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Sri Lankan Sign Language Tutor

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***Abstract*— Sign Language Recognition is a challenging research area of Human Computer Interaction. This system proposes a method which recognizes signs of Sri Lankan Sign Language using Fourier Transformation, which is invariant to translation, scaling, rotation and change of starting point. It discusses about using a Centroid distance based shape signature, which is capable of preserving both local and global information of the shape.**

This concept would be highly beneficial for primary school students who try to learn the basics of sign language. This system will help them to practice & check their knowledge without any help of their teachers or parents.

Digital Image Processing Techniques were used to obtain a closed contour image from the input image. Feature Extraction is done by using the theories of Fourier Transformation. Artificial Neural Network has been employed to train a large set of signs in order to increase the efficiency of the system. Supervised training method was used to train the neural network, which consists of 10 input nodes, 6 hidden layer nodes and 8 output nodes. The calculated weights were stored in file.

The system is implemented using C# programming language and Aforge.NET framework.

A still image of the sign is taken as the input for the system. The weight file, which is generated at the end of training the system for nearly 800 images of signs, was used to recognize the sign. The system will output the correctness of the sign to the user using visual indicators.

The system is capable of recognizing 8 static signs of Sri Lankan Sign Language successfully.

Keywords*— Sri Lankan *Sign Language, Digital Image Processing, Fourier Transformation, Artificial Neural Network

I. INTRODUCTION

Sign Language Recognition is one of the major research areas of Human Computer Interaction. A large number of researches had been done in this area for American Sign Language, Indian sign language[7], Chinese sign language, Thai sign language, etc. But, less amount of researches are done related to Sinhala sign language recognition[4],[5]. Specially no research work found in developing a tutor for Sinhala sign language. This reason motivated me to carry out this research to develop an automated tutor to the deaf community. The target group of this system is the primary students of Deaf School.

There are different sign languages in the world. In Sri Lanka, the deaf community use Sri Lankan Sign Language. There exist different sign languages for different deaf schools according to the regional areas. But the Sinhala Alphabet is almost the same.

There are problems when teaching sign language to disabled children such as, lack of teachers, less or no attention to every child at every moment due to lack of resources, parents of these disabled children may be too busy, less interest of children to study, etc. As a solution this system will help to practice & check their knowledge without any help of their teachers or parents, as a computer is an infinitely patient teacher.

II. METHODOLOGY

A. System Overview

This system can be divided into four major phases as shown in Fig. 1.

In Image Acquisition phase, a collection of 8 static signs as shown in Fig. 2 were captured by A4Tech 1.3MP USB connectable Web Camera. These images were captured under certain limitations to increase the accuracy of the system. The images were taken in front of a black background. The user has to wear a long sleeved black top or a black band with a white glove. Each image includes a sign in Sri Lankan Sign alphabet. All the images were taken under resolution of 200*200 dpi.

In Image preprocessing phase a number of image processing techniques such as Grayscale filter, Gaussian Blur filter, Iterative Thresholding filter, Morphological filters, Canny Filter, etc. were used to take the contour of the sign which will be the input of the next phase as shown in Fig. 3.

In the Feature Extraction phase, Centroid distance based Fourier Descriptors were used to extract features from the contour of each sign [1]. Contour of the shape of each sign was sampled into 64 points and centroid based shape signature was calculated using (1). (Fig. 4)

$$r(t) = ([x(t) - x_c]^2 + [y(t) - y_c]^2)^{1/2} \quad (1)$$

where,

$$x_c = 1/L \sum_{L=0}^{L-1} x(t)$$

$$y_c = 1/L \sum_{L=0}^{L-1} y(t)$$

The resulted shape signature is transformed into its frequency domain by applying Discrete Fourier Transformation. The generated Fourier coefficients were indexed to achieve shape invariance. First ten Fourier coefficients except the first coefficient were used to feed the neural network's input nodes.

In the Recognition phase An Artificial Neural Network was designed with 10 input nodes, 6 hidden nodes and 8 output nodes.

Based on the training of the neural network for the signs, it will generate a file with calculated weights. This neuron weight file will be used to get the output for a sign in real time. It delivers the correctness of the sign (right/wrong) to the user.

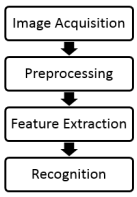

Fig. 1. System Overview

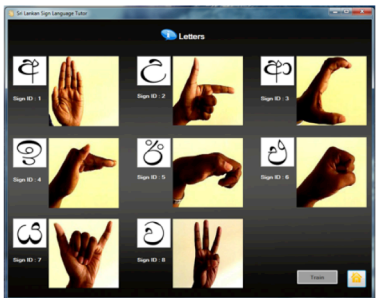

Fig. 2. : Recognized signs of Sinhala Alphabet

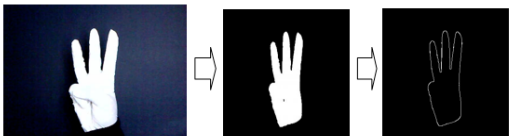

Fig. 3. : Conversion of the RGB image into a contour image

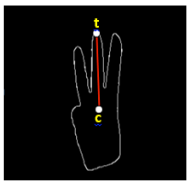

Fig. 4. : Centroid distance

III. Implementation

As the target group of this system is the primary students of Deaf School, graphical user interface of the system was designed in a simple manner and more colors were used.

Start-up window provides four options as shown in Fig. 5. They are Learn, Search, Help and Letters & Training.

Learn window is the main window of this system as shown in Fig. 6. It will facilitate the user with image acquisition and checking the correctness of it with few button clicks. First the user has to select and click on a letter. Then he/she can pose the sign, capture the image and check the correctness of the sign. A visual indicator will show the correctness of the sign as shown in Fig. 7.

Search window will facilitate the user to search a sign. It will produce an image of the letter of the corresponding sign. User can pose the sign and search the letter of the corresponding sign. Help window will provide the instructions to follow when using the system. Letters window displays the list of letters with an image of each sign. It will also show the ID of each sign, which is useful in training more samples for each sign in Train window.

Train window is used to train the system with more samples to minimum error rate. Admin can select the sign ID, capture an image of the corresponding sign, process the image, get the Fourier descriptors and add those descriptors and corresponding output pattern to the input and output text files of the Neural Network. This window provides the facility to train a Neural Network from the beginning, stop the training and resume the training from the previous state.

Fig. 5. Start-up window

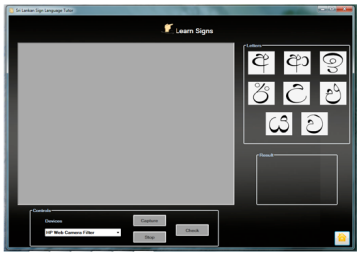

Fig. 6. : Learn window

Fig. 7. : Visual Indicators for the correctness of sign

IV. Testing and Results

The system is tested with 800 images of signs including 100 images from each sign for scale, rotation, translation and starting point invariance and the obtained accuracy level for each letter is listed in Table 2.

The system is trained by using 200 images of signs including 25 images from each sign.

ACCURACY LEVEL FOR LETTERS

Letter	Accuracy
ඇ	100%
ඵ	100%
ඉ	80%
ඵ	80%
ඊ	70%
ඣ	70%
ඊ	70%
ඛ	60%

V. Conclusion

Sri Lankan Sign Language Tutor is capable of recognizing 8 static signs, which are invariant to scale, translation, rotation and starting point. Different lighting conditions and image noise may fail the sign recognition. But under the constraints, system is able to deliver accurate results successfully.

The system uses Centroid based Fourier descriptors for feature extraction. Although the centroid distance is taken based on the boundary information it contains the region information as well. Centroid distance preserves both local and global information of the shape. Fourier Descriptors are easy to derive and are robust to image noise. And also Fourier descriptors provide easy shape normalization, which is mandatory in shape comparison. By using normalized Fourier coefficients, we can obtain translation invariance, rotation invariance, scale invariance and starting point invariance.

VI. Future Work

The system can be extended to recognize more number of Signs in Sri Lankan Sign Language including dynamic signs. It can be used to validate words and sentences in Sri Lankan Sign Language by using a video.

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