Novel Technique for Background Removal from Sign Images for Sign Language Recognition System

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ABSTRACT
The Sign Language Recognition (SLR) system involves recognition of signs and their translation into normal spoken language. The hearing and speech impaired people are deeply associated with Sign Language as it is their fundamental medium of communication. Although such people can easily communicate amongst themselves, they face a serious challenge when they try to integrate into the educational, social and work environments around. The Sign Language Recognition system intends in breaking down the communication barrier between the people who use Sign Language as their only means of communication and others who do not know sign language.

Non-uniform background in the edge images is a major challenge for object detection using Gradient operators. The paper discusses a novel technique for background removal in Sign Language Recognition System using the edge images of the ASL signs and morphological operations. Edge sign images are obtained by applying gradient masks (such as Sobel operator) and Slope Magnitude Method. Further with the help of these edge images and morphological operations background is removed. The proposed technique is tested on a generic image database with 312 images.

Keywords
Binary Image; Morphological operation; Slope Magnitude.

1. INTRODUCTION
Sign language can be considered as a collection of gestures, movements, postures and facial expressions corresponding to letters and words in natural languages. Most people use gestures and body language in addition to words when they speak. A sign language is a language which uses hand gestures instead of sound to convey meaning using hand gestures [1,2]. There are different sign languages all over the world such as American Sign Language (ASL), British Sign Language (BSL), French Sign Language, Danish Sign Language, Taiwan Sign Language, Australian Sign Language, etc. All these languages were developed independently. Sign languages are well structured languages with a phonology, morphology, syntax and grammar distinctive from spoken languages. American Sign Language (ASL) is a complete, visual-gestural language that employs signs made by moving the hands combined with facial expressions and postures of the body [10].

1.1 American Sign Language
ASL is a visual language meaning it is not expressed through sound but rather through movement of hands, arms and facial expressions. ASL has its own grammar that is different from other sign languages such as English and Swedish. ASL consists of approximately 6000 gestures of common words or proper nouns. Finger spelling used to communicate unclear words or proper nouns. Finger spelling involves using one hand and 26 hand gestures indicating the 26 alphabets of ASL, which can be used to spell out words from the English language.

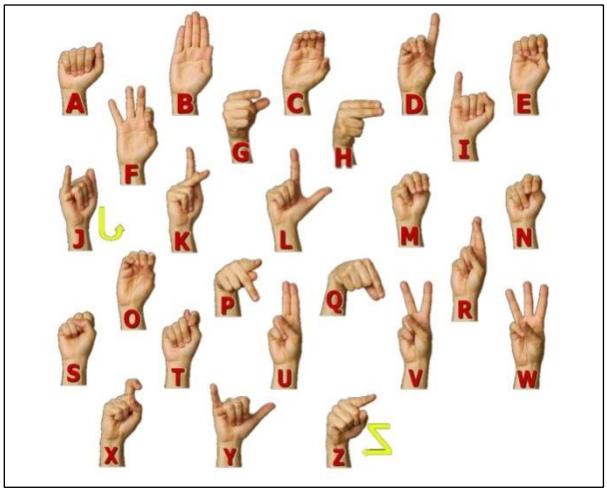

Figure 1: The American Sign Language alphabets

2. GRADIENT MASKS
The various gradient operators are used for finding the shape of objects in image [5,6,7] eliminating discontinuity in edges of the object. For the purpose of extracting edges from images, operators used are Sobel, Prewitt, Robert, Laplace, Canny and Frei-chen. The Sobel mask is as shown in Equation 1 and 2.

$$G_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} \quad (1)$$

$$G_Y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \quad (2)$$

3. SLOPE MAGNITUDE METHOD
The edge extraction using the different gradient operators simply gives us edges either in horizontal or vertical directions. But for the Shape based matching, one needs both the horizontal and vertical edges together to form the boundaries of a shape present in the image. The mask Gx gives us the gradient in X-direction and the mask Gy gives us the gradient in the Y-direction. These can then be combined together to find the absolute magnitude of the gradient at each point and the orientation of that gradient. The gradient magnitude is given by Equation 3

$$G = \sqrt{G_x^2 + G_y^2} \quad (3)$$

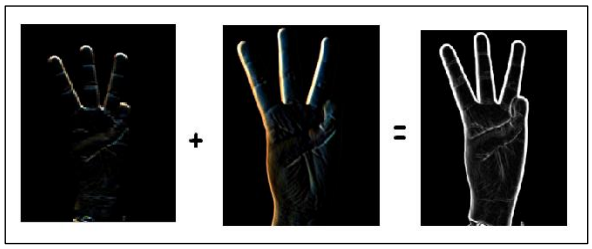

Figure 2: Slope Magnitude Image

4. SKIN PIXEL DETECTION

Skin color has proven to be a useful and robust clue for hand detection, localization and tracking. Various techniques have been proposed for detecting skin pixels. One such simple approach to build a skin classifier is to specify explicitly. The boundaries of skin cluster in some color space. The pixel values of the human skin lie in the range in which the red intensity value is greater than 95, green intensity value is greater than 40 and blue intensity value is greater than 20[11].Based on this survey the following Equation 4 was derived:

(R, G, B) *is classified as skin if* :

$$R > 95 \text{ and } G > 40 \text{ and } B > 20 \text{ and} \quad (4)$$

$$\max\{R,G,B\} - \min\{R,G,B\} > 15 \text{ and}$$

$$|R - G| > 15 \text{ and } R > G \text{ and } R > B$$

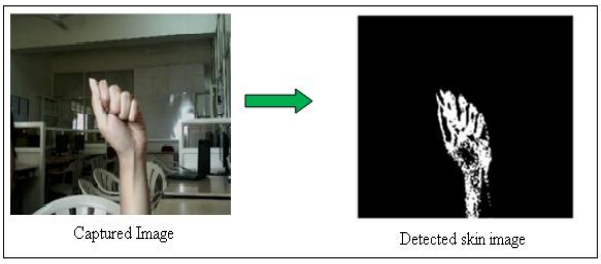

Figure 3: Skin detection

5. MORPHOLOGICAL OPERATIONS

Morphological functions can be used to perform common image processing task, such as contrast enhancement, noise removal, filling etc. In proposed method morphological close operation is performed.

5.1 Morphological Closing

Morphological closing fills in the gaps and smoothens the outer edges of the image and returns the closed image. This operation involves dilation followed by erosion, using the same structuring element for both operations. The size of the structuring element is taken as per the need.

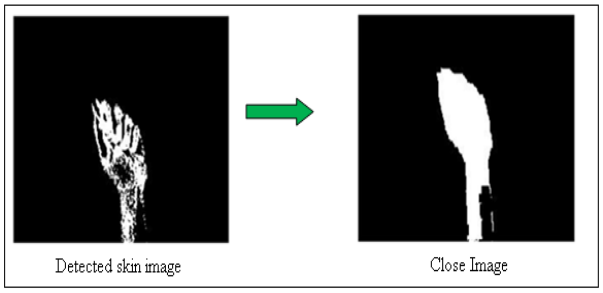

Figure 4: Morphological closing operation

6. PROPOSED SYSTEM

6.1 Capture Sign Image

A sign image is captured using webcam having non-uniform background. This image referred as Image A shall act as the original image and serve as input for the system.

Figure 6: Image A

6.2 Skin Detection

After capturing sign image, skin region in the captured sign image is detected using Equation 4 mentioned earlier. The result obtained is shown in Figure 7 and is referred as Image B.

Figure 7: Image B

6.3 Morphological operation

Morphological operations are performed on the Image B, obtained after skin detection. First dilation operation is performed followed by erosion operation. The result obtained is shown in Figure 8 and is referred as Image C.

Figure 8: Image C

6.4 Edge Detection

Edge detection is performed using the Sobel Gradient operator on the original input image (Image A) to detect the edges. The result obtained is shown in Figure 9 and is referred as Image D.

Figure 9: Image D

6.5 Superimposition of Image D and C

Morphological image (Image C) and edge image (Image D) are superimposed to remove the black patches, if any, as observed in Image C. The result obtained is shown in Figure 10 and is referred as Image E.

Figure 10: Image E

6.6 Superimposition of Image E and A

Image obtained after applying morphological operations (Image E) is superimposed with the original image (Image A) to get the coloured image with nullified background. The result obtained is shown in Figure 11.

Figure 11: Resultant image with nullified background

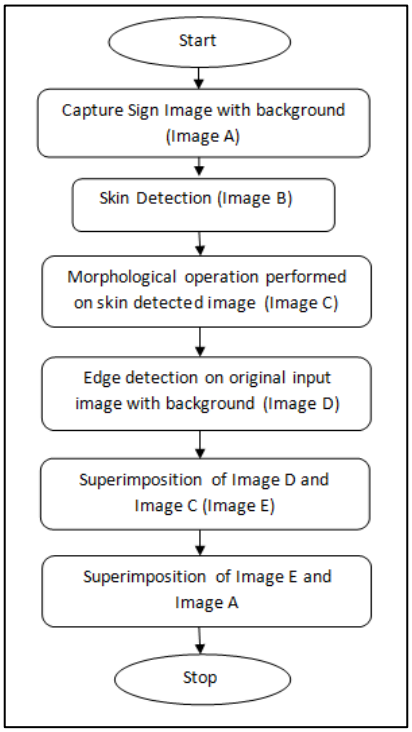

Figure 12: System Overview

7. IMPLEMENTATION

System is designed to recognize all the static signs of (American Sign Language) ASL. The users are not required to wear gloves or use any artificial devices to interact with the system.

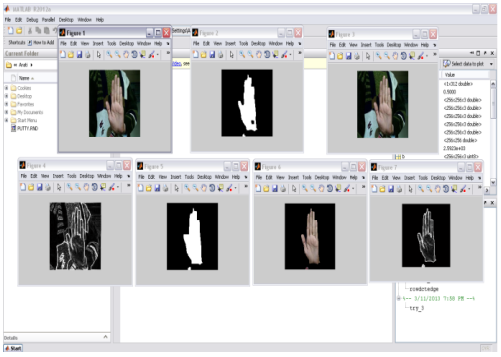

Figure 13: Demo Result

7.1 Platform

The system is implemented in MATLAB version12.0. The training and testing were run on standard laptop (1.18GHz Core-2Duo processor, 1.96GB of RAM running under windows XP) web camera is used for capturing images.

7.2 Dataset

The dataset used for training and testing the recognition system consists of 312 images. 12 samples for each sign will be taken from 12 different volunteers.

8. RESULTS AND DISCUSSION

The proposed technique is tested on various images captured using web-cam. After applying all the operations for background removal we get a sign image with clean black background and skin pixel data as shown in Figure 14.

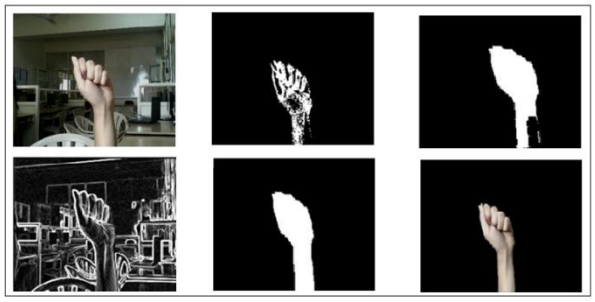

Figure 14: Background removal in SLR system.

9. CONCLUSION

Uniform background in Sign Language Recognition system is essential for classification of hand gesture sign from captured image. The paper proposes a novel technique for nullifying the background of the images with the help of gradient operators and morphological operations. The constraint of having plain black background is eliminated using this technique.

10. REFERENCES

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