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Dynamic Tamil Sign Language Recognition System

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***Abstract*—Tamil sign language (TSL) is possibly the prevalent sign language in Tamil Nadu used by most of the mute people. It has its own phonetics, grammar and syntax which differ from other sign languages. Research related to TSL is now only being standardized. Considering the challenges in TSL recognition, a new method for recognition of dynamic gestures of TSL has been proposed in this work. Tamil Sign Language (TSL) Interpretation system is away to help the mute people to interact with normal people with the help of computer. Most researches on continuous sign language recognition were done with frames obtained by processing the videos with regular/equal interval. If a system developed is strong enough for processing the static and dynamic gestures then it would be the finest system to process the frames obtained while processing the continuous gestures. The developed algorithm for the hand gesture recognition system in TSL formulates a vision-based approach, using the Two-Dimensional Discrete Sine Transform (DST) for image compression and the Self-Organizing Map (SOM) or Kohonen Self Organizing Feature Map (SOFM) Neural Network for pattern recognition purpose, simulated in MATLAB. It is shown that this system performs well with 91% accuracy.**

***Index Terms*— Tamil Sign Language, DST (Discrete Sine Transform), SOM (Self Organizing Map)**

I. INTRODUCTION

A sign language (also signed language or simply signing) is a language which uses manual communication and body language to convey meaning, as opposed to acoustically conveyed sound patterns. Wherever communities of mute people exist, sign languages have been developed. Signing is not only used by the mute, it is also used by people who can hear, but cannot physically speak. While they use space for grammar in a way that spoken languages do not, sign languages show the same linguistic properties and use the same language faculty asdo spoken languages. A common misconception is that all sign languages are the same worldwide or that sign language is international. They are unique in some ways in that they cannot be written like spoken language. Sign language varies from country to country with its own vocabulary and grammar. Even within one country, sign language can vary from region to region like spoken languages. Tamil Sign Language (TSL) is a language used by the mute community of the southern region.

The main objective of this work is to develop a Tamil sign language recognition system for mute people using image processing techniques. There are two main directions in sign language recognition. One is using data gloves and the other is visual approach. Vision based approach is most suitable, user friendly and affordable. So, it is widely used. Hence, a vision based approach is used to recognize signs of Tamil Sign Language. In the proposed work, single right hand palm image, two handed Tamil sign gestures and also hand with facial gestures are taken to process. This work contains three phases of work. First phase is pre-processing, Second phase is feature extraction. Moment Descriptor (MD) is one of the well-known methods of shape matching. MD has been used when a region based analysis of the object is performed. Finally, Support Vector Machine (SVM) classifier is used to recognize the signs from trained set of hand gestures. In the proposed work image processing techniques are handled in a way to get a better classification result. Factors affecting the recognition result are eliminated by selecting a right set of features. Features are the decisive key for this Tamil Sign Language recognition application. In this work an image processing technique has been presented and designed for recognizing the signs of Tamil language for mute persons. It perfectly recognizes the Tamil Sign Language by comparing the sample images of different persons with previously available standard set of images. The rest of the paper is organized as follows. Section 2 deals with related work, Section 3 describes the proposed work, Section 4 describes the Methodology used, Section 5 deals with Experiments and Results, Section 6 and Section 7 deals with Conclusion and Future Enhancement respectively.

II. RELATED WORK

P.V.V.Kishore, P.Rajesh Kumar, E.Kiran Kumar and S.R.C.Kishore proposed a sign language recognition system for transforming signs of Indian sign language into voice commands using hand and head gestures of humans [1].Database of extracted features are compared with input video of the signer using a trained fuzzy inference system.

Balakrishnan, G., P. S. Rajam, et al., [2] proposed a method of recognizing a 32 set of combinations, 10 for each up and down position of fingers to get corresponding Tamil letters. The method was used up/down position of fingers into decimal numbers which is further categorized to recognize the

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Tamil alphabets. A set of static data in the form of images of sizes 640×480 pixels were captured. Palm image extraction was used to convert RGB to Gray scale images.

Futane, P. R., *et al*., [3] in their work proposed two approaches, one for device based and the second is vision based for Indian sign language recognition. In the device based approach they used an electronic glove for sign input. In the vision based approach two processes involved, first one was used for sign capturing and second one was used for sign analysis. They used three modules for capturing and analysis of sign symbols. First one was used for Gestures Acquisition, pre-processing and creation of gestures database. Second module was on Gestures classification and Key features extraction and analysis. Third one they used for Building Gestures recognition engine.

Ghotkar, A. S., et al., [4] in their work described four modules for recognition of sign languages. First method used was the hand tracking system in which CAM-SHIFT method was employed. Second was the hand segmentation in which HSV colour model and neural network.

Rekha.J., et al., [5] proposed an approach to recognize TSL double handed static and dynamic alphabet signs. 23 static TSL signs from 40 signers were collected as training samples and 22 videos were used as testing samples. The shape features were extracted by the method of Principle Curvature Based Region Detector, texture features of hand were extracted by Wavelet Packet Decomposition and features from fingers were extracted by complexity defects algorithms. Multi class non-linear SVM, KNN and DTW were used as sign classification.

III. Proposed Work

Signs vary from person to person so it is very significant for the researchers of sign language recognition to develop a system which recognizes the sign of deaf/dumb person is a very challenging task. Various factors like color, angle and position of hand disturb the perfect recognition of the signs. Fig.1 describes the block diagram of the dynamic gesture recognition system.

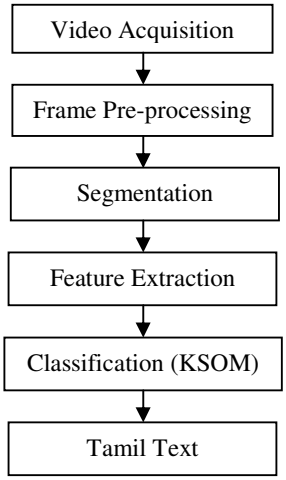

Fig. 1.Block Diagram of Dynamic Gesture Recognition System

In pre-processing, the obtained images are processed through the steps like resize, gray conversion, filtering for reducing the distortion and Black and White conversion.

In feature extraction, in order to extract the necessary feature vectors from the output obtained at the pre-processing phase, Shape Descriptor/Moment Descriptor (MD) has been selected. Moment Descriptor is one of the well-known methods of shape matching. MD has been used when a region based analysis of the object is performed.

In Hand recognition we should compare each pixel value in each frame with its threshold the sign from each frame is compared withthe template and corresponding text will display. The recognition of human gestures and facial expressions in image sequences is an important and challenging problem that enables a host of human-computer interaction applications.

Hand gestures are classified into twotypes, static and dynamic gestures. Static hand gestures are defined as orientation and position of hand in the space during an amount of time without any movement and if a movement is there in the aforementioned time duration it is called dynamic gesture.

IV. Methodology Used

A vision based analysis is used in the present work. Vision based analysis, is based on the way human beings perceive information about their surroundings, yet it is probably the most difficult to implement in a satisfactory way. As there are no resources to download TSL dataset, the Tamil Sign Language database has been created by capturing images with the help of a digital camera. Signs of the captured images are shown below in Fig. 2.

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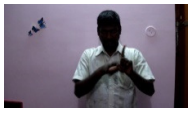
INPUT IMAGE	CORRESPONDING TAMIL TEXT
	என்அம்மாவிற்குஉடம்புசரியில்லை
	என்குழந்தைபள்ளிக்குசெல்கிறான்
	என்மிதிவண்டியைகாணவில்லை
	எனக்குதண்ணீர்வேண்டும்
	எனக்குபசிக்கிறது
	எனக்குபாடம்புரியவில்லை

Fig. 2.Tamil Sign Language (TSL) Dataset

The system includes four stages like,

1. Input Video
2. Video Pre-processing
3. Feature extraction
4. Classification

All these four stages are discussed briefly in the way how the dynamic gestures are handled can be seen further. In the first stage, the 2D-DST for each hand gesture image is computed, and feature vectors are formed from the Discrete Sine Transform (DST) coefficients. The second stage uses a self-organizing map (SOM) with an unsupervised learning technique to classify vectors into groups to recognize if the subject in the input image is "found" or "not found" in the image database. If the image is classified as found, the best match image found in the training database is displayed as the result, else the result displays that the image is not found in the image database. Fig. 3 shows the Schematic View of Dynamic Hand Gesture Recognition.

A. *Image acquisition*

A collection of Videos with facial gestures are taken by using USB connected camera. Since a vision based analysis has been performed, a certain limitations are followed such as black background and fixed distance between the signer and the background and also between the signer and the camera.

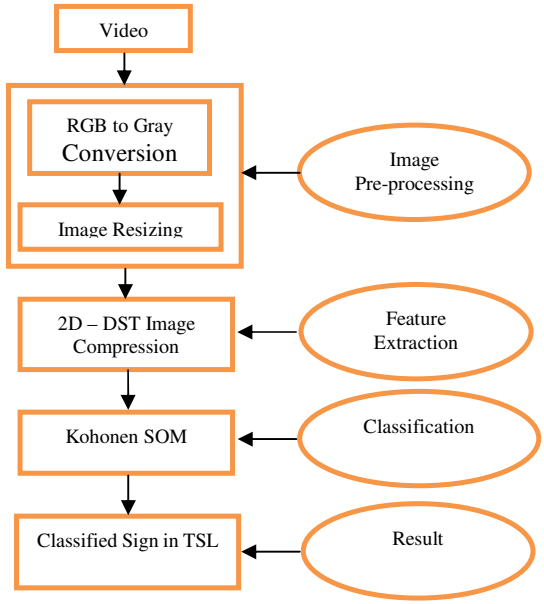


Fig. 3. Schematic View of Dynamic Hand Gesture Recognition for TSL

B. *Video Pre-processing*

Pre-processing is very much required task to be done in sign language recognition system. Pre-processing is applied to images before extracting features from hand images. Pre-processing consists of two steps

- Segmentation
- Gaussian filtering

Segmentation is done to convert gray scale image into binary image so that we can have only two object in image one is hand and other is background. After converting gray scale image into binary image we have to make sure that there is no noise in image so we use Gaussian filter technique. A very good segmentation is needed to select adequate threshold of gray level to extract hand from background .i.e. there is no part of hand should have Background and background also shouldn't have any part of hand. If we take close look into the segmented image sometime we find that the segmentation is not perfectly done. Background may have some 1's which is known as background noise and hand gesture may have some 0's that is known as gesture noise. A Gaussian filtering approaches been applied to obtain a smooth, closed, and complete contour of a gesture. The desired output at the pre-processing stage is Black and White (BW) image which is obtained by using the image processing technique like RGB to gray conversion, filtering and thresholding.

After collecting the images from the database, the images were pre-processed. First the RGB images were converted to

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gray scale image by RGB to gray function available in Matlab environment. It converts the true colour image RGB to the gray scale intensity image. The function converts RGB images to gray scale by eliminating the hue and saturation information while retaining the luminance. We used first derivative Sobel edge detector method because it computes gradient by using discrete difference between rows and columns of 3×3 neighbors. The Sobelmethod finds edges using the Sobel approximation to the derivative, where the gradient of image is maximum,Sobel returns edge points. Sobel is the best amongst because it provides good edges, and it performs reasonably well in the presence of noise.

C. *Feature extraction*

In this work shape descriptors have been handled which are used when a region based analysis of the object is performed. In region based techniques, all the pixels within a shape are taken into account to obtain the shape representation. Common region based methods use moment descriptors to describe the shape. Because moments combine information across an entire object rather than providing information just at a single boundary point, they capture some of the global properties missing from many pure contour-based representations: overall orientation, elongation, etc. Region-based analysis exploits both boundary and interior pixels of an object. Solidity, Perimeter, Convex area, Major axis length, Minor axis length, Eccentricity, Orientation are some of the shape descriptors used as features in this work. These shape descriptors are more robust to noise and distortions. Region-based analyses are invariant to translation, rotation and scale. Then, the Two-Dimensional Discrete Sine Transform (2D-DST) for each region is computed, and feature vectors are formed from the DST coefficients. The DST is a widely used transformation for data compression. It is an orthogonal transform, which has a fixed set of image independent basis functions, an efficient algorithm for computation, and good energy compaction and correlation reduction properties.

D. *Classification using KSOM*

- Assume output nodes are connected in an array (usually 1 or 2 dimensional)
- Assume that the network is fully connected - all nodes in input layer are connected to all nodes in output layer.
- Use the competitive learning algorithm as follows:
  - Randomly choose an input vector x
  - Determine the "winning" output node i, where w_i is the weight vector connecting the inputs to output node i.

Note: the above equation is equivalent to $w_i x >= w_k x$ only if the weights are normalized.

$$\left|\omega_i - x\right| \le \left|\omega_k - x\right| \qquad \forall k$$

- Given the winning node i, the weight update is

$$w_k(new) = w_k(old) + \mu\, \aleph(i,k)\,(x - w_k)$$

where $\aleph(i,k)$ is called the neighborhood function that has value 1 when i=k and falls off with the distance $|r_k - r_i|$ between units i and k in the output array. Thus, units close to the winner as well as the winner it, have their weights updated appreciably. Weights associated with far away output nodes do not change significantly. It is here that the toplogical information is supplied. Nearby units receive similar updates and thus end up responding to nearby input patterns.

V. EXPERIMENTS AND RESULTS

An efficient classifier and recognition method plays very important role in any gesture recognition system. This step goes forward with the sign language recognition and machine learning field. Any sign language recognition problem is classified into two methods i) supervised and ii) unsupervised classification. Though an intensive research is being carried out for the last 60-65 years in the field of sign language recognition, but the complex pattern with variant to translation rotation and scale is still unresolved [12]. Various supervised classification methods are available such as nearest neighbourhood classification with Euclidean distance [6] and other similarity measures [11], Bayesian classifier [8], Neural network [7], and unsupervised classification methods such as clustering methods: K-mean, Fuzzy k-mean, Minimum spanning tree, Single link, Mutual neighbourhood, Single-link, Complete link, Mixer decomposition. In sign language interpretation, as the previous classes are known, supervised classification is the good choice.

Training and testing the system is the very important aspect of any research work. There are many error estimation methods available such as redistribution methods, Holdout method, Leave-one Out method, Rotation method, n-fold cross validation and bootstrap method. Depending on the availability of sample data and required performance one can choose the error estimation method for analysis of results. Experimentation is carried out in an Intel (R) Core (TM) 2 Duo processor machine with 2.10GHz, 4.00GB RAM, MATLAB R2013 and a 16.0 MP digital camera.

Dataset for TSL- A dataset of 35 Video is loaded into MATLAB which includes 5 different sign gestures with 7

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different backgrounds and slightly different postures for the training database. The system is purely data dependent. For testing purpose, we have used some untrained Video.

Experiment- A Graphical User Interface (GUI) has been created to automatically train and recognize the gestures as shown in fig. 4 below. Fig. 5 represents shows the output for the recognized dynamic Tamil Sign.

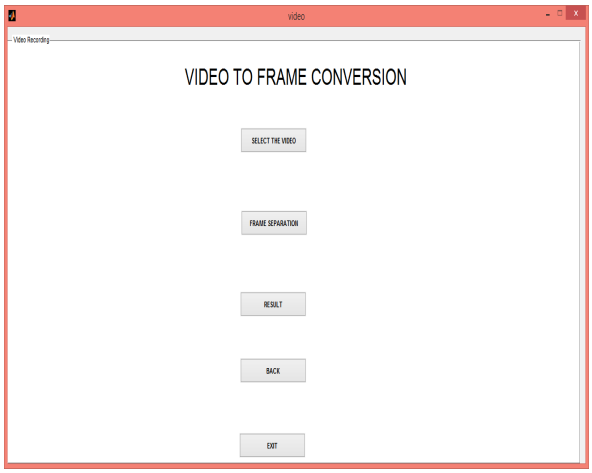

Fig. 4. GUI model of Dynamic Hand Gesture Recognition System in TSL

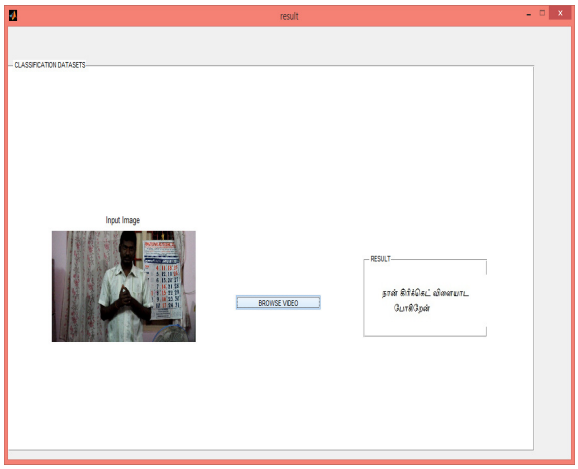

Fig. 5 output for the recognized dynamic Tamil Sign.

VI. CONCLUSION

The Primary focus of this system is to examine image processing as a tool for the conversion of dynamic gestures into corresponding Tamil text. The proposed system can handle different types of words, sentences and a number sign in a common vision based platform.The system is suitable for complex TSL Dynamic signs.

However, it is to be noted that the proposed gesture recognizer canbe considered as a complete sign language recognizer, as for complete recognition of sign language, information about other body parts i.e., head, arm, and facial expression. The developed algorithm for the hand gesture recognition system in TSL formulates a vision-based approach, using the Two-Dimensional Discrete Sine Transform (DST) for image compression and the Self-Organizing Map (SOM) or Kohonen Self Organizing Feature Map (SOFM) Neural Network for pattern recognition purpose, simulated in MATLAB. It is shown that this system can be used as a "working system" for Tamil Sign Language words, sentences and numerical recognition performs well with 91% accuracy.

VII. FUTURE WORK

In future, there can be many possible improvements that will broaden the scope of this work. First of all, this work can be implemented as a real time application in improved light conditions and controlled environment.

Feature extraction algorithms like Wavelet transform, Invariant moments and other existing methods can be included in conducting experiments for improving the results. Other classifiers like multi class Support Vector Machine (MSVM), Principal Component Analysis (PCA) and Linear Discriminate Analysis (LDA) or a combination of these classifiers can be included in conducting experiments to improve the recognition rate.

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