Hand Gestures Detection using Open Computer Vision

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Abstract

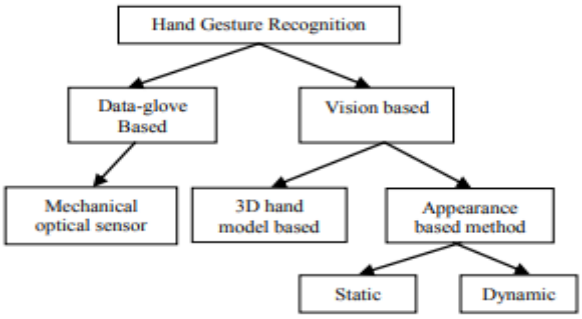
The purpose of the sign language recognition system is to establish communication with the people having hearing and speech problem. The proposed system is implemented for recognition of hand gestures into numerical formats. In this paper, we compare the performance of two methods i.e. Contour-SVM based method and Decision Tree Algorithm under different conditions like rotation, scaling with a constant background.

In both, SVM and Decision Tree we find the contour and draw convex hull. Used for classification purpose. SVM method achieves accuracy of 69% and our proposed algorithm attains 91% of accuracy.

Keywords - *SVM, Decision Tree, Contour, Convex Hull, Hand Gestures.*

I. INTRODUCTION

The purpose of the sign language recognition system is to establish communication with people having hearing and speech problem. Sign language is a collection of gestures and postures. Gestures are nothing but the communication of hand with or without an object. It is the type of activity that represents the meaningful message. Hand gestures are natural means of communication. Hand gesture signals have the applications in various fields like Robotics, virtual condition, Augmented Reality (AR) and in electronic gadgets. Sign Language Recognition system helps to deaf and dumb people to express their idea without the help of an interpreter. The main aim of this technique is to identify the gesture from imaging devices and convert into corresponding text. The spoken language changes with respect to regions, states and countries. Gesture-based communications also vary along with the language complexities. Some of the distinct gesture-based communication languages are as per the following: Korean Sign Language [2], Arabic Sign Language [3], Indian Sign Language [4], American Sign Language [5], Chinese Sign Language [6], Bangladeshi Sign Language [7] and Tamil Sign Language [8]. Different methods for hand gesture recognition [9] are shown in Fig. In data glove-based method, motion sensors are connected to the hand. These sensors collect the information about the position and motion of the hand. The sensor-based method requires an appropriate equipment setup. It may interfere with the natural movement of the hand and is costly. To overcome the constraints of data glove-based method, a vision-based method is developed. Vision-based method employs cameras to capture the hand gestures. Vision-based techniques are classified as 3-D hand model-based and appearances-based methods. 3-D hand model based method uses four different types of cameras such as stereo, monocular, angle eye, time of flight, infrared etc. to generate 3-D hand model for gesture recognition.



State-of-the-art techniques for hand gesture recognition

Static and dynamic hand gestures are used in appearance based method. Important features are extracted from captured images and unnecessary part of images is eliminated. This method is more useful for real-time implementation.

II. LITERATURE SURVEY

J. S. Kim et al. [2] presented a data glove-based method for recognition Korean sign language. This method is used for translation of sign into Korean text. In this method, pairs of hand gloves are used. This is utilized as a detecting gadget for recognizing the movement of hand and fingers. For better recognition of hand gesture, a fuzzy min-max neural network is used. This technique used for online pattern recognition. The recognition rate is up to almost 85%.

T. Shane bleh et al. [3] provide a system for recognizing cut off Arabic Sign language gesture. This method used in user individualistic mode. In this technique, feature extraction is assessed by KNN and polynomial networks. But the devices used are expensive. This technique reduces naturalness of sign language. It provided recognition rate of 87%.

P. Subha Rajam et al.[4] design a method for identification of Tamil Sign Language. This method is used for static and dynamic hand image conversion. By using binary number conversion and palm

extraction method hand gesture is recognized. The binary numbers are converted into a decimal number. These decimal numbers are converted to corresponding Tamil letters. It achieved recognition rate for static gesture 96.87% and for dynamic gesture 98.75%.

B. M. Lee cosia et al.[5] planned a method based on Artificial Neural Network (ANN) which is used for categorization and gesture recognition. They used an accelerometer-based hand gesture recognition method and fuzzy automata algorithm. This technique is used to reduce computation cost and memory consumption. Fast Fourier transform and K-means algorithm used for data normalizing and filtering process. The recognition accuracy has improved up to 95%.

Wen Geo et al.[6] presented a system for a Chinese sign language recognition based on SOFM/SRM/HMM. This sign language system is developed for both isolated and continuous signs. This system shows that the proposed system has better accuracy compared to conventional HMM.

S. Gupta et al.[7] presents a method for static hand gesture recognition using local Gabor filter. In this method PCA, LDA, Gabor filters, and SVM are used. Feature extraction and classification is done by using Gabor filter and SVM respectively. SVM gives improved classification with least complexity and high accuracy. The classification gives the accuracy rate of 96.1%.

F. S. Chen et al.[8] present a system for hand gesture recognition. They used Hidden Markov Model for recognition. In this system, Fourier Descriptor (FD) used to classify spatial feature and motion analysis to characterize temporal features. In this experimentation, the system makes many error observations. HMM, the model does not justify correct recognition. Also, they do not have enough training data to make a good estimation of HMM model parameters. It gives accuracy above 90%.

I. Hussain et al.[10] described a hand gesture recognition system for American Sign Language on palm tracking. In this system, good features of hand such as a fingertip, palm centre are used. The principal component analysis (PCA) is used to eliminate ambiguity between two similar gestures. Optical flow used to detect hand motion. The recognition accuracy stands at 96.55%.

S. Begum et al.[11] presented computer vision based Bangladeshi sign language recognition system. In their proposed system Pattern matching method is used for Principal Component Analysis (PCA). This method also uses both hands to represent signs.

III. PROPOSED METHODOLOGY

A. *Contour-SVM based hand gesture recognition*

Fig. 1 shows a general block diagram of the digit gesture recognition system. It contains various sub-blocks such as frame extraction, pre-processing, contour detection, storing features in the database in training phase. In the testing phase, additionally, Support Vector Machine (SVM) is used for classification followed by digit recognition step and display of output in the form of labels.

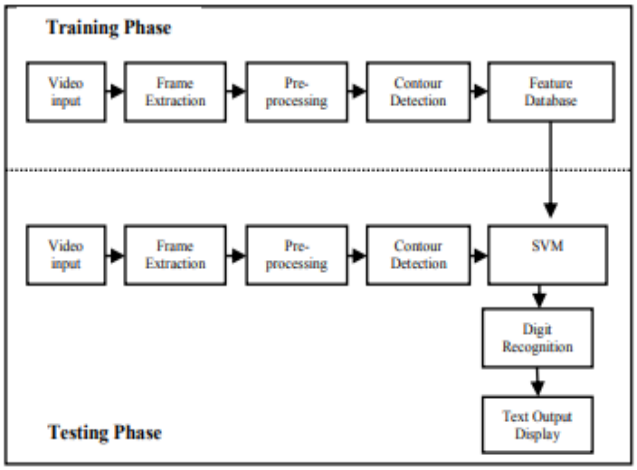


Fig. 1. Block diagram for digit recognition through hand gestures using contour detection and SVM

In the hand gesture signal recognition system for digit recognition, a video is captured from web-camera or is accessed from the database. This video is then passed through the further steps for digit recognition:

1) Image Acquisition

The first module in the proposed system is the image acquisition module. A live video is captured using a webcam. The recorded videos are of resolution 640x480 pixels.

2) Video Frame Extraction

The recorded video is then converted into frames. These frames are named serially as per their sequence.

3) Pre-processing

Image processing techniques are used to improve the quality of the image frames. First, hand region is extracted using bounding box. The RGB image is converted into a grayscale image and further is converted into the binary image. Thresholding is applied using Otsu's method to find the region of interest (ROI). The Gaussian filter is used for blurring the image. This step is applied for removal of high-frequency noise and smoothing.

4) Contour and convex hull

A curve which combines continuous points along the boundary is called as contour [12]. The contour points may be same colour or intensities. Contour detection is mostly used in applications like object detection, recognition and gesture recognition. In hand gesture application contour is drawn around the boundary of hand region i.e. the region of interest. It is found using following command from Open CV: hierarchy = cv2.findContours (thresh1, cv2.RETR_TREE,

cv2.CHAIN_APPROX_SIMPLE).After this step, the biggest contour is being found as a hand contour.

The convex hull is a set of continuous points in the Euclidean space which is drawn around the contour. The boundary points are inside the convex hull. Convex hull works as an envelope around the hand. To draw a convex hull, Hull = cv2.convexHull (cnt) command in Open CV is used. Convexity defects are found next.

5) Support Vector Machine (SVM)

Support Vector Machine (SVM) [12] is a set of supervised learning techniques. It is used for classification purpose. This is a generalization of linear classifiers. After contour detection, feature extraction is carried out. Extracted features are stored in the database during the training phase. In the testing phase, SVM classifier is applied for the features extracted from testing images. In the feature extraction stage, we have more information about the hand shape, finger number and the palm centre position. For good feature detection of hand, we have used the relative distance between the fingertips and the hand centre with their positions. Depending upon the number of defects, angle and length we classify the corresponding gesture using SVM. Support vector machine is a flawless method to find out the hyperplane between two different particular classes in high dimensional feature space. The output of recognition system will be displayed in the form of labels (0-9 digits)

B. Decision tree algorithm based hand gesture recognition

Decision tree algorithm falls under the category of the supervised learning used for classification problems. Also uses tree representation to solve the problem. It contains various sub-blocks such as detecting background, background subtraction, contour extraction, convex hull and defects, training and finger detection.

1) Detecting background

We use running average over a sequence of images to find the average image which will be chosen as a background.

$$CurBG[i][j] = alphaCurBG[i][j] + (1-alpha)CurFrame[i][j]$$

These stationary pixels become more prominent with every iteration. Thus after a few iterations, we get above average value which contains only background. At that point, it needs to detect only our hands neglect the rest.

2) Background subtraction

Here we subtract the pixel values. It results in both negative values and values are greater than 255, which is maximum value used to store an integer. If the background is black, simply no values are subtracted. Background subtraction involves calculating a reference image, subtracting each new frame from this image. Which result is a binary segmentation of image which highlights regions of non-stationary objects.

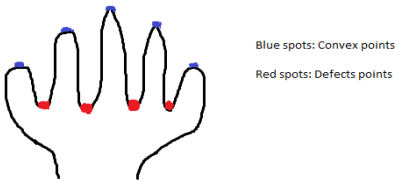
3) Contour extraction

Contour extraction is performed using open CV's inbuilt edge extraction function. It uses canny filter to get better edge detection.

e.g. ***cv2.Canny(img, 100, 200)***

4) Convex hull and defects

We find the smallest area convex hull that covers the contours. These points are to be on the fingers. Hence can be used for finding the number of fingers.



In case of entire arm, there will be another points of convexity too. So, we find the convex defects. Also, find the deepest point of deviation on the contour.

5) Tracking and finger detection

Thus the defect points are at the centre of the finger valleys. We find the average of defects which is bound to be in the centre of the palm.

Due to noise, this center keeps jumping to stabilize we take an average over a few iterations.

Now to detect the number of fingers consider the maxima defect point at the fingertip and 2 minimal defect points to indicate the valleys. Hence these 3 forms a triangle.

Now we get list of maximal defect points using these we find the number of fingers. If number of fingers is 0, it means user shows his/her fist.

IV. EXPERIMENTAL RESULTS

A. Software Platform

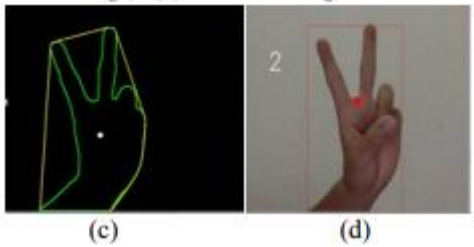
Implementation of digit recognition system is carried out using Open CV and Python on Intel core TM i5 Processor.

B. Results

a) Contour-convex hull-SVM method

The proposed method counts the number of fingertips. Convex defect points are between the corresponding fingers. In this method, we count the hull and after that, we recognize the gesture.

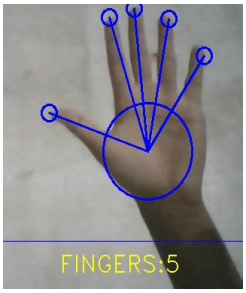
Contour-SVM based digit gesture recognition method: (a) Original image, (b)Thresholded image



Contour-SVM based hand gesture recognition method: (c) Contour detection (d) Recognized gesture with hull (red color) and class label

b) Decision tree algorithm

The proposed method also counts the number of fingertips. Convex defect points are between the corresponding fingers. In this method, we count the hull and after that, we recognize the gesture.



Decision tree algorithm based hand gesture recognition method: fig shows the gesture value

V. CONCLUSION AND FUTURE SCOPE

The proposed method is not assisted by the sensors, data gloves etc. Hence a comparison of sign gesture recognition is carried out using vision-based contour-SVM technique and decision tree based technique for 0-9-digit recognition.

In both, SVM and Decision Tree we find the contour and draw convex hull. Used for classification purpose. SVM method achieves accuracy of 69% and our proposed algorithm attains 91% of accuracy.

In future, the method can be extended for the formation of grammatically correct sentences, facial expression and generating grammatically correct sign interpretation.

REFERENCES

[1] P.Nanivadekar, V. Kulkarni, “Indian sign language recognition: database creation, hand tracking and segmentation", in IEEE Conference on Circuits, Systems, Communication and Information Technology Applications, 2014.

[2] J. S. Kim, W. Jang, and Z. Bien, “A dynamic gesture recognition system for the Korean sign language (KSL)", IEEE Trans.Syst., Man, Cyber. B, vol.26, pp. 354359, Apr. 1996.

[3] T. Shanableh, K. Assaleh, “Arabic sign language recognition in user independent mode", International Conference on Intelligent and Advanced Systems, pp. 597-600, 2007.

[4] P. Subha Rajam, Dr. G. Balakrishnan, “Indian sign language recognition system to aid deaf dumb people ", IEEE International Conference on Computing Communication and Networking Technologies (ICCCNT2010), Karur-India, pages(s):1-9, July-2010.

[5] Blanca Miriam Lee-Cosioa, Carlos Delgado-Mataa, Jesus Ibanezb, “ANN for gesture recognition using accelerometer data ", Elsevier Publications, Procedia Technology 3 (109-120), 2012.

[6] Wen Gao, Gaolin Fanga, Debian Zhao, Yiqiang Chen, "A Chinese sign language recognition system based on SOFM/SRN/HMM", Pattern Recognition 37, 2389 2402, 2004.

[7] Salma Begum, Md. Hasanuzzaman, “Computer vision-based Bangladeshi sign language recognition system”, Proceedings of 2009 12th International Conference on Computer and Information Technology (ICCIT 2009) 21-23 December 2009, Dhaka, Bangladesh.

[8] F.S. Chen, C. Fu, and C. Huang, “Hand gesture recognition using a realtime tracking method and hidden Markov models", ELSEVIER, Image and Vision Computing, Volume 21, Issue 8, pp. 745-758, 2003.

[9] Mandeep Kaur Ahuja, Amardeep Singh, “Static vision-based hand gesture recognition using principal component analysis”, IEEE 3rd International Conference on MOOCs, Innovation and Technology in Education (MITE), (402-406), 2015.

[10] Imran Hussain, Anjan Kumar Talukdar, Kandarpa Kumar Sarma, “Hand gesture recognition system with real-time palm tracking", Annual IEEE India Conference (INDICON), 2014

[11] Shikha Gupta, Jafreezal Jaafar, Wan Fatimah wan Ahmad, “ Static hand gesture recognition using local Gabor filter”, International Symposium on robotics and intelligent sensors, Elsevier Publications, Procedia Engineering 41 (827-832), 2012.

[12] Houssem Lahiani, Mohamed Elleuch, Monji Kherallah, “Real-time hand gesture recognition system for android devices”, 15th International Conference on Intelligent Systems Design and Applications (ISDA), 2015 IEEE.

[13] Jose L. Flores C., E. Gladys Cutipa A., Lauro Enciso R., “Application of convolutional neural networks for static hand gestures recognition under different invariant features”, 2017 IEEE.

[14] Byeongkeun Kang, Subarna Tripathi, and Truong Nguyen, "Real-time Sign Language Fingerspelling Recognition using Convolutional Neural Networks from Depth map," Pattern Recognition (ACPR), 2015 3rd IAPR Asian Conference on, 2015

[15] Bheda, Vivek, and Dianna Radpour, "Using deep convolutional networks for gesture recognition in American sign language" arXiv preprint arXiv:1710.06836 (2017).

[16] Snehal R. kalbhor, and Ashwini M. Deshpande, “Digirt Recognition Using Machine Learning and Convolutional Neuaral Network”, 2018 IEEE.

[17] http://www.massey.ac.nz/~albarcza/gesture_dataset2012.html

[18] https://www.kaggle.com/ardamavi/sign-language-digitsdataset/version/2#