INTELLIGENT BIOMETRIC DETECTION SYSTEM FOR DISABLED PEOPLE

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Intelligent Biometric Detection System for Disabled People

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Abstract— **This paper presents an intelligent system for disabled people to have a full control of computers using biometric detection so that they can still operate computers like normal people do. An idea behind this project is a fact that the emergence of difficulties for disabled people to interact with computers. For instance, paralyzed people are unable to control computer mouse. Hence this project was conducted. This project only uses a webcam as an input which captures the user's head and then tracks their head movement and iris in order to control the mouse actions. It is done by using image processing techniques such as Component Localization, Haar Cascade classifier and Hough transform.**

Keywords-human computer interaction, face recognition, component localization, Haar cascade classifier, Hough transform

I. INTRODUCTION

Disability or paralysis is a serious illness which is still becoming one of the biggest problems and haunts anyone, anywhere, and anytime. It is important to understand the term of disability, before further explanation of the proposed system. Disability is the condition of being unable to perform as a consequence of physical or mental unfitness [1]. The disabled persons are unable to do the task which normal persons can do. In this case, that task is to control computer mouse.

There are many different types of impairments which led to disabilities. Those are:

- Visual impairment
- Hearing impairment
- Physical impairment
- Cognitive or language impairment
- Seizure disorder

In this case, this project only covers the physical impairment. The impairments include paralysis (complete or partial), severe weakness, interference with control, missing limbs, and speech impairment [2].

Based on the Disabled World statistics, disability affects hundreds of millions of families in developing countries. Currently around 10 % of the total world's population, or roughly, 650 million people, live with a disability [3].

After understanding the definition and seeing the statistics, questions come up are "how do those people with the disabilities or paralysis operate computers?" and "how can we help the enormous number of physical impairments people in operating computers?"

Dealing with those questions, this project introduces "Tuffah Wajaha", a software that allows the disabled people operates computers by controlling mouse using their head movement and eyes.

In this paper, the three image processing algorithms are hybridized in order to produce a system that will help disabled people in operating computers.

II. METHODOLOGY

There are various kind of techniques used in this project. The techniques used are either from the discipline of image processing, or other techniques proposed by researchers.

The overall system architecture of the hybridized three image processing techniques used in this project is shown in Figure 1.

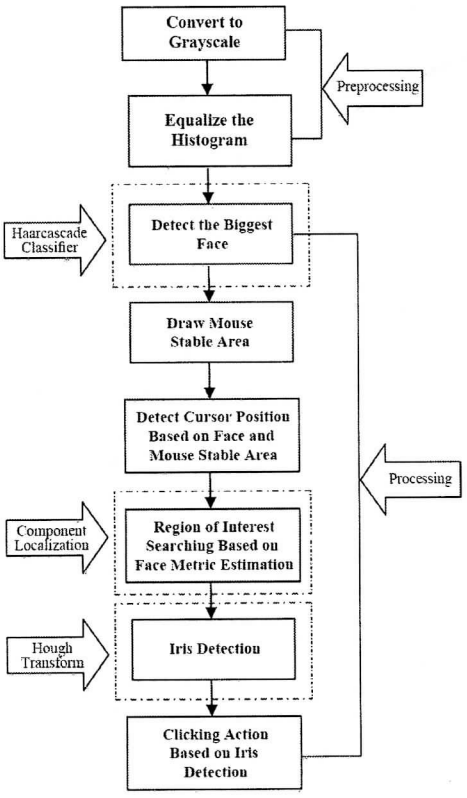

Figure 1 : Tuffah Wajaha System Architecture

A. *Preprocessing Task*

In order to obtain the best input for the system, the images obtained must be preprocessed before proceeding to further step. The histogram of the gray scaled images will then equalized in order to get the best brightness, sharpness and saturation of the images.

B. *Processing Task*

After the preprocessing phase is done, the first image processing technique will be then directly applied to detect the face, which is called the Haar classifier.

1. *Haar Cascade Classifier*

A Haar Cascade classifier is based on haar wavelets instead of using usual image intensities. The idea of adapting haar wavelets in real time face detection was done by Viola and Jones [4].

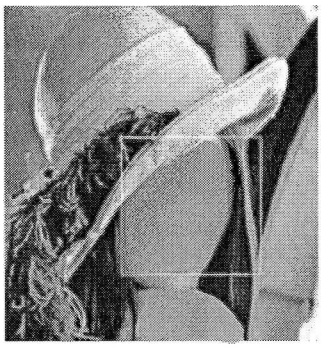

Figure 1 : Face detection using Haar classifier

By adapting this technique, the system can detect facial features in high accuracy.

The accuracy test was done by Wilson and Fernandez [5]. The test was done by training the three separate classifiers, one for the eyes, one for the nose, and one for the mouth.

Once the classifiers were trained, they were used to detect the facial features within another set of images from the FERET database. The accuracy of the classifier was then computed as shown in Table 1. With the exception of the mouth classifier, the classifiers have a high rate of detection.

TABLE 1 : ACCURACY OF CLASSIFIER

Facial Feature	Positive Hit Rate	Negative Hit Rate
Eyes	93%	23%
Nose	100%	29%
Mouth	67%	28%

The mouse stable area is drawn in the form of blue rectangle representing an area where the mouse will be idle or stop. It is also used to initialize the mouse position where the program is loaded for the first name.

In order to let only one user controlling the mouse, the system has to be able to detect the biggest face found in image. It is done by comparing the area of each of the face images found and take the biggest one as output or result.

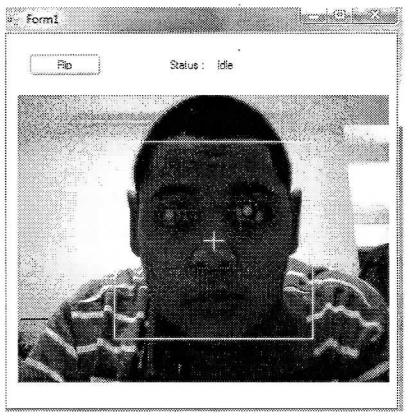

Figure 2 : detected biggest face in image

After face is detected and mouse stable area is drawn, the system then detects the mouse cursor position based on face and mouse stable area. It is shown in the system by green cross which representing the current mouse cursor position or the centre spot of the facial image in the system.

By importing the windows library, the system is able to trigger the windows to do mouse movement actions based on green cross as a cursor; hence, the user can control the mouse by using their head movements.

2. *Component Localization*

In order to gain the best performance and execution time of the system, component localization is applied. Component Localization is a technique which is able to directly locate eye and mouth based on the calculation of color space component from an image [6].

It is applied to the system in a purpose of minimizing the area of eye's region of interest searching or iris ROI (Region of Interest) searching in facial image which automatically will affect to time efficiency of the system, which is the execution time.

Based on the explanation above, the division of the face area as well as left or right eye area is clearly defined. Thus, by referring that technique, it can be translated into programming code in order to develop computer software.

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To understand the technique, the description of the technique, figures, and formulas are elaborated. The first thing need to be known is the division of the face area. The division is meant to detach the detection area among eye

and mouth features. The area division is based on assumption as follows:

- Both eyes are always reside in upper half of face area
- While, mouth is always reside in undercarriage half of face area

This division is conducted while a face image is assumed as the result from face detection phase [7].

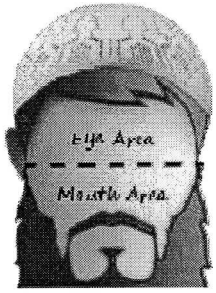

Figure 3 : Division of Face Area

After the division of face image produces division like figure above, the second thing is to define the division of eye area. The area shown in Figure above will be divided again as shown in figure below

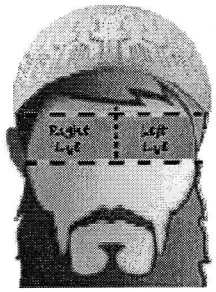

Figure 4 : Division of Eye Area

The aim of this division is to narrow the possibility area of right eye and left eye location reside and then separate them, based on assumption:

- Half of upper eye area is eyebrow/ forehead
- Half of lower eye area is the location/ position of the right and the left eye
- The position of eyes is assumed symmetrically, right eye reside in half of right shares and left eye reside in half of left shares of face [8].

Thus, the formulas will be as follows:

$$\text{EyeMapC: } 1/3\ \{(Cb2) + (\hat{C}r)\ 2 + (Cb/\ \hat{C}r)\} \quad (1)$$

$$\frac{Y(x,y)\ (+)\ g\alpha\ (x,y)}{Y(x,y)\ (-)\ g\alpha\ (x,y) + 1} \quad (2)$$

Forming of chroma component of the eye map is based on the perception value of the highness Cb and the lowness Cr that found around eye. Where the value of $\hat{C}r$ is negativity of Cr value (255 - Cr) and the result of EyeMapC is normalized into [0..255] range. Where (+) and (-) symbols are the operation of dilation and erosion. The result of EyeMapL is normalized into [0..255] range. Both map of the eye will be joined to become one map of eye by using AND operator and return into [0..255] range [9].

3. *Hough Transform*

The Third technique used in this system is Hough transform for feature extraction which means extracting feature fetched from the image. Hough Transform is a technique to identify specific shapes in an image. It converts all the points in a curve into a single location in another parametric space by coordinate transformation [10].

This concept can also apply to detect a circle, eclipse, or another geometric shapes, which is in this case is an eye's iris.

The basic formula can be defined as follows:

$$c = -x'm + y' \quad (3)$$

Where, m is the line slope and c is the intercept with y-axis.

The steps to identify a line in Hough transform are:

1. Let the parameters (ρmax, ρmin) and (max, min) represent the maximum and minimum distances from the origin and the maximum and minimum angles of the line, respectively.
2. Subdivide the parametric space into accumulator cells.
3. Initialize the accumulator space into accumulator cells [11].

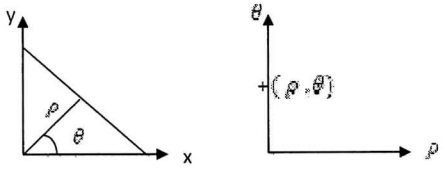

Figure 5 : transformation from the (x,y) domain

For every point of interest (x, y), increment θ and solve for the corresponding ρ using the normal line equation, $\cos \theta j + y \sin \theta j = \rho i$, to find the line intersect at (ρi, θj). The cell determined by (ρi, θj) is associated with the A (i, j) of the accumulator cells, which would be incremented by one when the equation is solved.

As a result, the system will be able to determine whether the user's eyes are closed or opened based on iris detection using Hough transform.

Figure 6 : Detected Iris in Image

The windows library then imported to the system to make mouse clicking actions based on iris detection. If the right eye's iris is detected or means the user's right eye is opened, the system will trigger right click actions, and vice versa.

As the final result, by embedding those three algorithms and windows library, the system is able to detect face and eye's iris in facial image, draw them with rectangular and circular shape, and triggering mouse movement and clicking actions based on detected face and eye's iris.

III. EXPERIMENTAL SETUP AND RESULT

Tests are conducted in order to know the outcome of this system. Hence, three testing personnel were chosen to be involved in this testing phase. The testing personnel were obtained from the NASAM – National Stroke Association of Malaysia and for the last personnel; Mr. Salim was obtained by our own hunt process. The personnel are listed on table below:

TABLE 2 : TESTING PERSONNEL

Names	Description
Mr. Lim	80 years old, who suffers from stroke
Mr. Yahya	78 years old, who suffers from stroke and brain block.
Mr. Salim Harmanain	21 years old, who suffers from paralysis.

After observing on how they use the system, it is found that this system is not suitable and cannot be used to people who suffer stroke and brain block. To know the reason why it is not suitable, the knowledge of what is stroke and brain block is necessary.

Stroke is a brain attack that happens when the brain experiences a problem with blood flow. This disruption of blood flow cuts off the supply of oxygen to the cells in that part of a brain, and these cells begins to die [12].

The stroke sufferers have half of their bodies unfunctioned. They don't have full control of half of their body because of this lack of blood flow including the lost ability to control the eyes. Hence, the stroke sufferers cannot totally use Tuffah Wajaha as they cannot open their eyes to make clicking actions but they can only move the cursor of the mouse.

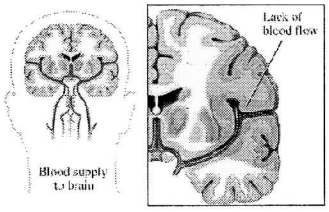

Figure 7 : Blocked Blood Flow Stroke Sufferer's Brain

Therefore, the first test towards two personnel who suffer from stroke fails. Tuffah Wajaha yet cannot assist them to operate a computer mouse like normal people do. This result can be a verification that it is not for stroke sufferers.

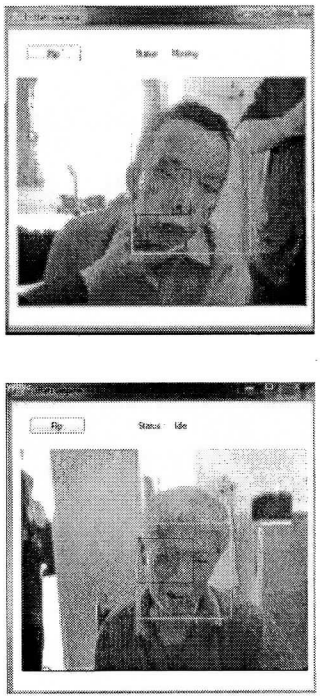

Figure 8 : Stroke user has to be helped to use the system

As it is shown in figure above, the user named Mr. Yahya, who suffers from stroke, cannot use the system unless in this case, is being helped to move his head by his wife. The same case happens to Mr. Lim, who can only move the cursor to right and left a little bit.

The next test is done towards Mr. Salim Harmanain, 21 years old, who suffers from paralysis. Again, it is important to know what paralysis is before the next phase is explained.

Paralysis is loss of muscle function for one or more muscles. Paralysis can be accompanied by a loss of feeling

(sensory loss) in the affected area if there is sensory damage as well as motor [13].

In other words, paralysis sufferers only have a loss of their muscle function. It means that they still have their muscle function, but not optimal. Therefore, it is expected that they still can use Tuffah Wajaha optimally to ease them to control computer mouse.

When the third personnel, Salim Harmanain, tested by using the tool, he enables to control the computer mouse well. Moreover, it assists him to read the holy Koran through holy Koran software easily by himself.

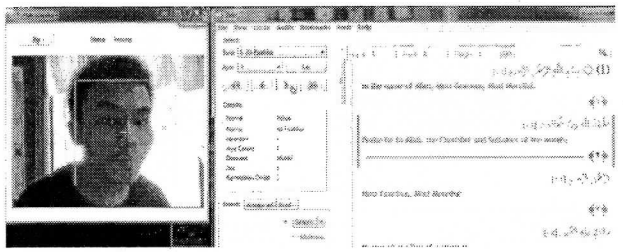

Figure 9 : Salim is using the system to recite Holy Koran

For further result, an analysis has been done by analyzing the screencast video which is recorded when the test personnel were using the system. It is done by calculating the percentage on the number of successes rate which means the number of how many times the system can detects face and iris on given number of trial. The analytical result is presented on table below:

TABLE 3 : ANALYTICAL RESULT

Personnel	Cursor Movements								Cursor Click			
	Right		Left		Down		Up		Right Click		Left Click	
	Trial	Success (%)	Trial	Success (%)	Trial	Success (%)	Trial	Success (%)	Trial	Success (%)	Trial	Success (%)
Mr. Lim	5	80%	1	0%	2	50%	0	0%	0	0%	1	0%
Mr. Yahya	3	100%	3	100%	3	67%	1	100%	2	0%	2	0%
Mr. Salim	3	100%	3	100%	3	100%	3	100%	4	75%	5	80%

As it can be seen on table above, Mr. Lim and Mr. Yahya, both of them have a fair cursor movement success rate and zero cursor click success rate. Which means that both of them can not open their eyes to do clicking actions, all they can do is just moving their head to do cursor movement actions, even though when doing that they have to make a great effort.

While on the other hand, Mr. Salim has a perfect cursor movements and reach 75% on right click, and 80% on right click. Which means that, given 4 trials, the right click is triggered 3 times, while for the left click it is successfully triggered 4 times, given 5 times trials.

Hence, for Mr. Lim and Mr. Yahya, the stroke sufferer, they cannot use this system fully while Mr. Salim the paralysis sufferer can fully use this system.

IV. CONCLUSIONS

Tuffah Wajaha has successfully assisted paralyzed people to control the computer mouse, in this case to recite the holy Koran independently, by their self.

Tuffah Wajaha is also useful for people with disabilities as well such as people without hands, Parkinson sufferers, and others as long as they can still move their heads and eyes.

It can also be concluded that Tuffah Wajaha is not suitable and cannot optimally used for stroke sufferers since they cannot move their eyes to open their iris so the system can detect it and triggers clicking actions.

This way, is actually not the most practical and comfortable way to make computer mouse clicked based on eyes detection. Therefore, for future improvement, Tuffah Wajaha may uses different image processing algorithm which allows the users to only blink their eyes in order to make mouse clicking actions.

By using eyes blink detection, certainly, is more practical way than using eyes opening and closing which is used by Tuffah wajaha recently. This is an improvement that can be done for Tuffah Wajaha in the future.

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