TWO HANDED SIGN LANGUAGE RECOGNITION SYSTEM USING IMAGE PROCESSING

H.F.S.M.Fonseka[1], J.T.Jonathan[2], P.Sabeshan[3] and M.B.Dissanayaka[4]

[1]Department of Electrical And Electronic Engineering, Faculty of Engineering, University of Peradeniya, Sri Lanka.
Email: shalinimarian@gmail.com,
[2]jeraldtownly@gmail.com, [3]psabesane09@gmail.com, [4]maheshid@ee.pdn.ac.lk

ABSTRACT

Speech impaired people are silent suffers of the society when it comes to communication between normal people due to less transparency in their communication. They use sign languages for communication. However, if they are able to express themselves effectively, it could benefit the nation as well as the world. The goal of this research is to develop a tool that will help a speech impaired person to communicate with a person who is not aware of sign languages with the help of modern technology. This paper presents a low cost approach for two handed sign language recognition system. The research addresses three fundamental issues of still gesture–based human–computer interaction. After applying pre-processing techniques like cropping, rotation, colour filtering, the mapping was done using "correlation coefficient method" and "nail detection method". The accuracy of the system was tested with real time simulation setup using MATLAB. The research outcome will help to fill the gap created by the non-existence of simple, efficient application to convert dynamic gestures made by the signer to a predefined word, phrase or command.

***Key words*:** Correlation, Finger nail detection, Image processing, Two handed signs

1. INTRODUCTION

Speech and hearing impaired people cannot communicate with others as normal people do as they have some difficulty of hearing and speaking. For the communication they use signs which is a visual form of communication and is an organized collection of gestures. As most people are not aware of these hand gestures there exist a gap between communications of the two parties. In order to fill this gap, a translation platform is needed. The importance of such a platform is the ability to connect two parties. But implementing such a platform is challenging as sign languages are different from country to country and region to region.

To date, most work on sign language recognition has employed expensive wired "Data gloves" which the user must wear [9]. In addition these systems have mostly concentrated on finger orientation. In literature there exist some efforts on computer vision based [4] sign recognition systems for many sign languages around the world. Two hand sign Language recognition systems for disabilities is being a new research area of Hand recognition system for many languages including Bangla language [5], American Sign Language [4], Korean sign language [7] and Japanese Sign Language [8]. In the Bangla two hand sign language recognition system, the authors have proposed a method which consist of two steps; i) refinement and ii) recognition. Initially in refinement, a Red-Green-Blue (RGB) color model is adopted to select heuristically threshold value for detecting candidate region and the region is obtain by colour segmentation and filtering. Finally, statistically based template matching technique is used for recognition.

In American sign Language recognition system [4] they have used Hidden Markove Model (HMM) to implement the recognition system. They have demonstrated that HMMs can improve the robustness of their recognition system even on a small scale, together with breaking down the signs into phonemes, which provided a powerful and potentially scalable framework for modeling their hand gesture recognition system. The Korean sign language recognition system [7] presents a vision-based recognition system of Korean manual alphabet (KMA) which is a subset of Korean Sign Language. The KMA system can recognize skin-colored human hands by implemented fuzzy min-max neural network algorithm.

As described above, although there are many number of approaches for sign language recognition, most of them use a coloured glove or a coloured band to identify two hands separately. Very little number of research is carried out without using any of these wearable external components such as coloured gloves and coloured bands. The research presented is carried out without using any of these external materials and using only the colour separation of pixel of the skin in an image to recognise. Therefore any user can use this system without requiring additional components and materials. This is the key advantage of the proposed system.

2. METHODOLOGY

2.1. Two Handed Gesture Mapping

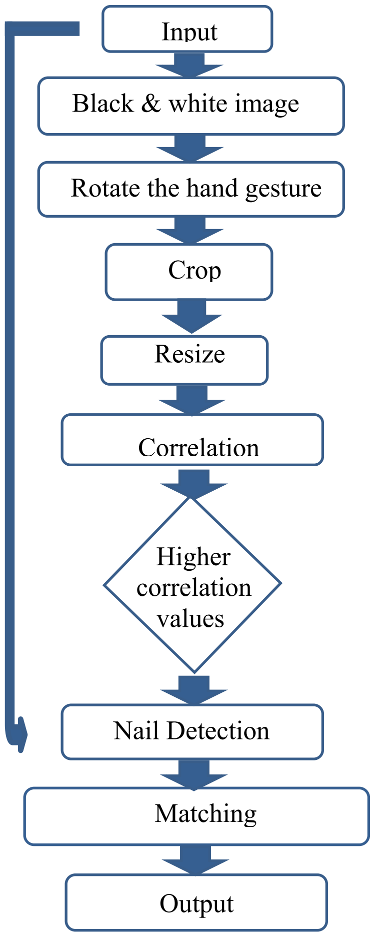

Figure 1: High level architecture of still gesture mapping

Two handed gesture matching system presented in this paper uses several steps as shown in the Figure 1. In this system, a green background is used to capture the image for the simplicity of the implementation. First, the RGB image captured from the web camera is separated into the three colour matrices, red (R), green (G) and blue (B). Then G matrix is subtracted from the R matrix because it was experimentally found that red is the most dominant color of the skin [3]. The obtained image is the gray image in Figure 2 (a).

Then that image is converted to binary image by defining a threshold. The threshold was determined as 0.65 of the white to gray scale, through Monte Carlo simulations. The resulted binary image accuracy is highly dependent on lighting condition at which the image is captured. If the lighting intensity is sufficient to capture the image with its natural colors or closer to natural colors then the binary image is said to be noise free.

Next the hand gesture in the binary image is rotated, so that non-dominant hand becomes vertical to the x-axis, when the hands not correctly oriented. This is done by drawing a line connecting the tip of the middle finger (highest point) and the middle of the fore arm as shown in the Figure 2(b) and rotating the line so that it becomes vertical. This is performed because the different orientations of the hand gesture affects the accuracy of the system. After rotating the hand gesture, unnecessary segment of the arm is removed by cropping the image. Then image is taken to its default pixel values (640x480) by stretching in order to convert all the images to same resolution.

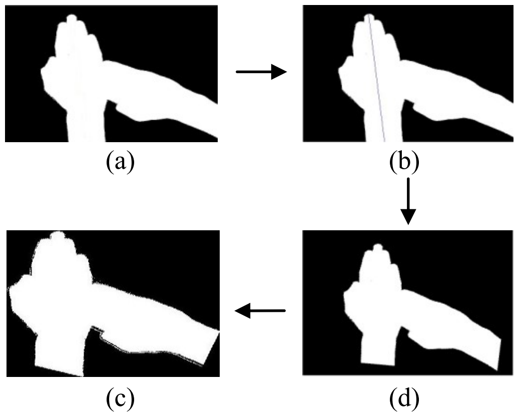

Figure 2: (a)Hand gesture (b)Drawing the line (c)Rotating the hand gesture (d)Cropping extra portions and resizing

After converting the input image into predefined pixel size, it is ready to analyze the correlation with database entries. The Input image is correlated with each and every entry in the database and correlation coefficient is obtained. Then the entities with the maximum correlation are found. The correlation coefficient equation can be calculated from eq. (1) [10].

$$r = \frac{\sum_m \sum_n (A_{mn} - \bar{A})(\boldsymbol{B}_{mn} - \bar{B})}{\sqrt{(\sum_m \sum_n (A_{mn} - \bar{A})^2)(\sum_m \sum_n (B_{mn} - \bar{B})^2)}} \quad (01)$$

$where\ \bar{A} = mean2(A)\ and\ \bar{B} = mean2(B)$

In this research ten images are used as the database. The images which have higher correlation values with the input could be assumed as possible candidates for the correct gesture. Therefore maximum five correlation coefficient values are selected. Then corresponding images which have higher correlation coefficient values are considered further to be checked using nail detection method while images which have lower correlation coefficient values are neglected.

Nail detection method is applied for those selected five images. By analyzing the colour information histogram of the sample hand gestures, it is found that red and blue colours are more dominant than green in nail potion in a hand gesture image. Using this finding, a threshold value, which is obtained from analyzing the histogram of RGB image, is set to extract the nail position from the input. When defining threshold values, different colour filters in spatial domain are defined as human skins are spread over wide pixel range. Therefore by changing filter parameters, the accuracy of the system is improved. And approximate range of area is defined as the nail portion in order to remove small portions affected by noises. The number of small portions equal to the number of nails. Number of nails equals to the number of fingers. Using this method number of fingers in the dominant hand can be obtained. It is shown in the Figure 3.

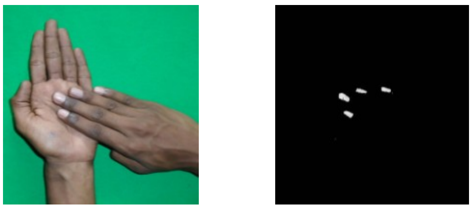

Figure 3: Nail detection method

If the number of fingers in input image is equivalent to the number of fingers in any database image, it is the matched image.

3. RESULTS AND DISCUSSIONS

Figure 4 shows the database images which are used to match two handed gestures. It consists of 10 images. The set up for the experiment is designed using TOSHIBA web camera which has 1280 pixel width and 800 height resolution.

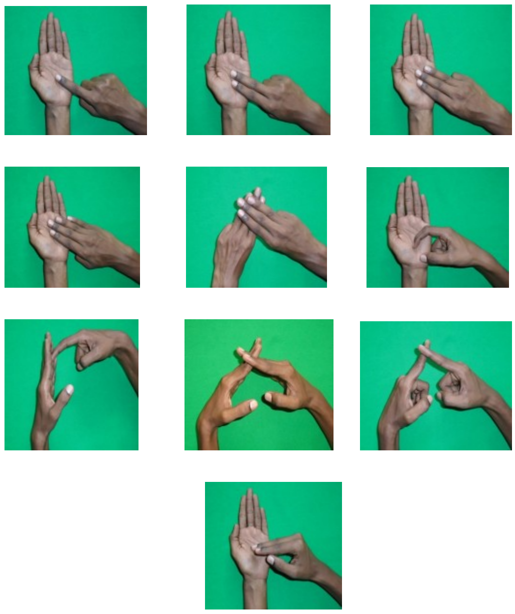

Figure 4: Database gestures

The hand gestures are made against a green color background. The proposed still gesture mapping prototype was tested in real time with 14 random participants, against a database of 10 signs shown in Figure 5.

Real time input	**Matched gesture in database**

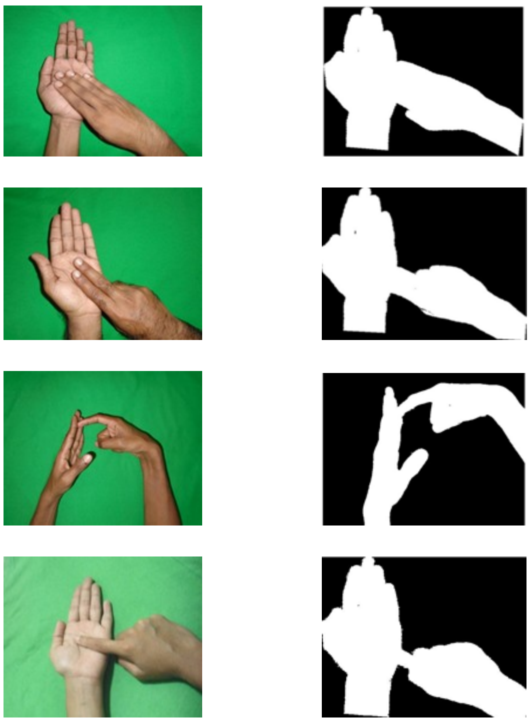

Figure 5: Real and matched images in still gesture mapping

The success percentage of this method is calculated using eq. (02).

$$Success\ percentage = \frac{Success\ matches}{Input\ images} \times 100\% \qquad (02)$$

The same two handed gesture is obtained using different participants and it is applied to the system. Then the success percentage is calculated using eq. (02).

According to the results presented in Figure 6, the gesture id 9^{th} gets the lowest successive rate. That's because the 8^{th} gesture id and 9^{th} gesture id are somewhat identical to each other in front view and also it detect same number of nails for the two gestures. So the system gives a lower successive rate for gesture 9^{th} compared to others.

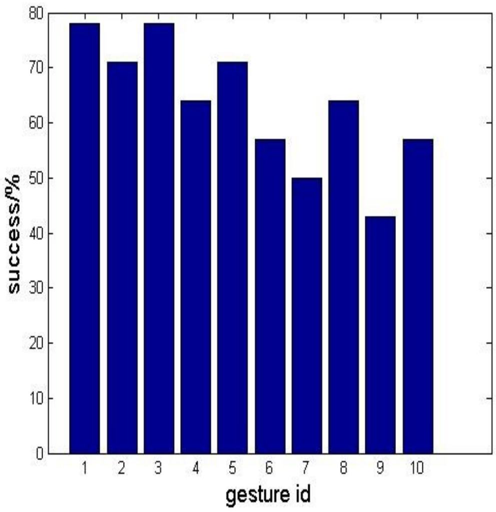

Figure 6: Success percentage for each image in the database

4. CONCLUSIONS

The research paper presents a mechanism that can be used to recognize two handed sign languages using image processing techniques. The target of this project is to develop a prototype system using above mentioned mechanism that will help a person who is not aware of sign languages to communicate with deaf or inarticulate people who use sign language. Further, the system is implemented using Matlab 2012 but any person can use this system as a standalone application even without opening Matlab command prompt. And the system is capable of analyzing real time gesture image as well as pre-saved gesture images.

5. REFERENCES

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