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Hand Gesture Recognition for Nepali Sign Language Using Shape Information

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***Abstract*—**With the advance of technology the use of human computer interaction (HCI) has improved day by day. Computer vision plays an important role to provide information to design more simple and efficient approaches for HCI. The proposed approach uses skin color model to identify the hand from the image, and further preprocessing is done in order to remove unwanted noise and areas. Blob analysis is done in-order to extract the hand gesture from the image considering that the largest blob is the hand. Then the blob is resized into a standard size in order to eliminate size variant constraint. Sampling of the boundary line of the hand gesture is done by overlapping grid lines and extracting the point of intersection of the grid line and the boundary. Freeman chain code is used to represent the boundary of the hand gesture. In order to minimize the length of chain code run-length encoding is done. Finding the first difference of the chain code its shape number is obtained. Shape number can be used to identify each of the gesture uniquely.

***Keywords*—**Human Computer Interaction, Computer Vision, Static Gesture, Nepali Sign Language, Blob, Freeman Chain Code, Shape Number

I. INTRODUCTION

Gesture as defined by Kurthenbach and Hulteen(1990) " A gesture is a motion of the body that contains information. Waving goodbye is a gesture. Pressing a key of the keyboard is a gesture." The concept of Human Computer Interaction that is to further communicate with computer interactively, gesture recognition has become one of the area of interest of many researchers motivating them to design various approach, procedures and techniques to perform human computer interaction using gesture as the input. This paper also tries to present a similar approach for gesture recognition considering Nepali sign language gestures.

Nepali Sign language [4] is somewhat standardized language based informally on the variety of Kathmandu, with lesser input from varieties of Pokhara and elsewhere. It uses both static and dynamic fingerspelling (i.e. manual alphabet) and uses only single hand. Working with Nepali sign language for gesture recognition using digital image processing, static gesture was only considered at the initial phase. There are 36 consonant and 13 vowels in total 49 alphabet set or manual alphabet for Nepali language and the same set represented using gesture for Nepali sign language. Vowels are basically dynamic gesture and consonant are static gesture. Considering only the consonant set gesture recognition has been performed.

Fig. 1 Consonant alphabet set of NSL [4]

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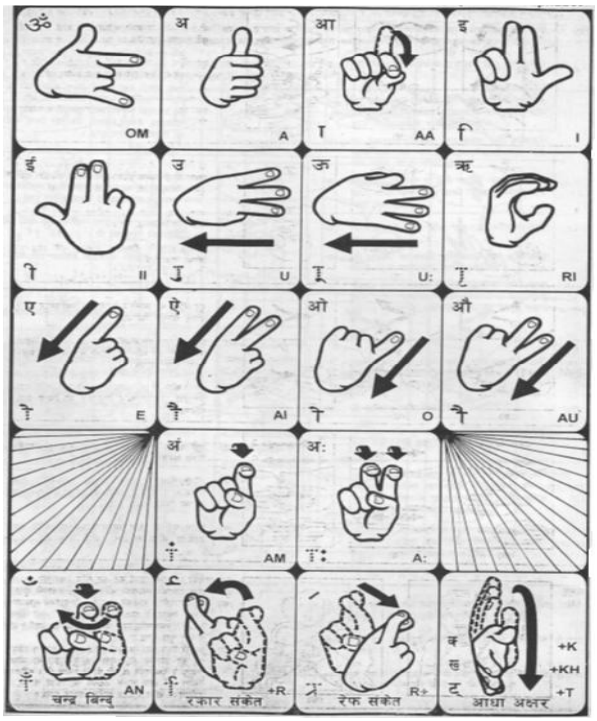


Fig. 2 Vowel alphabet set of NSL [4]

Computer vision is becoming more popular with the advancement of ubiquitous computing where systems are being made more compatible for use. In the field of digital image processing computer vision is used in the areas like human computer interaction (HCI). In simple terms it can be stated as HCI makes human computer interaction as human to human interaction. Human motion tracking in 2D or 3D, Tracking activities, gesture and sign, robotics are some of the application area of computer vision.

Digital image processing can be used for Image sharpening and restoring , in medical field remote sensing ,transmission and encoding, machine or robot vision, pattern recognition, video processing, color processing etc.. Gesture recognition is done using digital image processing steps as given in figure 3.Initial step image acquisition is the process of obtaining the digital image of the object. In the proposed work the image was acquired by using 4 megapixel cameras and manually preprocessed to reduce the size of image to ease the processing.

Image enhancement is done for improving the quality of the image so that the analysis of the image is reliable. The brightness and contrast of the image is adjusted manually to enhance the quality of the resized image.

All the component of the acquired image may not be important for processing, so image segmentation is done to extract only the region that is necessary for further analysis i.e. only the region of concern is extracted from the original image. The process of segmentation is achieved by the use of skin color detection in RGB image.

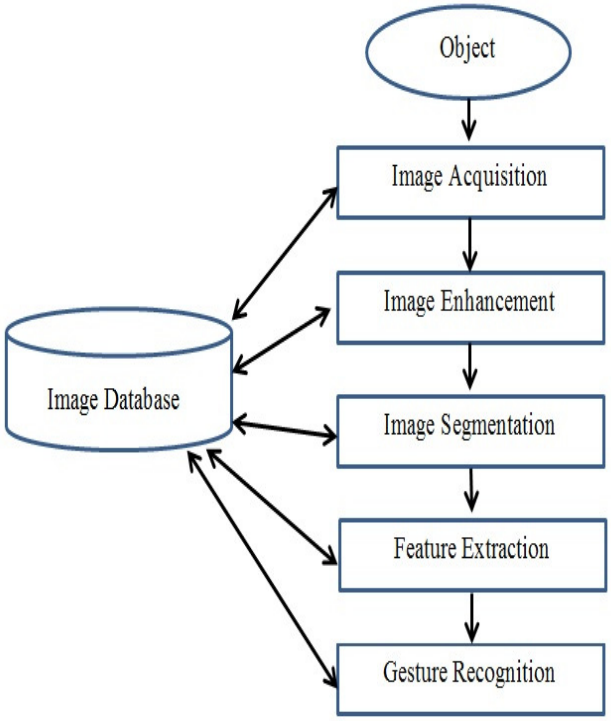
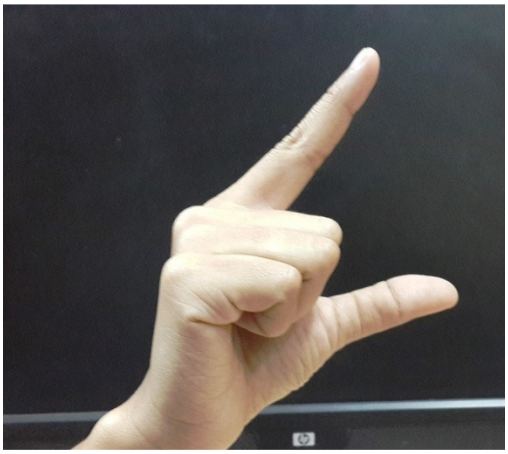


Fig. 3 Steps in Gesture recognition

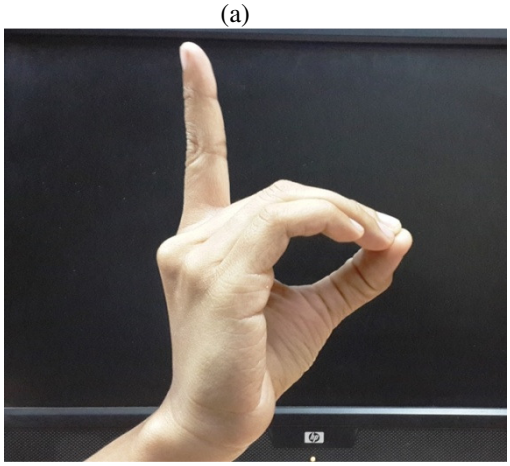
After segmentation process some unwanted information may come along with the segmented image (referred as noise) so further processing of the segmented image was done using the filtering of image, erosion and dilation and fill operation in-order to improve the quality of the segmented image.

Feature extraction is done for extracting necessary features for recognition. The extracted features of object are represented in meaningful data structure. In the proposed approach the shape information that is, shape of the hand gesture is considered as the feature and using the Freeman chain code [5] it is represented by a single integer number.

The final step is to identify and recognize the object that is present in the image. Feature generated in the earlier step the gesture are recognized and classified. Each of the steps of image processing plays a vital role to form the desired task. The entire work can be justified as, given an image containing hand gesture we need to find a gesture in a large database of predefined gesture which is most similar to that and write the equivalent consonant alphabet of the input gesture. The figure below shows some gestures of Nepali sign language that has been considered to perform the desired operation.



(a)



(b)

Fig. 4 Gesture of consonant NSL [4]

II. METHODOLOGY

First task of the work was to collect primary data of the consonant set of NSL as it was not available on internet. The collection of the image was done considering any type of background avoiding any skin colored type of object near by the hand. Figure 4 shows some NSL gesture. After the successful collection of the image database the next task was to preprocess the data so that it was appropriate to take those images as the input to the gesture recognition process. All the information in the image is not necessary for the purpose of recognition and the object of interest is only of concern. The images that are collected can be cropped in such a manner that the unrequired information can be removed manually. But this makes the approach bit bottleneck as it supports only the offline gestures and real-time classification of gesture cannot be done. This can be improved by incorporating automatic cropping approach. Then the next task that is left is to extract only the hand gesture by removing the background and unwanted objects in the image. This process may be referred as background subtraction, background elimination or simple segmentation of image. Here the segmentation is done by the use of color cue model. The color cue model is the simple approach to segment the image as pre the color component of skin color.

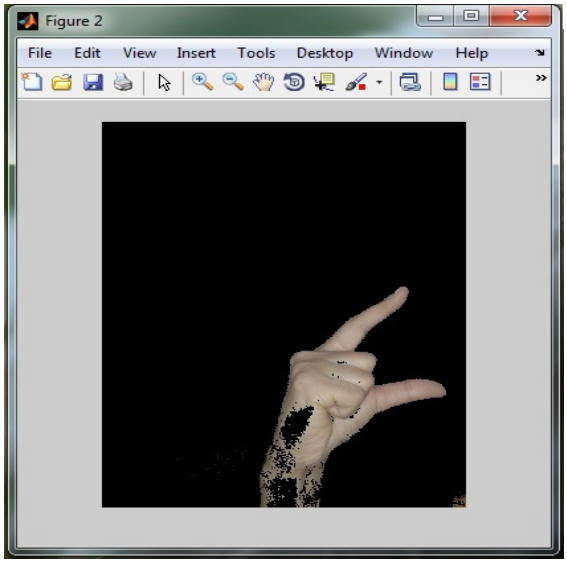


Fig. 5: Segmented image

Segmented image may contain certain portion of background component which may hamper further processing of the image. Use of appropriate morphological operators like filling holes, erosion, dilation operation, filtering the image and smoothen the image helps to enhance the quality of the segmented image.

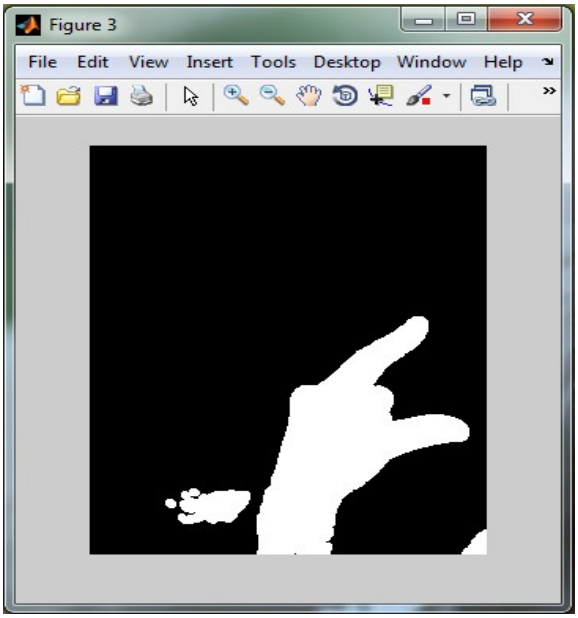


Fig.6 Noise found in segmented image

Figure 7 represents the image after removal of noise that was found after converting the RGB image to binary image.

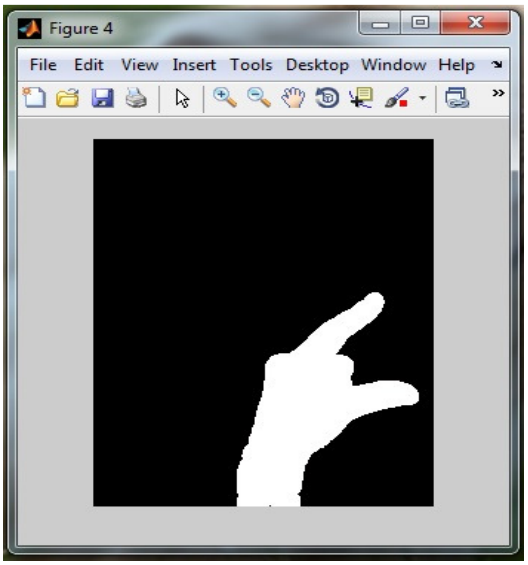


Fig. 7: Final enhanced image

The image is resized to a standard size and grid lines of 25×25 was overlapped to find the sampled boundary points of the hand gesture. The intersection of the grid line nearest to the boundary of the line was taken as the boundary point. This was done to reduce to points that represent the boundary.

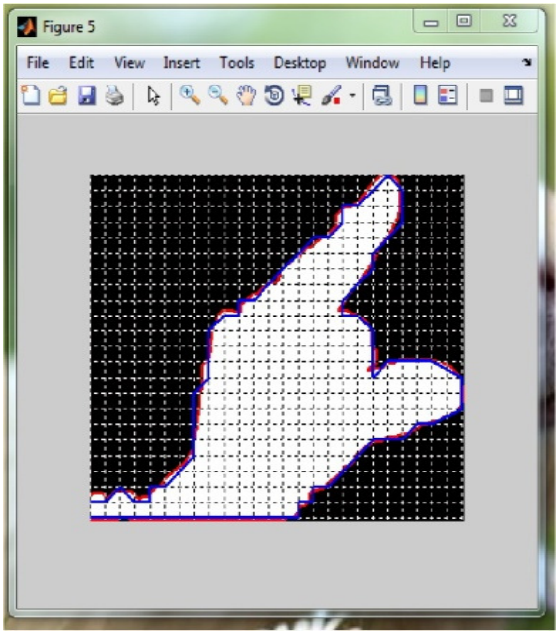
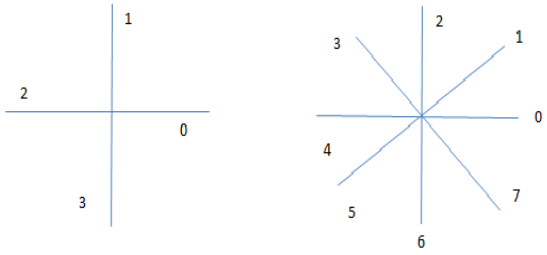


Fig.8: Sampling of contour using grids of 25×25

Each gesture is classified by representing each of the gesture by its unique shape number. In order to derive the shape number we need to represent the boundary of the gesture in a suitable form using a data structure so that the analysis can be done. The boundary representation scheme used is chain codes or Freeman chain codes. A chain code is a compact representation of an image and is translation-invariant. Chain code is useful for representing the contour of the hand. Here 8-directional coding is used rather than using 4-directional code as shown by the below figure.



(a) (b)

Fig. 9 Freeman Chain code (a) 4-Directional code (b) 8-directional Code [16]

However there are some problems related to chain codes are:

i) Starting point of the code construction determines the chain code.
ii) Chain code is sensitive to noise.

To solve the above problem the obtained chain code needs to be resampled. Resampling is done using the fix grid to smooth out the small variations of the contour. Normalizing the chain code solves the problem of starting point and is done by taking the first difference of the chain code. First difference of chain code is obtained by taking two numbers of the chain code and calculating the number of transitions required to reach the second number from the first number in the counter-clockwise direction. First difference of the chain code is referred as the shape number and each gesture or shape of the gesture has a unique shape number.

The table below represents the Freeman chain of five hand gesture, the reduced chain code of after performing run-length encoding and its corresponding shape number.

Image database is processed and shape number of corresponding gesture is stored using a data structure. The above steps are used in order to form the database of shape number of all gestures of NSL. The process of classification is to now read the input image containing hand gesture that needs to matched with a gesture in a large database which is most similar to that and write the equivalent consonant of the input gesture which is referred as classification. The following process can be show as the block diagram as below.

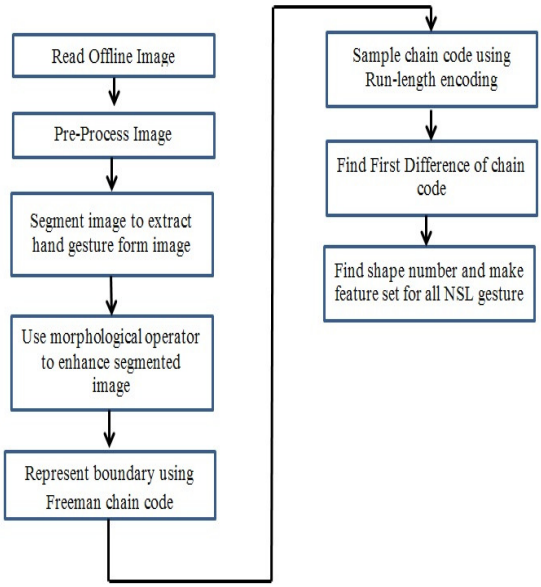
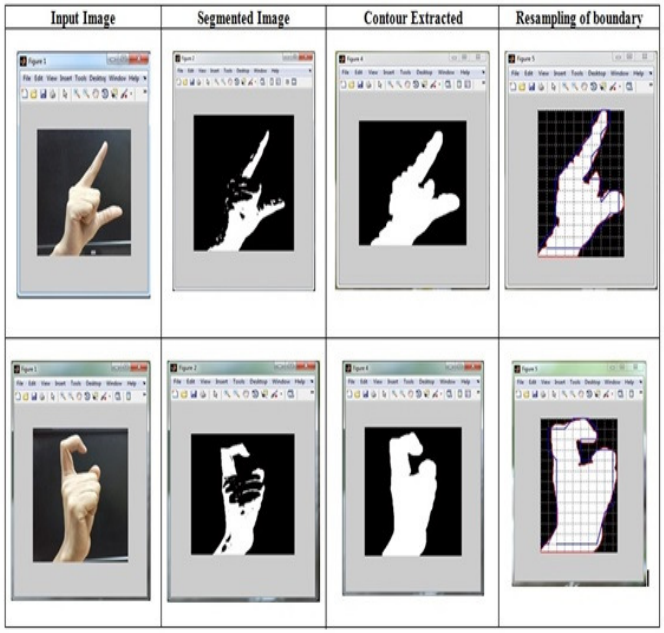


Fig. 10: Block Diagram to classify Gesture

Further the above processes can be broken down as the learning phase and recognizing or classification phase. Where in learning phase the updates the shape number database and classification phase recognizes the hand gesture.

III. RESULT AND DISCUSSION

Results obtained for different Nepali sign language manual alphabet is given below:



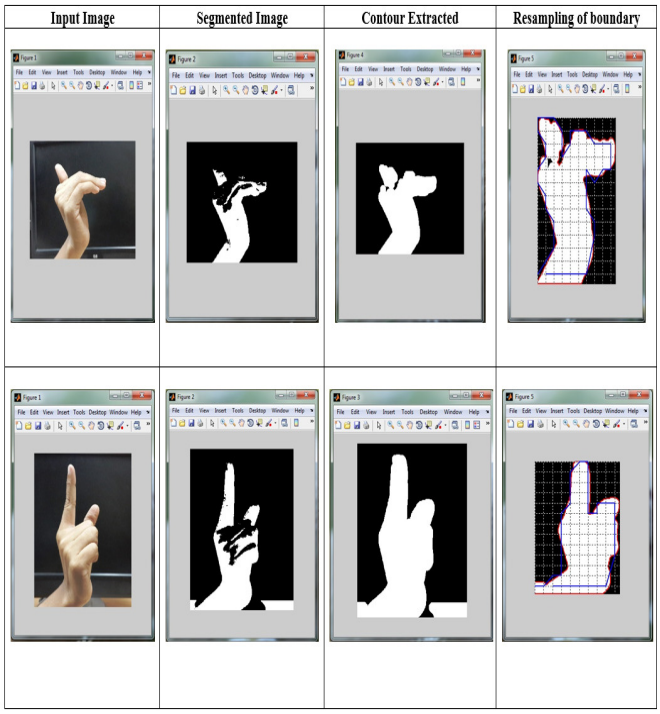


Fig. 11 Outputs of each process during recognition

After the boundary line of the hand gesture is obtained then the freeman chain code for the same is obtained which is normalized by finding its first difference. The chain code obtained for each gesture was longer in range and was difficult to be store in an array so by finding the run-length the length of the chain code it was reduced. Finally shape number of the hand gesture is obtained from the first difference of the shape number by finding the minimum magnitude number form it as shown below:

Freeman chain code, encoding, first difference and shape number obtained for corresponding gesture			
Freeman chain code	**Run-length Encoding**	**First Difference**	**Final Shape number**
006610664555444412222111121065656 5	061064541212106565665	63766175171776717107	07637661751717767171
001007644660100666665544440122222322	010764601065401232	17776221767741117	11171777622176774
006645366676544444112232321232007612007	064536765412323212320761 2007	66163177751 17177117677 31607	07661631777 51171771176 77316
006666654444440102222212221066666602	065401021210 6002	67741727177 6202	02677417271 7762
016654544444102221222222060666661066666	016545410212 0606106	15771757271 6626376	15771757271 6626376

a. Freeman chain code, encoding, first difference and shape number obtained for some gesture

Classification was done by simply finding the maximum count of the matching sequence between the shape numbers of the data base with the hand gesture to be classified. The final result is shown below:

Srl. No	Input Image	Segmented Image	Equivalent Alphabet of NSL
1			KHA
2			GA

Fig. 12 Final Result

IV. CONCLUSION

Gesture recognition is the art of recognizing the hand gesture by applying the methods of digital image processing. The use of object descriptor representing boundary information hand has made classification easy and simple by transforming the gesture to shape number. The chain code to represent the boundary is sampled using grid lines to refine the chain code obtained for the contour. This approach proves to be simple approach for gesture recognition and is found satisfactory after processing some gestures of NSL and further needs to be verified on more gestures.

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