STATIC HAND GESTURE RECOGNITION FOR ASL USING MATLAB PLATFORM

Sallauddin Mohmmad¹, Ramesh Dadi², A. Harshavardhan³, Syed Nawaz Pasha⁴, Shabana⁵

¹Assistant Professor, Department of CSE, SR University, India
²Assistant Professor, Department of CSE, SR University, India
³Assistant Professor, Department of CSE, SR University, India
⁴Assistant Professor, Department of CSE, SR University, India
⁵Assistant Professor, Department of CSE, Sumathi Reddy Institute of Technology for Women, India

¹sallauddin.md@gmail.com, ²ramesh_d@srecwarangal.ac.in, ³harshavgse@gmail.com, ⁴snp786@gmail.com, ⁵87shabana@gmail.com

https://doi.org/10.26782/jmcms.2020.08.00030

Abstract

Generally communication with people in our daily life is by speaking with voice but some communications can possible with body language, facial expressions and hand signs. Expect the voice also we can communicate with others. Apart from that hand gestures are playing very important role in communication. Here we developed a gesture identification system which interprets the American Sign Language. This system helps the people who are deficiency with deaf and dumb. This system lead them to understand communicate as like normal people. Lot of proposals is introduced on gestures specified with their languages like ASL, ISL, etc. Here we are introducing new static gestures using MATLAB on bases of existing systems. Our input captured from camera then system applies the preprocessing on captured image. The set of features are retrieved using PCA. Comparison of the features is done using Euclidean Distance with the help of training sets. Finally optimal gestures identify and produce the output inwards of text or voice.

Keywords: Static gesture recognition, PCA, Euclidean Distance, MATLAB software

I. Introduction

Gesture recognition system has been adjusted for different research applications from facial motions to finish substantial human activity. Different applications have developed and made a more grounded requirement for this kind of Gesture recognition system [1]. More researches are going on this platform to make...
human activity easy. This kinds of research also introduced in Machine Learning, Cognitive Sciences and more other advanced technologies. Several proposed strategies for perceiving static and dynamic hand gestures by breaking down the raw streams produced by the sensors connected to human hands. This technique accomplished an acknowledgment pace of more than (75%) on the ASL signs [II]. Presently these kinds of hand gesture systems are using in the smart mobiles. In any case, the client needs to utilize a glove-based interface to extricate the advances of the hand motions which constrains their ease of use in certifiable applications, as the client needs to utilize extraordinary gloves so as to communicate with the framework.

Another examination introduced a real time static isolated gesture application utilizing a hidden Markov model methodology. The features of this application were separated from signal outlines. Nine diverse hand signals with different degrees of turn were thought off. The drawback of this element extraction strategy is the utilization of skin-based segmentation technique which doesn't work appropriately within the sight of skin-shaded items out of sight. Gesture based communication isn't just utilized by those in need of a hearing aid and the discourse weakened people to discuss either with one another or the ordinary people, however it is utilized by numerous individuals to convey [XII] [X]. Communication through signing doesn't mean the utilization of hand signals no one but, it very well may be any sort of sign utilizing any piece of body, it might be eyes, legs, and so on. This language fluctuates from nation to nation. Here, the Signs of ASL is utilized for advancement of the framework for acknowledgment of signs [X]. A segment of the challenges experienced by talk and hard of hearing people while talking with regular people were social participation, correspondence dissimilarity, guidance, direct issues, mental wellbeing, and security concerns.

The manners by which one can interface with PC are either by utilizing gadgets like console, mouse or by means of sound signs, while the previous in every case needs a physical contact and the last are inclined to commotion and aggravations. Physical activity conveyed by the hand, eye, or any part of the body can be considered as signal of gesture [I] [X]. Hand signals are the most appropriate and effectively interpretable for people. Here, solitary gesture recognition framework is proposed, it utilizes right handed gesture signals, and are characterized and perceived for the particular character. Static gesture recognition framework proposed which doesn't require any color code. The sign acknowledgment framework proposed, perceives the sign with extraordinary precision and with less features and lesser time.

Copyright reserved © J. Mech. Cont.& Math. Sci.
Sallauddin Mohmmad et al
In this paper we presented our project with five sections. The first section is complete literature survey and introduction. Second section explained about the process of methodology steps in recognition of gestures with image transformation [VII]. The third section explained about involved algorithms for our project and some related program segments. Fourth section explained about implementation of project with some related test cases. Finally we concluded the project with our contribution and future work.

II. Methodology

Our model is developed based on the static had gestures recognition system. In the static hand gesture system basically follows the four steps. They are preprocessing and segmentation, feature extractions, classification and bit generation and Hand gestures interpretation [III] [XII]. For our project we have prepared the set of input images for each sign which may have slide difference with each other but prepared for same sign. When the camera scans the image of sign as input to the system then application start the comparisons with stirred data set. In this technique, the hand gestures are captured using a camera and saved. After that this images send to image processing techniques to provide the output for given gesture.

Fig. 1: Methodology for Static hand gestures

Fig. 2: Basic steps for static hand gesture recognition technique.
Retrieving of image from saved database and apply the gray code conversion is a one of important process in the algorithm. Initially the captured gesture will save as an image. These saved images are retrieved from the dialog box. The image which selected from dialog box send for gray scale conversion process means the 24bit pixel image converted into 8 bit pixel image.

The RGB color values should converted into gray-scale values by forming a weighted sum of the $R$, $G$, and $B$ components based on this formula:

$$\text{Gray} = 0.2989 \times R + 0.5870 \times G + 0.1140 \times B.$$  

The RGB formatted image converted into gray coded image then gray coded image converted into Binary image .In this process Pixel Count Algorithm recommended using MATLAB function im2. The binary image consisting of only two values they are 0 and 1.white pixels are represented by 1 and black pixels are represented by 0.the medium value is 0.5 used to help in identify the skin pixels and background pixels.

**Morphological Operations:**

To identify the correct gesture here we are applying morphological operation which erode and dilate the image. Erosion removes the finger part dots or pixels. Dilation is used to filter the image after the fingers part removed .This process separate the hand part and finger parts.

Basic Formulas for Erosion and Dilation are:

**Erosion:**

$$ (A \ominus B)(x,y) = \min \{ A(x+x',y+y') - B(x',y') | (x',y') \in DB \},$$  

(1)

**Dilation:**

$$ (A \oplus B)(x,y) = \max \{ A(x+x',y+y') - B(x',y') | (x',y') \in DB \},$$  

(2)

Where, $A$ is the image and $B$ is the structuring element and $DE$ is the domain of the structuring element.
Fig. 3: Complete processing steps of hand gestures.

We need to identify only sign covered part of the hand only remaining part should be eliminated. So that we need to select the complimented image which is a binary coded image from that subtract the image who applied with erosion and dilation operation.

Subtracted image = Binary image – Image after morphological operations.

**Feature Extraction:**

We present the gestures in different shapes .these shapes are detected by Feature extraction methods .In this procedure some redundant pixels like some shadows get remove and also remove the white dots below the threshold .finally it keeps the refined suitable part of the image.

**Edge Detection:**

Hand gestures represented with only fingers .we need to identify the proper hedge part of the fingers to extract it. For this process in our project we implemented the Canny Edge detection method. This algorithm is more efficient because it will not effected by any kinds of unnecessary noise detect the exact true values. Canny edge detection has a series of process they are:

(1) Applying Gaussian filter to smoothen the image.
For Gaussian filter kernel of size $(2k+1) \times (2k+1)$.

(2) Finding the intensity gradients

\[
G = \sqrt{G_x^2 + G_y^2}
\]

\[
\Theta = \text{atan2}(G_y, G_x)
\]

Where, $G_x$ is the horizontal direction and $G_y$ is the vertical direction.

(3) Non maximum suppression.

(4) Double threshold.

(5) Edge tracking by hysteresis.

III. Algorithms with Matlab for Gestures

Our application is integrated with many technologies and algorithms. We need to apply the image processing to identify the proper comparisons with features, filter the data and convert into binary format, classification among the related images, clustering and etc. different kind of algorithms and their related code parts are included with our project in the MATLAB. There are some primitive methods, procedure and variables are available in the MATLAB to perform the above mentioned operations.

Principal Component Analysis (PCA):

PCA may be a statistical method that uses an orthogonal transformation to show a group of observed content of possibly correlated variables into a group of values of linearly uncorrelated variables called principal components. This change is clarified in such how that the essential head part has the most significant conceivable fluctuation and each succeeding segment will have the absolute best difference conceivable under the imperative that it's symmetrical to the former segments [VIII] [IV]. The output vectors are an uncorrelated orthogonal basis set. PCA is sensitive with reference to the relative scaling of the first variables.

Principle Component Analysis (PCA) is used to calculate the Fisher Linear Discriminant (FLD) features to evaluate the most discriminating features between images. In our project we have implemented in the MATLAB with PCA base primitive procedures and commands to process the images.
Code segment of PCA in MATLAB:

Train image

[PCA features omega] = PCA Training (ImgMat, nRows, nColumns, Show Output, nEig Val Thres); [V_Fisher Projected Images_Fisher] = ASLfisher (ImgMat, PCA features, nRows, nColumns, omega, size (cAlpha, 2), nTraining Samples, Show Output);

%%Test Classifier Start

Image = 1;
End Image = 5;
No Of Image = End Image – Start Image - 1;
PCA Correct_SVM = zeros (size (cAlpha, 2), 1);
PCA Correct_KNN = zeros (size (cAlpha, 2), 1);
LDA Correct_SVM = zeros (size (cAlpha, 2), 1);
LDA Correct_KNN = zeros (size (cAlpha, 2), 1);
for ii = 1: size (cAlpha, 2)
for jj = Start Image: End Image

%% Input Image

Input Image = strcat (cAlpha (ii), '-test', int2str (jj), '.jpg'); % Form filename
img1 = imread (char (Input Image)); %% Perform preprocessing of input image
ProcImg = preprocessing (img1, nRows, nColumns, threshold, Show Output);
In Im Weight = PCA get (double (ProcImg), PCA features);
In Im Weight 2 = Fisher get (double (ProcImg), PCA features, V_Fisher)

Linear Discriminant Analysis (LDA):

LDA is a speculation of Fisher’s linear discriminate, a technique utilized in measurements, pattern recognition, and AI to locate a linear combinations of highlights that portrays or isolates at least two classes of objects or events [XIII]. The subsequent mix might be utilized as a linear classifier, or, all the more ordinarily, for dimensionality decrease before later classification. LDA is additionally firmly identified with PCA that the two of them identify the linear combinations of variables.

Code segment for LDA in MATLAB:

LDA Correct_SVM = zeros (size (cAlpha, 2), 1);
LDA Correct_KNN = zeros (size (cAlpha, 2), 1);
total_images = size (cAlpha, 2)* No Of Image;
display ('Percentage PCA SVM correct -');
sum (PCA Correct_SVM) / total_images display ('Percentage PCA KNN correct-');
sum (PCA Correct_KNN) / total_images display ('Percentage LDA SVM correct-');
sum (LDA Correct_SVM) / total_images display ('Percentage LDA KNN correct-');

**K-Nearest Neighbors Algorithm (K-NN):**

In the pattern recognition k-nearest neighbor’s algorithm is used for classification and regression process. In that cases input consisting of the k numbers of closest training examples in the feature set. The output depends on the whether k-NN is used for classification or regression.

Code segment for k-NN in the MATLAB:

This function performs KNN classification

Function Class = ASlknn (cAlpha, nTraining Samples, In Im Weight, omega) %
this function performs KNN classification

Class = fitcknn (In Im Weight, Training, Group, nTraining Samples, 'euclidean',
'random');

% perform knn classification with Euclidean norm as basis
Perform KNN and SVM classification

Class = ASlknn (cAlpha, nTraining Samples, In Im Weight, omega);
Ind = ASLsvm (cAlpha, nTraining Samples, In Im Weight, omega);
Class2 =
ASlknn (cAlpha, nTraining Samples, In Im Weight2', Projected Images_Fisher);
Ind2 =
ASLsvm (cAlpha, nTraining Samples, In Im Weight 2', Projected Images_Fisher);
Display Input and Matched Output f = figure ();
Set (gca, 'font size', 28);
Set (f, 'name', 'KNN') subplot (1, 3, 1) im show (img1);
Title ('Input image', 'font size', 20)
Sub plot (1, 3, 2)
Recong Img = strcat (cAlpha (Class), '-test1.jpg');
Im show (char (Recong Img));
Title (strcat ('Recognized Letter using PCA-', cAlpha (Class)), 'font size', 20);
Subplot (1, 3, 3)
Recong Img = strcat (cAlpha (Class2), '-test1.jpg');
Im show (char (Recong Img));
Title (strcat ('Recognized Letter using FLD-', cAlpha (Class2)), 'font size', 20);
f = figure();
set (gca, 'font size', 28);
set (f, 'name', 'SVM') subplot (1, 3, 1) im show (img1);
title ('Input image', 'font size', 20)
sub plot (1, 3, 2)
Recong Img = strcat (cAlpha (Ind), '-test1.jpg');
Im show (char (Recong Img));
title (strcat ('Recognized Letter using PCA-', cAlpha (Ind)), 'font size', 20);
sub plot (1, 3, 3)
Recong Img = strcat (cAlpha (Ind2), '-test1.jpg');
Im show (char (Recong Img));
Title (strcat ('Recognized Letter using FLD-', cAlpha (Ind2)), 'font size', 20);

**Support Vector Machine (SVM):**

A Support vector machine is a classification algorithm under category of supervised learning based and that sorts information into two classes [XIII] [VI]. It is prepared with a progression of information previously characterized into two classifications, fabricating the model as it is at first prepared. The undertaking of a SVM algorithm is to figure out which class another information point has a place in. This makes SVM a sort of non-double straight classifier [IV] [XIII]. A SVM calculation ought to put objects into classes. However have the edges between them on a chart as wide as could reasonably be expected. A few utilizations of SVM include:

- Text and hypertext characterization
- Image characterization
- Recognizing manually written characters
- Biological sciences, including protein characterization

Code segment of SVM in the MATLAB:

```matlab
Function Ind = ASLsvm (cAlpha, nTraining Samples, In Im Weight, omega) % this function performs SVM classification
```

*Copyright reserved © J. Mech. Cont.& Math. Sci.*

*Sallauddin Mohmmad et al*
Training = omega'; %Training based on features extracted
%SVM
Ind =1;
for ii = 2: size(cAlpha, 2)
  Group = [ii*ones (1, nTraining Samples) Ind*ones (1, nTraining Samples)];
  % perform classification between chosen and next group of training
  %samples
  Train = [Training ((ii-1) *nTraining Samples+1: (ii -) *nTraining Samples + nTraining Samples, :); Training ((Ind-1) *nTraining Samples + 1: (Ind - 1) *nTraining Samples + nTraining Samples:)]; SVM Struct = svmtrain (Train, Group);
  Ind = svmclassify (SVM Struct, In Im Weight); % Chosen group retained for next comparison
end

IV. Implementation

The input picture can be capture utilizing with web cam. The pictures caught have their specified position with support format of the device. The format which supported by the device of web cam can be identified by a command which initializing the order: “imaqhwinfo ('win video')”. This order gives the subtleties, for example, Adaptor Dll Name: [1x81 char] Adaptor Dll Version: '4.5 (R2013a)'
Adaptor Name: 'win video' Device IDs: Device Info: [1x1 struct]. With the utilization of device ID we can get the upheld group by the web cam for the picture. The caught picture ought to be resized to the size of the put away pictures of the informational collection. In this way grid of the pictures are of same estimate and can be utilized for numerical count of Euclidean distance.
Pre-Processing and Segmentation:

Pre-processing is required on every picture which captured by camera to improve the usefulness of picture preparing for gesture. Image processing need to identify the different objects with respect to features set. As we discussed previously image subtraction, pre-processing, RGB to gray conversion and segmentation are done in the first stage [XV] [III]. The segmentation process portioning the picture into two shades one is foundation and other one is closer view with district of intrigue.
that is hand locale. The portioned picture has the hand area with the pixel esteem '1' and the foundation as the '0'. This picture is then utilized as a veil to get the hand area from the RGB picture by duplicating the highly contrasting picture for example paired picture with the first RGB picture, plane via plane [XV] [XI]. The size of picture is resized to decrease size of the network, utilized for the acknowledgment procedure.

**Feature Extraction and Training Phase:**

Feature extraction is one of the important steps in the gesture identification. In this process the features are retrieved by using PCA technique and the hand region properly cropped with respect to signature of the character [XIV]. The subtraction of the image and normalization are the subsequent processes as we discussed in earlier.

In this the preparation set for the framework to perceive the predefined gesture is finished. During the age of the preparation set the pictures are pre-processed and afterward put away. Column matrix is inferred for every one of the picture of dataset [V]. Utilizing that column matrix Eigen vector is determined. Eigen vector matrix is then increased with every one of the section vector framed by the dataset pictures. Finally optimal hand gesture will recognize.

**Test Cases:**

![Fig. 6: Test case for character C.](image)

![Fig. 7: Test case for character A.](image)
V. Conclusion

Almost deaf and discourse disabled people utilize gesture based communication to impart. This framework application is to give a stage high precision to decipher the signs, empowering typical individual to get motion. The distinguished or perceived character can be shown just as articulated. Gesture recognition framework utilizing PCA method is created and it keeps up tantamount precision, for example with different frameworks or executed methods. Quiet Mute and hard of hearing people need translators to communicate to avoid the third person help. This system more helpful to the persons who are old aged deaf and dumb persons to communicate easily with society. However gesture recognition system needs more research and define easy way to communicate the people for physical defected people. In future I will continue my research in this area to resolve the complication in the gesture recognition system.

References

I. Anushree Pillai, Spandan Sinha, Piyanka Das, Oinam Robita Chanu, "Contrivance Of Recognised Hand Gestures Into Voice And Text Output," Proceedings of 35th IRF International Conference, pp.41-45, 2017.

II. C. Motoche, M.E. Benalcázar, “Real-time hand gesture recognition based on electromyographic signals and artificial neural networks,” International Conference on Artificial Neural Networks, pp. 352-361, 2018.
III. S. Saha, A. Konar, and J. Roy, “Single Person Hand Gesture Recognition Using Support Vector Machine,” Computational Advancement in Communication Circuits and Systems, Springer, pp. 161-167, 2015.

IV. Praveen P., Rama B. (2018) A Novel Approach to Improve the Performance of Divisive Clustering-BST. In: Satapathy S., Bhateja V., Raju K., Janakiramaiah B. (eds) Data Engineering and Intelligent Computing. Advances in Intelligent Systems and Computing, vol 542. Springer, Singapore

V. Pappula, Praveen, and Rama B. Ramesh Javvaji. "Experimental Survey on Data Mining Techniques for Association rule mining." International Journal of Advanced Research in Computer Science and Software Engineering (2014).

VI. M Sheshikala, D Rajeswara Rao, R Vijaya Prakash, "A Map-Reduce Framework for Finding Clusters of Colocation Patterns-A Summary of Results", Advance Computing Conference (IACC), 2017 IEEE 7th International, Pages 129-131.

VII. Mohammed Ali Shaik, P. Praveen and R. Vijaya Prakash, “Novel Classification Scheme for Multi Agents”, Asian Journal of Computer Science and Technology, Vol.8 No. S3, June 2019, ISSN: 2249-0701, pp. 54-58.

VIII. D. Kothandaraman, M. Shesikala, K. Seena Naik, Y. Chanti, B. Vijyakumar, “Design of an Optimized Multicast Routing Algorithm for Internet of Things”, International Journal of Recent Technology and Engineering (IJRTE), vol. 8, Issue 2, 2019.

IX. S. Saha, A. Konar, and J. Roy, “Single Person Hand Gesture Recognition Using Support Vector Machine,” Computational Advancement in Communication Circuits and Systems, Springer, pp. 161-167, 2015.

X. Joshi, C. Monnier, M. Betke, and S. Sclaroff, “Comparing random forest approaches to segmenting and classifying gestures,” Image and Vision Computing, vol. 58, pp. 86-95, 2017.

XI. Zhang, Y.; Cao, C.; Cheng, J.; Lu, H. Egogesture: a new dataset and benchmark for egocentric hand gesture recognition. IEEE Trans. Multimedia 2018, 20, 1038–1050.

XII. Coteallard, U.; Fall, C.L.; Drouin, A.; Campeaulecours, A.; Gosselin, C.; Glette, K.; Laviolette, F.; Gosselin, B. Deep learning for electromyographic hand gesture signal classification using transfer learning. IEEE Trans. Neural Syst. Rehabil. Eng. 2019, 27, 760–771.

Copyright reserved © J. Mech. Cont. & Math. Sci.
Sallauddin Mohmmad et al
XIII. Rekha, J. Bhattacharya and S. Majumder, Shape, Texture and Local Movement Hand Gesture Features for Indian Sign Language Recognition, IEEE 2011.

XIV. Y. Xu, Y. Dai, “Review of hand gesture recognition study and application. Contemp,” Eng. Sci.10, pp:375–384, 2017

XV. H. Mizuno, N. Tsujiuchi, T. Koizumi, “Forearm motion discrimination technique using real-time EMG signals,” 2011 Annual International Conference of the IEEE, Engineering in Medicine and Biology Society, EMBC, pp. 4435–4438, 2011.