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Signer Independent Numeral Sign Language Gesture Recognition

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Abstract-In this paper, the work carried out to design the sign language which represents the decimal numerals is discussed. Sign language is the tool used by the hearing and speaking impaired people for the exchange of information among themselves. The development of the sign language recognition system enables the common people to understand the information conveyed by the hearing and speaking impaired people. The sign language gesture recognition could be either signer dependent or signer independent. In the signer dependent recognition scheme, all possible sign gestures are of single signer. The sign language gestures generated by the single person are used for both training and testing the designed recognition system. On the other hand, multiple signer gesture data is used in the signer independent recognition scheme. Different signer data are used to train and test the recognition system. In this paper, the experimental results of the recognition system designed for the signer independent numeral sign language is presented. The sign gestures corresponding to ten numerals are captured by using the mobile phone from nineteen signers. Therefore, there are nineteen sign gestures for each of ten numerals. Out of nineteen sign gestures, ten gesture image data samples of each numeral are used for training and the remaining nine gesture image data samples are used to test the recognition system. The captured images of numeral sign gestures are cropped and converted into gray scale images. The gray scale images are used to train and test the recognition module. The nearest neighbor is used for the classification of the test gesture samples. The simulation experiment has yielded the average recognition accuracy of 91.1%.

Index Terms-Sign Language; Sign Language Recognition System; Numeral Sign Language.

1. INTRODUCTION

Communication with other fellow members of the society is one of the important and everyday activities of human beings. The exchange of information has become possible because of communication. Even living beings other than the human beings also communicate with their community for the exchange of information. The common communication modes used by the human beings for the exchange of information are voice and texts (written or printed). There exist a well-defined languages and scripts for establishing communication with voice and texts. In addition to voice and texts, various gestures are also used to convey information. However, the speaking and hearing impaired people use the sign language as the mode of communication. Various methods and sign gestures have been taught to these persons to represent the language. To understand the message formed through various gestures by these persons, the common man has to understand the structure and the meaning of respective sign language. In order to overcome these difficulties and also for other applications, machine based sign language recognition systems are being developed.

Machine based sign language recognition is the machine learning problem, wherein the machine is trained with various sign language gestures of a specific sign language. The trained machine can understand the sign gestures made by the hearing and impaired people and can covert the sign gestures into either voice or text.

The sign language recognition can be classified into; Signer Dependent or Signer Independent Recognition Modules. In the signer dependent recognition scheme, both training and testing sign gestures belong to a single signer. However, in the signer independent case, the sign language data contains multiple signer gestures. The sign gestures used for training the recognition module is different from that of the sign data used to test the recognition module. Obviously, the signer independent recognition module has to handle the complexity of varied gesture shapes, orientation, movement, etc. Hence, the recognition performance of signer independent recognition scheme is less than that of signer dependent one. The signer independent recognition system is suitable if the system has to be used by multiple users.

In general, the sign language data contains the gestures corresponding to alphabets, numbers, special symbols of a language and also common gestures which are used on regular basis for communication. To indicate the quantity, house number, street number, mobile numbers, etc. decimal numbers are used in most of the languages and scripts. Therefore, there is a need for the design and development of the recognition scheme for the numeral sign language. Keeping this in mind, the present work is focused on

the design of the recognition scheme for the numeral sign language. The proposed system is for the signer independent recognition system.

For the last two decades, may are working on the design and development of the effective translation of the message represented by sign gestures into either voice or text messages. In [1], the recognition scheme for the twelve graphic elements and thirty-six alphanumeric symbols is designed with the left-to-right HMM using location, velocity, and angle features. The shape and orientation feature based recognition for the six static sign language gestures for multimedia applications is implanted in [2]. The design of simultaneous segmentation and recognition scheme for the real-time recognition of decimal digits is given in [3]. A mobile application that translates the speech to either static or continuous sign language symbols is developed in [4]. With two-level finger counting, and convex hull and defect points, detection method to recognize the Indian sign language numerals is disused in [5]. The Eigen value and weighted Euclidean distance based classification is used in [6] to recognize twenty-four symbols of Indian sign language. Explanation on the recognition scheme for the alphabets and five numerals, one to five is given in [7]. Like these, design and development of numerous recognition modules are being carried out to recognize the sing language gestures to help the visual and hearing impaired people [8-10].

In most of the sign language gesture recognition works, segmentation of the hand gestures from the background and complicated feature extraction has been used. In the field of face recognition, people have designed the face recognition module by directly working with the grayscale face images. Based on this, in the present work, the recognition scheme for the numeral sign gestures is designed by using the normalized grayscale images as features and thereby avoiding the complicated feature extraction methods. The proposed system can recognize all ten sign gestures corresponding to the decimal numbers.

2. DATA COLLECTION

The hand gesture image database is created by collecting the hand gestures corresponding to the decimal numbers. Mobile phone is used to capture the hand gesture images. All gesture images are captured with the common background and illumination with the distance of two meter from the mobile phone to the hands of participants. Both male and female candidates are participated in the data collection process. While selecting the data provider, it is ensured that the size of the hands varies across the participants. Nineteen individuals including both male and female candidates are participated in the gesture data collection. Therefore, there are nineteen hand gesture images corresponding to each numeral of the decimal numbers. A sample of collected hand gesture images corresponding to decimal numbers zero to nine which are from different signers is shown in Figure 1.

3. PREPROCESSING AND FEATURE EXTRACTION

Since the captured image data from nineteen signers are of different sizes, the images are subjected to preprocessing. To obtain the region of interest, the images are cropped. Figure 2 shows the cropped images. The cropped images are resized to the size of 100 x 150 pixels so that all images in the database have the common size. The resized colour images are converted to grayscale images and are normalized so that all images in the database have same size and numerical range from zero to one. The normalized images of numeral signs are shown in Figure 3.

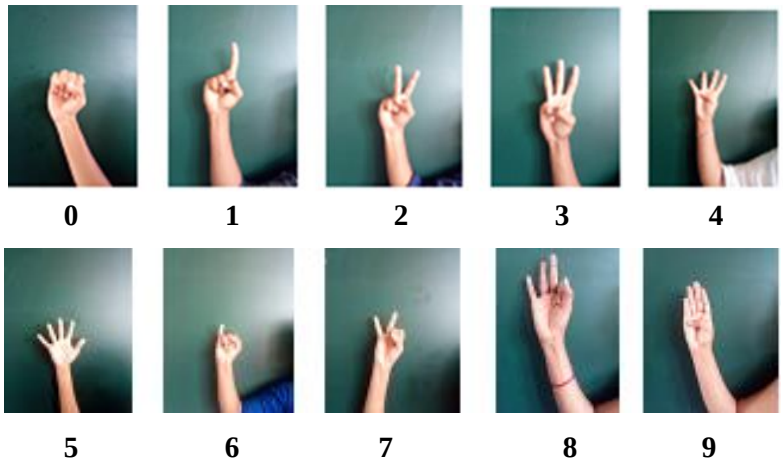

Fig. 1. Hand gesture images corresponding to numerals 0 to 9.

4. EXPERIMENTS AND RESULTS

The image database corresponding to decimal numbers are created using the mobile phone. Since the captured images are not suitable for direct processing, they are subjected to preprocessing. The images are cropped to get the region of interest. The cropped images are size normalized and then they are converted to grayscale images. The numerical values in the grayscale images are normalized such that the image pixel values vary from zero to one. These normalized images are used to train and test the numerical sign language recognition module. In order to carry out the signer independent recognition module, the captured numeral sign gesture images are segmented to the disjoint set of images. Out of nineteen sign gestures for each of the numeral, the first ten sign gesture images are used to train the recognition system and the remaining nine sign gestures are used to test the trained recognition module. For classification, nearest neighbor classifier with Euclidian distance metric is used. The simulation experiments are carried out using MATLAB. The simulation experiment has yielded the average recognition accuracy of 91.1%. The class-level average recognition accuracy obtained for numerals zero to nine is given in Table 1.

5. CONCLUSIONS

The paper presented the experimental work carried out in the design of the recognition system for sing language numeral recognition. To carry out the signer independent recognition module, the captured images are segmented into the disjoint set of training and testing units. Captured images are subjected to preprocessing and feature extraction. The normalized grayscale images corresponding to the ten symbols of decimal numbers are used for both training and testing

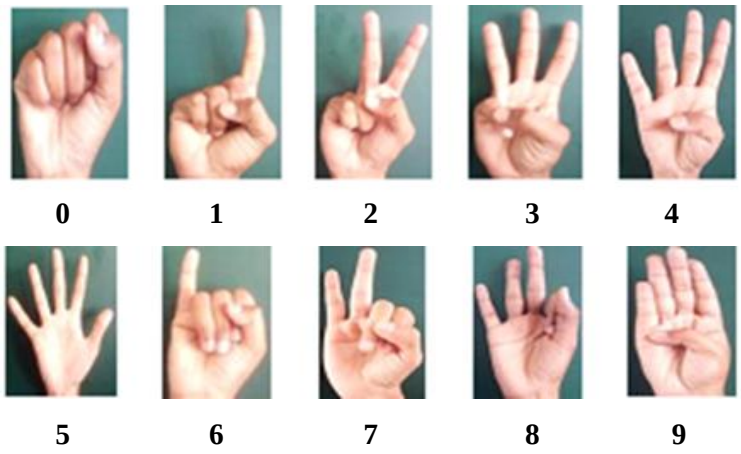

Fig. 2. The cropped and resized hand gesture images corresponding to numerals 0 to 9.

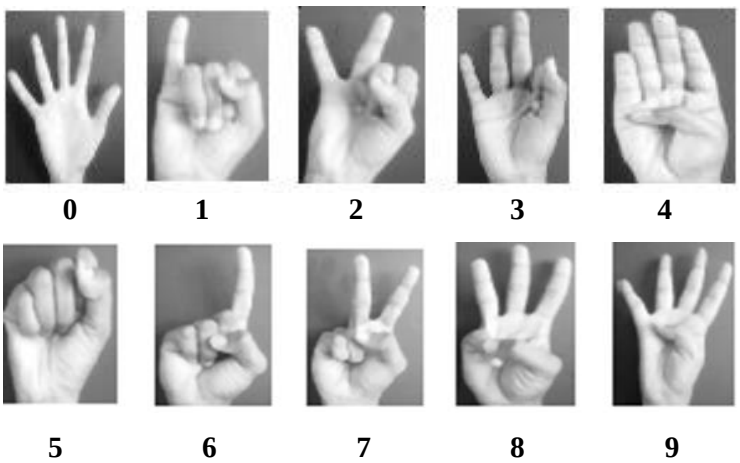

Fig. 3. The normalized and grayscale converted hand gestures images corresponding to numerals 0 to 9.

the recognition module. Out of the total of one hundred and ninety images corresponding to ten numerals, hundred gesture images are used for training and the remaining ninety images are used for testing. From the simulation experiments, the average recognition accuracy of 91.1% is achieved. The class-wise average recognition accuracy are also noted down.

Table 1. Class-wise recognition accuracy of numeral sign gestures from zero to nine.

Sl. No.	Numeral Signs	Average Recognition Accuracy in %
1.	0	100
2.	1	100
3.	2	88.9
4.	3	100
5.	4	77.8
6.	5	100
7.	6	100
8.	7	77.8
9.	8	66.7
10.	9	100

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