Color, Texture, and Shape

To calculate the Euclidean distance between color g histogram and color histogram h were carried out by using this formula [9].

$$d^2(h,g) = \sum\sum\sum (h(a,b,c) - g(a,b,c))^2$$

Searching and matching image query and image in the database, we used method proposed by [9]) namely Markov Random Field method (MRF). MRF method has been characterized by geometry structure and power of interaction between pixel neighbors, in this method texture can be considered as linier function as follow.

$$g(x,y) = \sum_{(m.n)\in N} a(m,n)g(x+m, y+n)sw(x,y)$$

Where N is the number of structure characteristic similarity measure parameter each pixel or DCT coefficients, (x,y) is signal probability in each pixel. Whilst, to calculate the similarity can carried out using this formula:

$$D(g,p) = \sum_{t=1}^{T} f_{g,t} \log \frac{f_{g,t}}{f_{q,t}}$$

Where D(g,q) as the different of two function distribution , fg = (fg,t: t=1, .., T) dan fq = (fq,t : t=1,.., T), The similarity can be obtained from average of D(g,q) and D(q,d).

The similarity based on structure, in this work uses SSIM method, in this method similarity can be measured based on relationships between two objects, structure function similarity and content function. Structure similarity measured based on structure two objects [10] stated that to calculate by structure based was carried out by using this formula:

$$SSIM(X,Y) = \left(\frac{2\mu_x\mu_y + C_1}{\mu_x^2 + \mu_y^2 + C_1}\right)\left(\frac{2\sigma_x\sigma_y + C_1}{\sigma_x^2 + \sigma_y^2 + C_1}\right)\left(\frac{\sigma_{xy} + C_3}{\sigma_x + \sigma_y + C_3}\right)$$

Where μx is mean of x and μy is mean of y, σx and σy are x and y standard, whilst σxy is covariant of x and , C1,C2 and C3 are constant. SSIM is Structure Similarity Measure or a measurement of curve slope based on structure feature.

2.7 Matching of the similarity

Similarity between image query and face image in the database is very expensive in term algorithm as well as very complex and takes time. To solve this problem, this work was carried out in 3 steps to match images: i). First searching the similarity of query face image topology of compare to image in database ;ii). Second, using information to improve image candidate retrieved; iii).

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Third, calculate the similarity between image query and image in the database. Whilst, to measure the effectiveness of image searching, precision and recall was used. Precision is the number relevant images retrieved divided by the number of images retrieved. Recall is the number of relevant images retrieved divided the number of images in category in the database[10].

$$p = \frac{a}{z} \qquad r = \frac{b}{y}$$

Where p is precision and r is recall, a is the number of relevant images retrieved, z is the number of all images, and y is the number relevant images in the database . The general system design illustrated in figure of the unobstructed face recognition system is illustrated by the system form, and described in Figure 2..

IV. RESULTS AND DISCUSSION

In this work we also did preprocessing to the images, it is carried out by following steps: i). Image cropping to 64 bit x 64 bit, ii). Cropping, segmented face image from original image by calculating maximum ratio of extracting image feature, iii), extracting image feature by taking face pose of 640/IV x 480/4 Pixels, iv). Use green, red, blue colors. When pre-processing was carried out completely, we did face recognition and built face database.

The work shows that all face image stored in database and indexed based on image retrieving. Retrieval process was delivered by matching query image and image in database. Snapshot of Face recognition without obstacles can be illustrated on fig 4, 5, and 6. Face images are stored in the database and images facing frontal forward without obstacles. This work deployed recognition method by matching similar face image used previously. When similarity result exactly the same or fully 100 percent recognize by system, otherwise face image not recognizable .

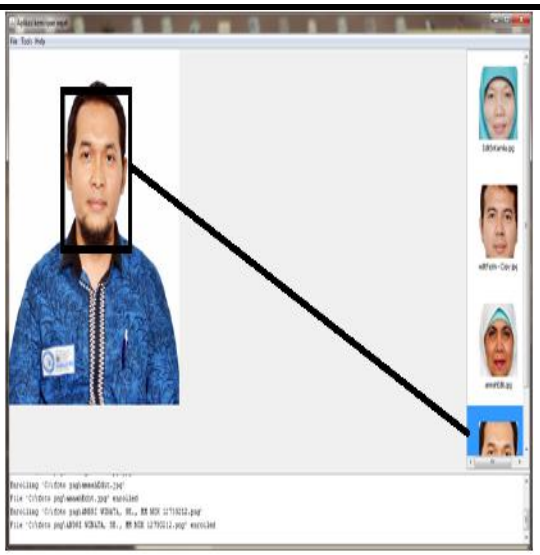

Fig.4: Snapshot of normal face recognition.

Before processing the images into our system, pre-processing was carried out by extraction face image using the maximum ratio, face image extraction was taken by using picture of face with size of 640/IV x 480/4 pixels, and RGB was used in pre-processing. After doing pre-processing, then this work deployed face recognition taken from previous step, and put into database to create an array of face pose position mage database. In here, all images stored and been rank as images retrieved, and face images were detected as mask. Retrieval process was carried out by matching face image with face detected. The algorithm of image detection and recognition can be described as java coding. In this work image position retrieved should be match to previous image similar, if image similar result exactly 100 % equal it can be considered that “identified person”. Otherwise, the person “Unidentified person” [18].

3.1 Facial detection and recognition Algorithms

In this work algorithm used to explore DCT coefficients features which the coefficients is considered as vector. The vector consists of energy to build a histogram in matching process of face recognition into image database. From figure 1, it can be concluded that the greater precision, it will be followed also by increasing the value of recall. Rate of facial images retrieval from the directory depends on the computer, the faster the processor, then the process will also be faster. Figure 3 and 2 display results of the face detection and face recognition of our algorithm.

```
image query
get pixel color
    for i= 0 to img
    for i= 0 to img
        Y= imgYUV
```

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```
        U=imgYUV
          If U >150 U<200 then U=255
          Else U=0
          V= imgYUV
          End
          If V > 140 and V <170 then V=255
          Else V=0
          End
      End
      End
\\ Edge detection
  For YYY = 1 to picY.Heigh-1
  For XXX = 1 to  pic.Width -1
```

From figure 5 , it can be shown that the average accuracy of face detectio of 25 testing is quite good which is more 60% or 0.60.

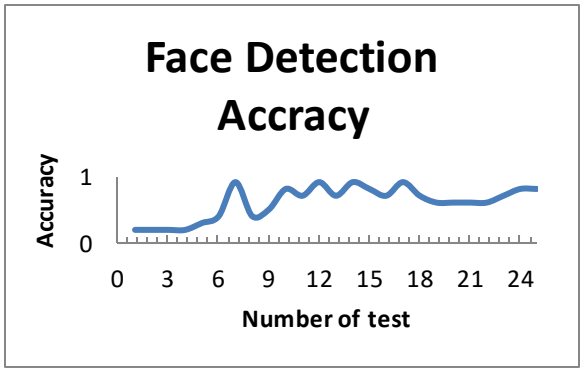

Fig.5: The accuracy of face detection

3.2 Calculating the effectiveness retrieval

From around 25 queries made in this work shows that the effectivity of retrieval is quite good in tern of precision and recall which are 0.75 or 75% and 0.05 or 5% respectively. Table 1 shows and illustrates precision recall of image retrieval. The precision and recall can be used to measure the performance of image retrieval system. Therefore our algorithm demonstrates performance the face retrieval algorithm of 75%. Before calculating precision and recall, the similarity of image query and image in the database. In order to get good result, the work rank images retrieved from the most relevant image, and the irrelevant images appear after.

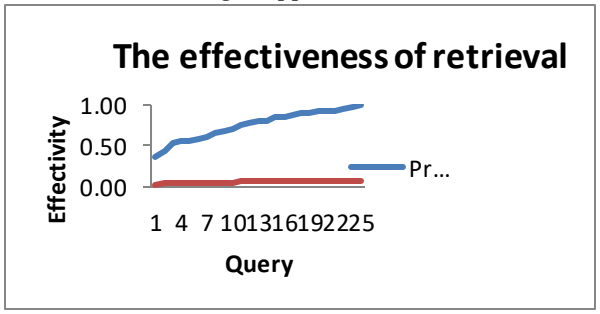

Fig.6: The effectiveness of retrieval in term of precision and recall

From Figure 6, can be described that the effectively of image retrieval is quite good. Consequently can be said that our algorithm is good to open the doors automatically.

Table 1. The effectivity of image retrieval

Query to	*Precision*	*Recall*
1	0,35	0,03
2	0,42	0,03
3	0,52	0,04
4	0,55	0,04
5	0,55	0,04
6	0,58	0,04
7	0,60	0,04
8	0,65	0.04
9	0,68	0,05
10	0,70	0,05
11	0,75	0,05
12	0,77	0,06
13	0,79	0,06
14	0,80	0,06
15	0,84	0,06
16	0,85	0,06
17	0,88	0,06
18	0,89	0,06
19	0,90	0,07
20	0,91	0,07
21	0,92	0,07
22	0,93	0,07
23	0,95	0,07
24	0,97	0,07
25	1,00	0,07

The algorithm of face detection and recognition was written in java, from table 1 we can explain that the application shows good performance in term of precision and recall. The user interface of our application not so good and user friendly, however it already and proved that the effectiveness of algorithm is above average.

V. CONCLUSION AND FUTURE RESEARCH

Intelligent face recognition application using content based image retrieval and Real Time Face Recognition. Application design was carried out quite good since the accuracy of detection fairly good. When face has been searching is not in the database the system that face data is not found. The accuracy of face detection is quite good

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which from 25 test produce the average of more than 75%.

Many works should be carried out in the future in order to improve the effectivity of retrieval. Future works may be used CBVR method which use walking style as key to open doors autometically. This can be carried out by building video clip database consists of 500 – 1000 video clips with 30 second to 60 second duration each clip.

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