

## CHAPTER 1

### ABSTRACT

**Gesture recognition** is a topic in computer science with the goal of interpreting human gestures via mathematical algorithms. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Gesture recognition enables humans to communicate with the machine and interact naturally without any mechanical devices. Using the concept of gesture recognition, it is possible to point a finger at the computer screen so that the cursor will move accordingly. This could make conventional input devices such as mouse, keyboards and even touch screens redundant.

In this project, we design a real-time human computer interaction system based on hand gesture. Hand gesture recognition system provides us a novel, natural, innovative user friendly way of communication with the computers. The whole system consists of three components: **Hand Detection, Gesture Recognition and Human-Computer Interaction (HCI)** based on recognition, and realizes the robust control of mouse and keyboard events with a higher accuracy of gesture recognition.

## CHAPTER 2

### INTRODUCTION

Communication in daily life is performed via the help of vocal sounds and body language. However vocal sounds are the main tool for interaction, body language and facial expressions have a serious support in the meanwhile. Even in some cases, interacting with the physical world by using those expressive movements instead of speaking is much easier. Body language has wide range of activities namely eye expressions, slight change in skin color, variation of the vibrations in vocal sounds etc. But the most important body language expressions are performed using hands.

Hand gesture recognition is identifying expressions which are meaningful of the hand or hand in motion. Hand gestures are used in our daily life as a nonverbal method of communication. Gestures are actions that contain some meaningful messages. There are number of systems used in input system for computer interaction such as mouse, keyboard. But in early years there were number of techniques for gesture recognition on tracking such as instrumental glows and optical markers etc. But the most efficient way is to identify hand gestures via webcam. This paper introduces hand gestures recognition system which uses hand gestures for computer interaction. We are using OpenCV image processing and C++ for pre-processing, hand detection, hand tracking and event triggering.

**OPEN CV:** Open CV (open source computer vision library) is a library which explicitly focuses on computer vision and real time CV. It is available free for everyone. It is compatible with C++, Python, Java and supports Windows, Linux, Mac OS and Android. Open CV was designed for relative applications. It has above 2000 optimized algorithms and comprehensive set of art CV and ML algorithms.

## **CHAPTER 3**

### **PROBLEM STATEMENT**

- A hand gesture recognition system was developed to capture the hand gesture being performed by the user and to control a computer system by that incoming information.
- Many of such systems in literature have strict constraints like wearing special gloves, having uniform background, long-sleeved user arm, being in certain lightning conditions, etc.
- This system eliminates some of the above constraints by just detecting the natural movement of the hand using a web camera and enabling the system to correctly determine the gesture that is being made and to perform the desired action.
- The scenario that will be used in this project will be the reading of a book and performing certain actions such as switching of pages, scrolling in a page, zooming in or zooming out of pages by recognizing hand gestures.

## **CHAPTER 4**

### **OBJECTIVES OF THE PROPOSED PROJECT**

Coming across the various spheres of life where this wearable technology can be applied, our major motivation for this project came from one such need. Among us, there are some people who do not have the voice to express, and sometimes, the capability to hear. The deaf and dumb sign language was developed to aid the communication for such people. Our idea was to create a device which could help them communicate, to give them a voice.

The proposed system is used to detect the hand movements of a person and performing certain actions such as switching of pages, scrolling up or down in a page, zooming in or zooming out of pages. This is the main objective of our system.

The hand detection is done using Machine Learning techniques. A dataset with various images of the human hand is used. A webcam is used to capture the images of the hand and compare it with the dataset in order to recognize the valid hand movements that are needed to perform the required actions.

## CHAPTER 5

### LITERATURE REVIEW

The survey throws light on the key aspects of the papers studied and also highlights their positive and negative points:

SL. NO	AUTHOR, TITLE AND YEAR OF PUBLICATION	METHODOLOGY	ADVANTAGES	LIMITATIONS
1.	Meenakshi Panwar, Pawan Singh Mehra,  <b>Hand Gesture Recognition for Human Computer Interaction.</b>  (International Conference on Image Information Processing- 2011)	The implementation is divided into four main steps: 1.Image Enhancement and Segmentation 2.Orientation Detection 3.Feature Extraction 4.Classification	1.The proposed and implemented algorithm does not require any kind of training of sample data. 2.It takes a less computation time as compare to other approaches.	Its main limitation is that different light condition leads to change of colors very rapidly, which may cause error or even failures. For example, due to insufficient light condition, the existence of hand area is not detected but the non-skin regions are mistaken for the hand area because of same color.
2.	Rafiqul Zaman Khan and Noor Adnan Ibraheem, <b>Comparative Study Of Hand Gesture Recognition System.</b> (AIRCC Digital Library DOI:10.5121/csit.2012.2320 -	Three main steps for hand gesture recognition system: 1. Segmentation 2. Feature Representation 3.Recognition Techniques Hand gesture recognition by	1.Recognises gestures from both 2D and 3D images. 2.Different groups of features are examined to decide the good performance group.	1.The main drawback of the system is it does not consider gesture recognition of temporal space, i.e; motion of gestures. 2.It uses images to classify the gesture

	2012)	<p>modeling of the hand in spatial domain.</p> <p>Uses various 2D and 3D geometric and non-geometric models for modeling.</p> <p>It has used Fuzzy c-Means clustering algorithm which resulted in an accuracy of 85.83%.</p>		<p>and is not in real time.</p> <p>3.It is unable to classify images with complex background i.e; where there are other objects in the scene with the hand objects .</p> <p>4.The computation time to recognize a gesture is high(2-4s).</p> <p>5. Classification of same gesture in two different images with variation of hand position gives contradicting outputs.</p>
3.	<p>Arpita Ray Sarkar G. Sanyal , S. Majumder</p> <p><b>Hand Gesture Recognition Systems: A Survey.</b> (International Journal of Computer Applications Volume 71– No.15, May 2013)</p>	<p>Hand gesture recognition system has four different phases to find out the gesture. They are -</p> <ol style="list-style-type: none"> <li>1.Data acquisition,</li> <li>2.Hand segmentation and pre-processing,</li> <li>3.Feature extraction and finally</li> <li>4.the recognition.</li> </ol> <p>1.Suitable input device should be selected for the data acquisition. There are</p>	<p>This paper proves to be advantageous as it provides a brief description of all the gesture modelling algorithms that can be used to recognize a hand gesture. It displays all the 4 phases of gesture recognition in a detailed and easy to understand manner. The</p>	<p>The paper presents some of the limitations regarding all the previously implemented systems:-</p> <p><b>1.Change in illumination:</b> When there is a change in the illumination condition, the system fails to recognize properly</p> <p><b>2.Rotation or orientation limitation:</b> An HGR</p>

		<p>a number of input devices for data acquisition. Some of them are data gloves, marker, hand images (from webcam/ Kinect 3D sensor).</p> <p>2. Gesture modeling has four different steps, viz. hand segmentation, filter/ noise removal, edge/ contour detection and lastly normalization.</p> <p>3. Large number of features, such as, shape, textures, contour, motion, distance, centre of gravity etc. can be used for hand gesture recognition.</p> <p>4. Hidden Markov Model (HMM) is a doubly stochastic model and appropriate for dealing with the stochastic properties in gesture recognition.</p>	<p>various input and sensor devices available that help the system and the user to simplify the recognition process are mentioned in an appropriate manner.</p>	<p>system fails to recognize if the hand is orientated in a different angle</p> <p><b>3. Scaling problem:</b> The problems of scaling arise due to different field of applications, hand size of the users, perspective.</p> <p><b>4. Special hardware:</b> A number of special hardware, like Range camera, 3D depth sensor, Data gloves have been used.</p>
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4.	<p>Manjunath A E ,Vijaya Kumar B P , Rajesh H</p> <p><b>Comparative Study of Hand Gesture Recognition Algorithms.</b></p> <p>(International Journal of Research in Computer and Communication Technology, Vol 3, Issue 4, April-2014)</p>	<p>This project is divided into 3 phases :-</p> <p><b>1.Hand gesture recognition using kinect camera</b> - Kinect camera is a line motion input sensing device that is used to sense the hand gesture made by the user.</p> <p><b>2.Algorithms for Hand Detection Recognition</b></p> <p><b>A.Edge Detection:</b></p> <p>Using the boundary function in MATLAB, images are filled up and the boundary pixels are detected and are stored in a linear array. The fingertips are detected using segmentation algorithm or vectorization technique.</p> <p><b>3.Hand Gesture recognition-</b>The system stores the orientation histogram corresponding to the input. It then tracks</p>	<p>This system captures the gestured image and compares it with the predefined images in the database. On finding a match, it outputs the number which the gesture signifying. For example, if the gesture is just a forefinger, then the generated output is 1, etc.</p>	<p>The edge detection and segmentation algorithms used here are not very efficient when compared to neural networks. The dataset being considered here is very small and can be used to detect very few sign gestures. The histogram matching method is not very reliable and can give false output at times.</p>
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		the histogram of the input to the histograms of the gestures stored in the database. If any of the histograms match, then the corresponding gesture will be shown.		
5.	Dnyanada R Jadhav, L. M. R. J Lobo, <b>Navigation of PowerPoint Using Hand Gestures .</b>  (International Journal of Science and Research (IJSR) - 2015)	The System architecture consists of : 1.Image acquisition 2.Segmentation of hand region. 3.Distance transform method for gesture recognition.	1.Distance transform method is better in performance than circular profiling method. 2. The presented gesture recognition system recognizes both static and dynamic gestures.	The limitations are: 1.The number of gestures that are recognized are less. 2.The gestures where not used to control any applications.
6.	Ruchi Manish Gurav Premanand K. Kadbe , <b>Real time Finger Tracking and Contour Detection for Gesture Recognition using OpenCV.</b>  (International Conference on Industrial	There are three main algorithms that are used: 1.Viola and jones Algorithm. 2.Convex Hull Algorithm. 3. The AdaBoost based learning Algorithm.	The work was accomplished by training a set of feature set which is local contour sequence. The main advantage of Local contour sequence is that it is invariant to rotation,	The limitations of this system are that it requires two sets of images for classification. One is the positive set that contains the required images. The other is the negative set that contains contradicting

	Instrumentation and Control (ICIC) – 2015)		translation and scaling so it is a good feature to train the learning machine.  We have achieved 92% accuracy with Convex Hull and 70% accuracy with AdaBoost.	images.
7.	Pei Xu, <b>A Real-Time Hand Gesture Recognition And Human Computer Interaction System.</b> (Arxiv Journal Repository- Cornell University Library – April 2017)	The system consists of three components: 1.Hand detection 2.Gesture recognition 3. Human-Computer Interaction (HCI) It has implemented the following methodology: 1.The input image is preprocessed and the hand detector tries to filter out the hand from the input image 2.A CNN classifier is employed to recognize gestures from the processed image, while a Kalman Filter is used to estimate the position of the	1.The system uses Convolutional Neural Networks(CNN) which reach an accuracy rate of 99% rather than other approaches such as Hidden Markov Model(HMM), Orientation Histogram which are less accurate. 2.It uses only one monocular camera to capture the image.	1.The system recognizes only static images. 2.The CNN used is not robust and reliable since the number of images and used to train and test the classifier is less. 3.It only recognizes a gesture and not a motion of gestures to control the mouse actions (Gesture one for dragging the mouse, Gesture two for clicking the mouse,

		<p>mouse cursor.</p> <p>3.The recognition and estimation results are submitted to a control centre which decides the action to be taken.</p>		etc).
8.	<p>P.Suganya, R.Sathya, K.Vijayalakshmi</p> <p><b>Detection And Recognition Of Hand Gestures To Control The System Applications By Neural Networks.</b></p> <p>(International Journal of Pure and Applied Mathematics, Volume 118 No. 10 -2018)</p>	<p>This project focuses on detection of hand gestures using java and neural networks. It is divided into two phases:-</p> <p>1.Detection module using java where in the hand is detected using background subtraction and conversion of video feed into HSB video feed thus detecting skin pixels,</p> <p>2.The second module is the prediction module, a convolutional neural network is used. The neural network is written with the Theano library. A NumPy array is used to collect the dataset</p>	<p>1.Optimised Recognition of Gestures Aided by Neural Networks (ORGAN) is used to control the mouse actions such as mouse press, mouse release, cursor movement etc. using hand gestures.</p> <p>2.ORGAN had proved to predict hand gestures using an optimized detection and prediction mechanism.</p> <p>It had shown its</p>	<p>There a few limitations regarding this project:</p> <p>1.Socket programming is required in order to connect the java and python modules.</p> <p>2.This socket programming is unreliable sometimes and requires constant internet connection.</p> <p>3.The training dataset used is small.</p> <p>4.In order to control the cursor movement robot class in java is being used and that again increases the complexity of the system.</p> <p>5.The number of gestures that are trained and classified</p>

		images. The input feed image is gained from Java. The input image is fed into the neural network and is analyzed with respect to the dataset images.	effectiveness without the use of any specialized hardware for boosting its performance and efficiency.	are less since the dataset used is small.
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## **CHAPTER 6**

### **LIMITATIONS OF EXISTING SYSTEM**

A hand gesture recognition system was developed to capture the hand gesture being performed by the user and to control a computer system by that incoming information. Many of such systems in literature have strict constraints like wearing special gloves, having uniform background, long-sleeved user arm, being in certain lightning conditions, using specified camera parameters etc.

Many of the existing systems have implemented gesture recognition using only spatial modelling, i.e. recognition of a single gesture and not temporal modelling i.e. recognition of motion of gestures. Also the existing systems have not been implemented in real time, they use a pre captured image as an input for gesture recognition.

Some of the limitations of the existing systems are that they ruin the naturalness of a hand gesture recognition system and also correct detection rates and the performances of those systems are not well enough to work on a real time HCI system.

## CHAPTER 7

### RESEARCH GAPS AND CHALLENGES

The following are the research gaps and challenges faced:

- **Variation of illumination conditions** : any change in the lighting condition affects badly on the extracted hand skin region.
- **Background problem** : refers to the complex background where there is other objects in the scene with the hand objects and these objects might contain skin like color which would contradict and produce misclassification problem.
- **Translation problem** : the variation of hand positions in different images also leads to erroneous representation and extraction of the features.
- **Real time motion detection** : capturing the motion of gestures in real time and classification of the right action.
- **Training the Neural Network** : building, modelling and training the neural network to produce accurate results is a major challenge as it has to built and trained using a very large dataset and evaluate its results.
- **Datasets** : The quality of the available datasets and size of the images / video frames have a great impact on the gesture recognition.
- **Computational Complexity** : Training and implementation of the real time gesture recognition system requires a lot of computational capabilities such as use of high end Graphical Processing Units (GPU's) .

## **CHAPTER 8**

# **PROPOSED SYSTEM ARCHITECTURE AND METHODOLOGY**

The system aims to design a vision-based hand gesture recognition system with a high correct detection rate along with a high-performance criterion, which can work in a real time HCI system without having any of the mentioned strict limitations (gloves, uniform background etc.) on the user environment.

It is composed of a human computer interaction system which uses hand gestures as input for communication. System is initiated with acquiring an image from a web-cam or a pre-recorded video sequence. Skin color is determined by an adaptive algorithm in the first few frames. Once the skin color is fixed for the current user, lightning and camera parameter conditions, hand is localized with a histogram clustering method. Then a hand gesture recognition algorithm is applied in consecutive frames to distinguish the current gesture. Finally, the gesture is used as an input for a computer application.

In the system that we are going to develop we are making use of Open Source Computer Vision, also known as OpenCV, a real time computer vision library with many image processing functions developed by Intel for the C++ or Java programming platform. This API provides many functions to perform calculation on captured video sources and special image processing on each frame of the video to support the HGR software. The video capture and the face detection components of this project are heavily supported by some of the functions built into the OpenCV library. The steps to be followed in hand gesture recognition are:

### **1.HAND DETECTION :**

We need to have an input image from webcam which is fetching at the speed of 20 frames per second. The distance between hand and camera should be in the range of 30 to 100 cm. The video input is stored frame by frame into a matrix after preprocessing. For faster processing we use skin color to detect the variants and hand area. Hand gestures are meaningful continuous hand action. The image sequences captured by webcam contains garbage gestures which need to be removed by counter tracing algorithm.

## 2.FEATURE EXTRACTION :

a) **Centroid:** On basis of image intensities we divide image into two parts one with hand and other with non-hand region part. The centroid divides these two halves at its geometric center. Centroid is the center of mass of an object which is calculated using image movement. Image moment, which is the weighted average of pixel's intensities of the image.

b) **Thumb detection:** Thumb is important in hand detection and a finger counting. The presence of thumb defines a set of gestures while absence defines other set. The thumb is on the corner of the box so we can identify which hand is there right or left-hand using thumb detection.

c)**Euclidean distance:** Calculate the distance between all tip of the fingers and centroid using Euclidean distance formula that is  $(a, b) = \{(x(a) - x(b))^2 + (y(a) - y(b))^2\}^{1/2}$ , Where a and b are the are figure tips.

This distance is used to remove redundant fingers. If there are two fingers at a closer distance they shouldn't be considered in figure count.

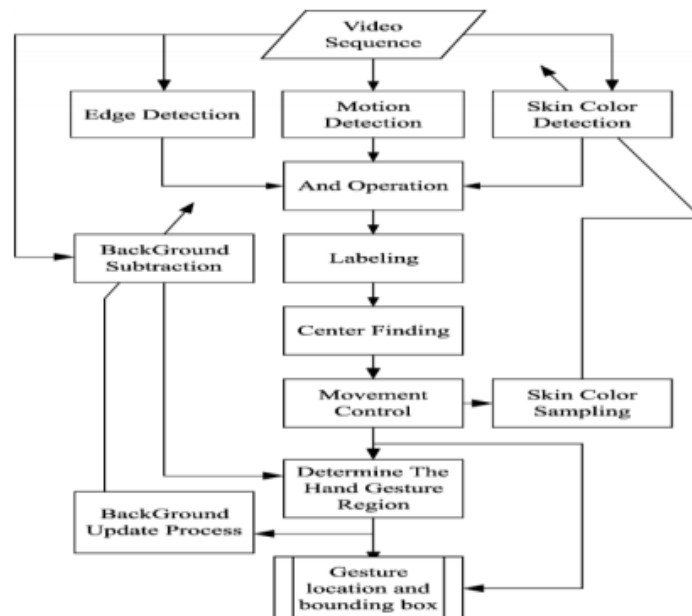
## 3. GESTURE RECOGNITION :

First, the number of fingers present in the hand gesture is determined by making use of defect points present in the hand gesture. The resultant gesture obtained is fed through a 3Dimensional Convolutional Neural Network consecutively to recognize the current gesture.

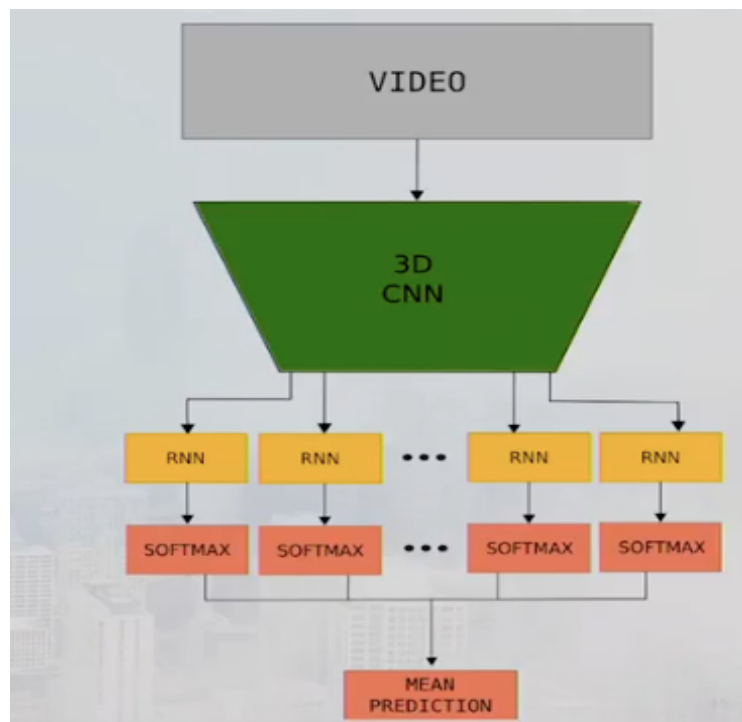
The recognized gesture is used an input for switching of pages, zooming in or zooming out, scrolling up or down, etc as each gesture would do a different task.



## SYSTEM ARCHITECTURE



Flow diagram of hand gesture recognition



Gesture fed through a 3D CNN to recognize it

## **CHAPTER 9**

### **SYSTEM REQUIREMENT SPECIFICATIONS**

#### **HARDWARE REQUIREMENTS :**

1. **Web Camera** : 10 Megapixels or higher
2. **Processor**: Intel Core i5 or higher
3. **Graphical Processing Unit (GPU)** : 4 GB
4. **Memory** : 25 GB Disk Space

#### **SOFTWARE REQUIREMENTS :**

1. **Operating System** : Windows / Linux.
2. **Dataset** : of different hand gestures to train the neural network.
3. **OpenCV** : A real time computer vision library.
4. **NumPy** : Python package for scientific computing.
5. **Pandas** : Data analysis and manipulation library.
6. **Scikit - learn** : Python library for machine learning.

## **CHAPTER 10**

### **EXPECTED OUTCOMES**

The expected outcomes of the proposed project are :

1. A vision based hand gesture recognition system with a high correct detection rate along with a high performance criterion, which can work in real time HCI system without having any of the limitations such as gloves, uniform background, etc on the user environment.
2. The application to which the system will be put to use is a scenario where the user is reading a book on his/her laptop and he/she can perform various viewing actions such as switching of pages, scrolling the pages, zooming in and zooming out of pages.
3. Performing these actions even with movement of the eye of the user will also be implemented depending on the requirement.

## **CHAPTER 11**

### **REFERENCES**

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