Hand Gesture Real Time Paint Tool – Box: Machine Learning Approach

Vandit Gajjar  
Department of Electronics and Communication Engineering  
L. D. College of Engineering  
Ahmedabad, India  
gajjar.vandit.381@ldce.ac.in

Viraj Mavani  
Department of Electronics and Communication Engineering  
L. D. College of Engineering  
Ahmedabad, India  
mavani.viraj.604@ldce.ac.in

Ayesha Gurnani  
Department of Electronics and Communication Engineering  
L. D. College of Engineering  
Ahmedabad, India  
Ayeshtagurnani1302@gmail.com

Abstract— With current development universally in computing, now a day’s user interaction approaches with mouse, keyboard, touch-pens etc. are not sufficient. Directly using of hands or hand gestures as an input device is a method to attract people with providing the applications, through Machine Learning and Computer Vision. Human-computer interaction application in which you can simply draw different shapes, fill the colors, moving the folder from one place to another place and rotating your image with rotating your hand gesture – all this will be without touching your device only. In this paper Machine Learning based hand gestures recognition is presented, with the use of Computer Vision different types of gesture applications have been created.

Keywords— Computer Vision, Machine Learning, Hand Gesture, Human Computer Interface.

I. INTRODUCTION

In the future of Steven Spielberg’s Report, Tom Cruise turns on a wall-sized digital display simply by drawing a line with his hand, which are covered with brown, gloves which are wireless. The touchless technology it shows may arrive in sooner as evident from Vision Based Interfaces have gained in the recent years.

Hand Gestures are a powerful means of communication among humans. In fact, hand gesturing is so deeply rooted in our communication that people often continue hand gesturing provide a separate complementary modality to speech for expressing one’s ideas. Information associated with hand gestures in a conversation is degree, discourse structure, spatial and temporal structure. So, a natural interaction between humans and computing devices can be achieved by using hand gestures for communication between them.

The key problem is hand gesture interaction is how to make hand gestures understood by computers. The approaches can be mainly divided into “Data-Glove based” [1] and “Vision Based” [2] approaches, so we have developed another method with using of “Machine Learning Based” in which a lot of images of hand gestures have been collected and created a dataset, then using of features of Haar-Like [3] model we have trained the dataset. So, with this we have achieved good accuracy for detecting hand gestures. Then with use of computer vision, we have developed a user interface in which with the hand gestures one can draw the shapes, fill out the colors, rotate a shape or image and many other things. Moreover, such systems must be optimized to meet the requirements, including accuracy and precision.

A. Overview

The organization of the rest of this paper is as follows. Section II highlights the various aspects of hand postures and gesture recognition using of machine learning. Section III discusses the results about the method that we have develop for gesture recognition. Section IV describes various application of hand gestures recognition. Section V points out the open issues related to this and Section VI concludes the paper.

II. HAND GESTURES RECOGNITION MACHINE LEARNING BASED TECHNOLOGY

The human hand has a variety of anatomical structure consisting of different connected parts and joints, involving complex relations between them providing a total of roughly 27 degrees of freedom (DOFs). User Interface development requires an understanding of human hand’s [4] anatomical structure to determine what kind of gestures are comfortable to make. Although hand gestures are often identical, the
distinctions between them need to be cleared. Hand gesture is defined as a dynamic movement [5] referring to a sequence of hand postures connected by continuous motions over a short time span, such as waving hands from one direction to other and like that. In Machine Learning [6] based hand gesture recognition system, there is a dataset to be trained with the help of Haar-Like features model. Some form of filtering may also be performed on the dataset to remove the unnecessary data. For example, the hands are isolated from other body parts as well as other background objects. The isolated hands (Fig.2) are identified for different postures. Since gestures are nothing but a sequence of hand postures connected by rapid motions. Now using the tensor flow API [7] for machine learning the different images of hand gestures will be trained, and the final model will be ready with those gestures that we have trained. So now with this, hand gestures can be specified as building up out of a bunch of images of those different gestures. The recognized gestures can be used to drive a different type of applications [8] including the paint tool-box. The flow of Machine Learning based hand gesture recognition is shown (Fig.1).

![Fig. 1. Machine Learning Based Hand Gesture Recognition](image1)

![Fig. 2. Different Hand Gesture Images from Dataset](image2)

III. RESULTS FOR THE APPROACH

Here table 1 represents our result for the recognition of hand gestures. For Hand Gesture Recognition, we measure the accuracy when the classifier gives the exact classification of gestures. We can see here in the table that for the Glove Base the result of accuracy will low of 74%, [9] where for computer Vision base the result of accuracy will be of 89%, and with the use of Machine Learning Based the result of accuracy will be of approximately 96%, [10] which are very good result for the Hand Gesture recognition. Also the graph will show us the results of loss and accuracy with 30k steps (Fig. 3).

![Fig. 3. Loss Of The Model for 30K steps](image3)

![Fig. 4. Learning Rate of Model](image4)

Table 1 Hand Gesture Recognition Results based on Machine Learning Technology

| Method       | Accuracy |
|--------------|----------|
| Glove Base   | 74%      |
| Computer Vision | 89%     |
| Machine Learning | 96%     |

A. Dataset

We have used the dataset of Sebastian Marcel – Hand Gesture dataset. [11] There are 6 hand gesture about of 10 persons, Also the background is of light, dark and complex in this dataset, and the dataset images are in pnm format. With the dataset we can train our model using Haar – Like predefined model [12], for better results.

IV. APPLICATION – REAL TIME PAINT TOOL BOX

Hand gesture recognition finds applications in varied domains including virtual environments, smart surveillance, sign language translation, medical systems etc. but one of the major application that we have developed is that of real time paint tool box using the hand gestures. The following section gives an overview and how this application works. Hand gestures are used for analyzing and annotating video sequences of technical talks.
A. Block Diagram

The block diagram symbolizes the distribution of elementary color from a real-time video input. At initial camera device is acting as input device, it gives input of RGB images [13] to our algorithm. It accommodates numerous numbers of color images in motion. It provides the various color frame into the given development and the essential color are disjointed. Now due to the feature selection process, we can identify our hand using the contours. Then the selection of the different tools will be done by our hand-gestures i.e. joint the double fingers to select the dot, line and eraser tool, Open the hand to select the R, G & B color. Now this RGB output will be use for the hand recognition, and this recognition will be helping to draw those lines and mainly the contours are take major part in recognition of gestures. Following is the block diagram shown for Real Time Paint Tool Box. (Fig.5.)

![Fig. 5. Block Diagram – Real Time Paint Tool Box](image)

B. Gray Conversion:

It is the proceeding of alteration from color images into gray scale image. Color image consist of 24 bits per pixel; it is shortened to 8 bits per pixel. [14] Most frequently levels perform the interval number of quantization in gray scale image alter. At right now, the best generally used repository method is 8-bit storage. There are 256 gray levels in an 8-bit gray range image, and the magnitude of each pixel can have from 0 to 255.

C. Subtraction:

The RGB image enclose 24 bits, each of three colors having 8 bits per pixel. At side-by-side RGB is isolating into each 8-bit colors. [15] The color subtraction is the operation of subtracting the color amount between the two colors. Here every three colors are replaced with the gray image which transformed from the original RGB image.

D. Binary Conversion:

Binary conversion is the procedure of transforming any considerate of image into a binary (1, 0) image. Essentially binary image two bits image, it consists of only 1 and 0. [16] Here 1 will be shown as white and 0 will be shown as black. Hence, it’s named as black and white image. The determination of transformation is to calculate the black and white pixels in the image. Every detached color is transformed as black and other colors are converted as white.

E. Multiplication:

Image multiplication is the process of amplification of pixel amount between more than images; here this development is used to multiply binary images with breached color images. Subsequently this action we can get every elementary color that having above 300 PPI. [17] The range consist of below 300 PPI does not treated as color. After the multiplication, this proceeding having three disjointed colors that having 300 PPI. By bringing together these three colors we can get the anecdotal color image that consist of only elementary colors. From the given technique, the RGB color area can be disjointed like subsequent diagram.

F. Color Filtration

Color Filtration is the technique of disjointing the colors and analyzing the disjointed colors. It is the one of the human to computer interplay. Here the colors are substituting in a role as amalgamate between human and computer. [18] At introductory elementary color modal is used for a recognition technique, it only recognizing elementary colors in each color images, elementary colors are disjointed and disjointed colors are recognized to determine its name like blue, green, red. It gives the recognized color as an output by utilizing two ways, that is composition text on the output screen and playing audio(.wav) files which having the names of the elementary colors. The pixels of each three colors are check in order after disjointed it. At whatever time, it gets above 300 PPI of these three colors (RGB) it should identify that the given colors are establish or formed. That we set that below 300 PPI are not any phenomenon found there. It may be a emission from luminous. So, that it should not recognize the colors below 300 PPI of the elementary colors. Also, the other colors are also undervalued. These are the core technique of color identification. In the real-time proceeding, real time signals are refined by convinced algorithms, for this project real time input signal is uninterrupted motion of image signal like video signal. It does not have any restricted duration, algorithm observing for each frame and converting by the given algorithm. The given technique displays input and refined window. The input window has live video from the camera object and the refined window has sanctioned colors as an output.

![Fig.6. Output Image](image)

G. Feature Selection

For the given output now, we use contours to identify our hand and basically with Machine Learning based. The approach, Machine Learning based, is based on how humans perceive information about their surroundings. Edges are basic image features that carry useful information regarding the object boundaries, so using Haar – Like features [19] we can make the boundaries around our hand using gray values. Thus,
an edge is defined by a discontinuity in gray level values. Ideally, an edge is caused by changes in color or texture or by the specific lighting conditions present during the image acquisition process. Hand gesture recognition process involves several techniques and algorithms that fall under the areas of Computer Vision. So now with recognition of our hand using this contour, edge detection and Haar-Like methods [20] now we can detect those hand gestures of taping two fingers to select tool, open our hand to change the color value. The following figure shows the hand detection and feature selection, and basically, we have imported the different shapes i.e. Dot, Line, RGB Color (Fig. 7, Fig. 8, Fig. 9).

Fig. 7. Hand Detection using Model

Fig. 8. Tool Selection

Fig. 9. Drawing line with Hand Gesture.

V. CONCLUSION

Machine Learning algorithms support encouraging ways to human–computer through perceptive elementary colors from visual data. A substantial step to accomplish this goal is the prosperous and precise disjointing of elementary colors. Now this elementary thing is used for the different technologies [21] for sixth sense, virtual reality. Nevertheless, littered backgrounds, obscure luminous circumstances and diversified affecting objects make this tasks dispute. This paper mainly robust on hand gesture paint tool box with machine learning image segmentation and vision located color identification by marking these predicaments.

VI. FUTURE WORK

We can create a graphical user interface software for these utilizations and can amalgamate that graphical user interface with an extraneous camera module which will be in the saddle of a machine learning robot [22], and can be adequate to latch on to the video and the further refining of the video will take position with the help of the advanced graphical user interface. Then this Autonomous Robot [23] can be used for to teach the children about various activities and these concepts can also be used for virtual reality and augmented reality. Also, these application is used for games like snakes etc. In which with using of hand gestures you can play it.

VII. ACKNOWLEDGMENTS

I am thankful to Prof. Usha Neelakantan, Head of Department, Electronics and Communication Engineering, L. D. College of Engineering, Ahmedabad and Prof. Raj Hakani, Associate Professor, Gujarat Technological University, Ahmedabad for their expert guidance, Support and reviews throughout the research work.

VIII. REFERENCES

[1] Chen, Qing, Nicolas D. Georganas, and Emil M. Petriu. "Real-time vision-based hand gesture recognition using haar-like features." In Instrumentation and Measurement Technology Conference Proceedings, 2007. IMTC 2007. IEEE, pp. 1-6. IEEE, 2007.

[2] Garg, Pragati, Naveen Aggarwal, and Sanjeev Sofat. "Vision based hand gesture recognition." World Academy of Science, Engineering and Technology 49, no. 1 (2009): 972-977.

[3] Lienhart, Rainer, and Jochen Maydt. "An extended set of haar-like features for rapid object detection." In Image Processing, 2002. Proceedings. 2002 International Conference on, vol. 1, pp. 1-I. IEEE, 2002.

[4] Freeman, William T., and Michal Roth. "Orientation histograms for hand gesture recognition." In International workshop on automatic face and gesture recognition, vol. 12, pp. 296-301. 1995.

[5] Flórez, Francisco, Juan Manuel García, José García, and Antonio Hernández. "Hand gesture recognition following the dynamics of a topology-preserving network." In Automatic Face and Gesture Recognition, 2002. Proceedings. Fifth IEEE International Conference on, pp. 318-323. IEEE, 2002.

[6] Bishop, Christopher M. Pattern recognition and machine learning. springer, 2006.

[7] Abadi, Martin, Paul Barham, Jianmin Chen, Zhifeng Chen, Andy Davis, Jeffrey Dean, Matthieu Devin et
al. "TensorFlow: A System for Large-Scale Machine Learning." In OSDI, vol. 16, pp. 265-283. 2016.

[8] Wachs, Juan Pablo, Matthias Kölsch, Helman Stern, and Yael Edan. "Vision-based hand-gesture applications." Communications of the ACM 54, no. 2 (2011): 60-71.

[9] Starner, Thad, Joshua Weaver, and Alex Pentland. "Real-time american sign language recognition using desk and wearable computer based video." IEEE Transactions on Pattern Analysis and Machine Intelligence 20, no. 12 (1998): 1371-1375.

[10] Starner, Thad, Joshua Weaver, and Alex Pentland. "Real-time american sign language recognition using desk and wearable computer based video." IEEE Transactions on Pattern Analysis and Machine Intelligence 20, no. 12 (1998): 1371-1375.

[11] Marcel, Sébastien, Olivier Bernier, J-E. Viallet, and Daniel Collobert. "Hand gesture recognition using input-output hidden markov models." In Automatic Face and Gesture Recognition, 2000. Proceedings. Fourth IEEE International Conference on, pp. 456-461. IEEE, 2000.

[12] Pavani, Sri-Kaushik, David Delgado, and Alejandro F. Frangi. "Haar-like features with optimally weighted rectangles for rapid object detection." Pattern Recognition 43, no. 1 (2010): 160-172.

[13] Gevers, Theo, and Arnold WM Smeulders. "Color-based object recognition." Pattern recognition 32, no. 3 (1999): 453-464.

[14] Kumar, Tarun, and Karun Verma. "A Theory Based on Conversion of RGB image to Gray image." International Journal of Computer Applications 7, no. 2 (2010): 7-10.

[15] Lew, Yuan Pok, Abd Rahman Raml, S. Y. Koay, R. Ali, and V. Prakash. "A hand segmentation scheme using clustering technique in homogeneous background." In Research and Development, 2002. SCOReD 2002. Student Conference on, pp. 305-308. IEEE, 2002.

[16] Gechterian, Vartkes. "From binary to grey tone image processing using fuzzy logic concepts." Pattern recognition 12, no. 1 (1980): 7-15.

[17] Bryngdahl, Olof. "Image formation using self-imaging techniques." JOSA 63, no. 4 (1973): 416-419.

[18] Dix, Alan. "Human-computer interaction." In Encyclopedia of database systems, pp. 1327-1331. Springer US, 2009.

[19] Dash, Manoranjan, and Huan Liu. "Feature selection for classification." Intelligent data analysis 1, no. 1-4 (1997): 131-156.

[20] Babenko, Boris, Ming-Hsuan Yang, and Serge Belongie. "Visual tracking with online multiple instance learning." In Computer Vision and Pattern Recognition, 2009. CVPR 2009. IEEE Conference on, pp. 983-990. IEEE, 2009.

[21] Rao, S. Sadhana. "Sixth sense technology." In Communication and Computational Intelligence (INCOCCI), 2010 International Conference on, pp. 336-339. IEEE, 2010.

[22] Dorigo, Marco, and Uwe Schnepf. "Genetics-based machine learning and behavior-based robotics: a new synthesis." IEEE Transactions on Systems, Man, and Cybernetics 23, no. 1 (1993): 141-154.

[23] Thrun, Sebastian, Dieter Fox, Wolfram Burgard, and Frank Dellaert. "Robust Monte Carlo localization for mobile robots." Artificial intelligence 128, no. 1-2 (2001): 99-141.