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Vision Based Hand Gesture Recognition for Human Computer Interaction

Radhika Bhatt [1], Nikita Fernandes [2], Archana Dhage [3]
[1],[2],[3]University Of Mumbai

Abstract— This project presents an approach to develop a real-time hand gesture recognition enabling human-computer interaction. It is "Vision Based" that uses only a webcam and Computer Vision (CV) technology, such as image processing that can recognize several hand gestures. The applications of real time hand gesture recognition are numerous, due to the fact that it can be used almost anywhere where we interact with computers ranging from basic usage which involves small applications to domain-specific specialized applications. Currently, at this level our project is useful for the society but it can further be expanded to be readily used at the industrial level as well. Gesture recognition is an area of active current research in computer vision. Existing systems use hand detection primarily with some type of marker. Our system, however, uses a real-time hand image recognition system. Our system, however, uses a real-time hand image recognition without any marker, simply using bare hands.

Index Terms— **Background Subtraction, Gesture Recognition, Hand Tracking, Human-Computer Interaction**.

I. INTRODUCTION

In today's computer age, every individual is dependent to perform most of their day-to-day tasks using computers. The major input devices one uses while operating a computer are keyboard and mouse. But there are a wide range of health problems that affects many people nowadays, caused by the constant and continuous work with the computer. Direct use of hands as an input device is an attractive method for providing natural Human Computer Interaction which has evolved from text-based interfaces through 2D graphical-based interfaces, multimedia-supported interfaces, to fully fledged multi participant Virtual Environment (VE) systems. Since hand gestures are completely natural form for communication it does not adversely affect the health of the operator as in case of excessive usage of keyboard and mouse. Imagine the human-computer interaction of the future: A 3Dapplication where you can move and rotate objects simply by moving and rotating your hand - all without touching any input device. In this paper a review of vision based hand gesture recognition is presented.

II. NEED OF HAND GESTURE RECOGNITON

Generally, Hand Gesture Recognition technology is implemented using "Data Gloves" or "Color pins" which in turn leads to additional cost and lack of availability among majority of masses. Also, using additional devices, involves more amount of maintenance. Webcam is an easily available device and today every laptop has an integrated webcam along with it. In our project, we will implement a hand gesture recognizer which is capable of detecting a moving hand with its gesture in webcam frames. In future, it may be considered that willing to be more natural and more comforted, human being, who has been communicated with computers through mouse, keyboards, several user interfaces and some virtual environments, may use their bare hands to interact with machines without any mediator. As the set of materials above, recognition of hand gestures and postures is a satisfactory way to first steps of solutions instead of using keyboards, mouse or joysticks. A very common disease known as Parkinson's disease is very relevant now-a-days among the common masses. This disease is caused due to excessive use of keyboard and mouse. Use of Gesture recognition technology will prevent this in future.

III. APPROACH TO VISION BASED HAND GESTURE RECOGNITION

In vision based hand gesture recognition system, the movement of the hand is recorded by video camera(s). This input video is decomposed into a set of features taking individual frames into account. The hands are isolated from other body parts as well as other background objects. The isolated hands are recognized for different postures. Since, gestures are nothing but a sequence of hand postures connected by continuous motions, a recognizer can be trained against a possible grammar. With this, hand gestures can be specified as building up out of a group of hand postures in various ways of composition, just as phrases are built up by words. The recognized gestures can be used to drive a variety of applications. The method we are using is background subtraction. Other methods include image segmentation, color pins etc.

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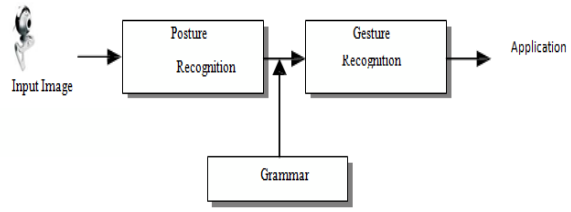

Hand Gesture Recognition Process

Fig 1: Basic System Structure [1]

BACKGROUND SUBTRACTION-

There are various algorithms to background subtraction [3]. The method we are using includes the following steps:

(i) First, on running the project, leave the camera and the background that one will be using. The background must remain constant for an entire session (that is from the time one clicks on play till one clicks on stop after that.). During this, the camera will capture certain amount of frames (we have given 300 frames, it can be modified depending upon the amount of precision required or the time factor.). When the frames are captured one must not perform any gestures as it may also be included in the background further by the program.

(ii) The program uses these background images in later for recognizing gestures.

(iii) After the frames are captured, one may perform the required gestures.

(iv) The background is considered by our program that will actually be the average of the previously captured frames (that is, average of 300 frames).

(v) The corresponding function to the gesture is then performed, depending upon the conditions stated in our program.

The process of gesture recognition is implemented by us in this project by using the concept of peeks and valleys. That is, finger tips are considered as peeks and the gaps between each pair of finger is considered as a valley. Thus, total number of peeks and valleys are counted in the program using which it is detected that in which region the gesture is being made. Also it enables us to count the number of fingers that are being demonstrated by the user.

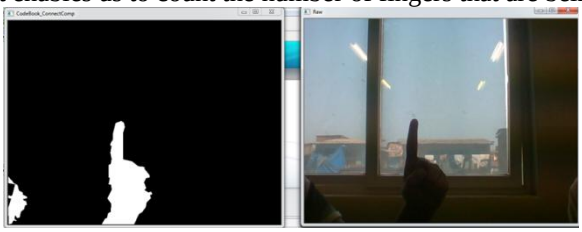

Fig 2: CodeBook_ConnectComp

Fig 3: ForegroundCodeBook

We have implemented our project using JavaCV. Currently, gesture recognition is successfully implemented using OpenCV but it is not implemented using JavaCV. We have used various functionalities of OpenCV in java by importing packages of OpenCV in our java program.

IV. MAJOR FUNCTIONALITIES

Major functionalities of our project is:

(i) Image Gallery

(ii) Music Player

(iii) Operate games

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(iv) Counting number of fingers that are being shown.

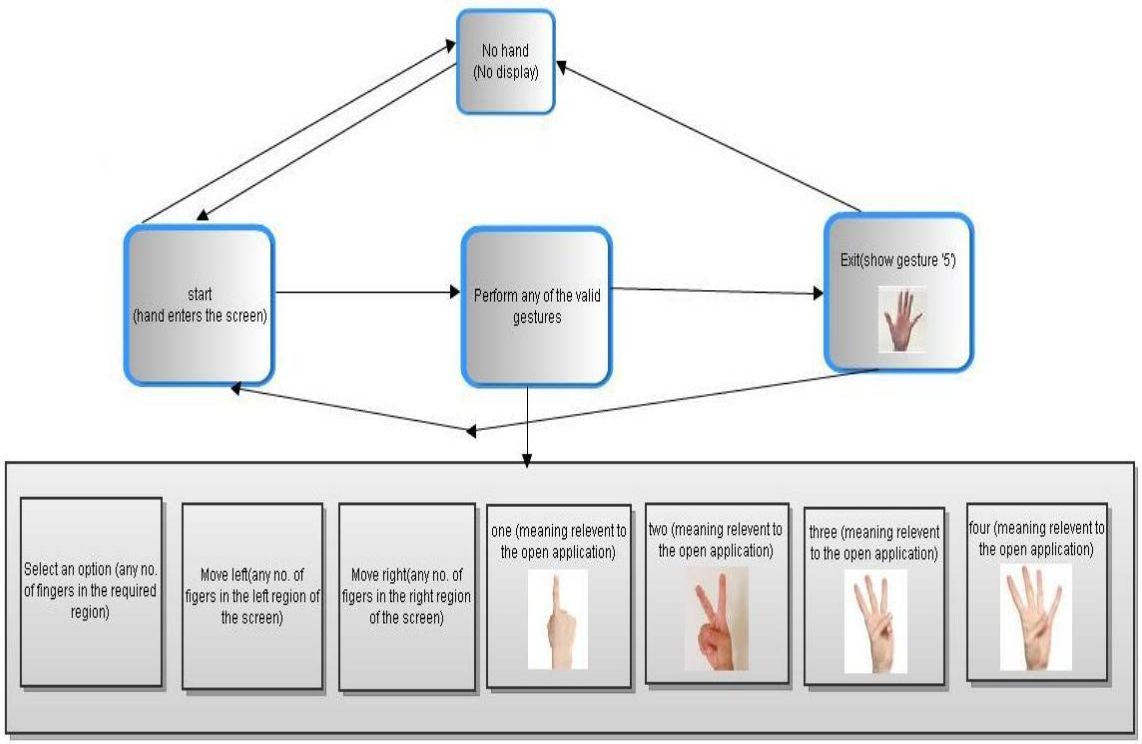

Fig 4: Basic functionalities

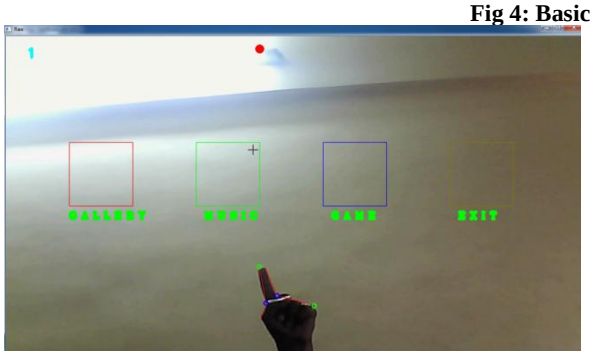

Fig 5: Main menu

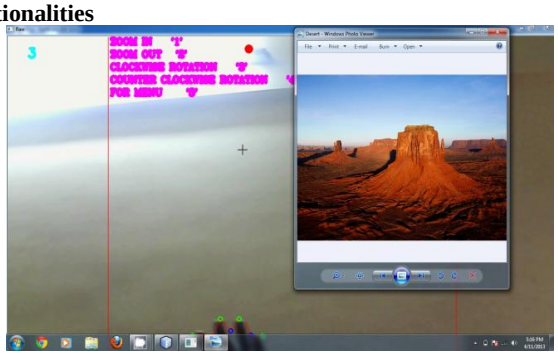

Fig 6: Gallery

The main menu consists of four major options representing the above functionalities (Fig 5).In our project, we have created an image gallery (Fig 6) can be operated based on the gestures performed by the user. Various functionalities of the gallery can be performed using gestures, these include: next image, previous image, zoom in, zoom out, rotate clockwise, rotate anti-clockwise. There are two regions defined on the screen: left region and the right region for previous and next image respectively.

We have created music player (Fig 7) that performs functionalities of a basic music player that includes play, pause, next song, previous song. There are four different boxes to perform the above four functions. When a user points towards the area of the box, the corresponding functionality of that box is performed.

Basic games for example, bubble trouble (Fig8) that include moving left, right and shoot can be operated using gestures. For games, gesture demonstrating 'five' fingers makes the character shoot. The program counts the number of fingers and thus we have assigned various functionalities to various numbers from 1 to 9 [4].

Also, one can use gestures signaling left and right to change slides during a presentation from a distance. Thus, one might not use a remote control to do the same. Thus, our project can be used to operate all basic applications which involves moving left, moving right, listening to music, manipulating images to zoom in, zoom out, rotate etc.

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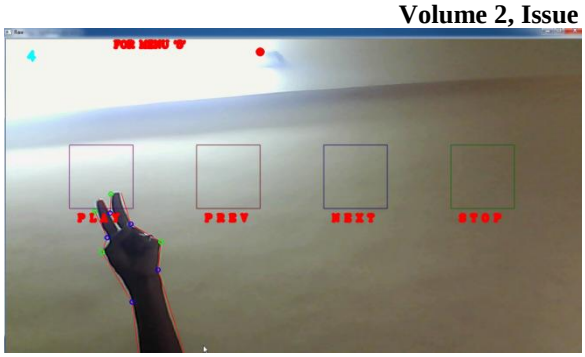

Fig 7: Music player

Fig 8: Game

V. SOME MAJOR DISADVANTAGES OF CURRENT TECHNOLOGIES USED

Currently major work on the computers is done by using mouse and keyboard. Latest input technologies include touch screens. Frequent and excessive usage of these technologies gives rise to many health problems to majority of people. These heath problems include:

(i) Carpal Tunnel Syndrome (CTS)-

The biggest medical problem associated with Computer-related work is Carpal Tunnel Syndrome (CTS) [7]. CTS is a stress-related injury caused by repetitive movement of joints, especially the wrist, and can lead to numerous musculoskeletal problems. Different research conducted cites the mouse as being the main cause of CTS as it was found that among the fingers the right thumb was revealed to be more susceptible to CTS due to the acute position of the thumb while using the mouse. CTS, although prevalent, seems to be very difficult to ameliorate or cure due to the consistency in the design of computer components such as the mouse and the keyboard, but some companies are leading the way with technologies such as touch screen monitors which will reduce stress on the hand and wrist. Here are two reasons why using a mouse regularly can be hazardous.

First, using a mouse requires a person to make small, exact movements with their hand, fingers, and thumb. By positioning, traveling, scrolling, and clicking the mouse again and again, the same small muscles can become tired and overworked. This can cause:

- Pain (ache, soreness) on the top of the hand (Fig 9)
- Pain (ache, soreness) around the wrist (Fig 9)
- Pain (ache, soreness) along the forearm and elbow (Fig 9)
- Formulation of painful nodules, and in the later stages, ganglion cysts, around the joints and along the tendons
- Numbness and tingling in the thumb and index finger

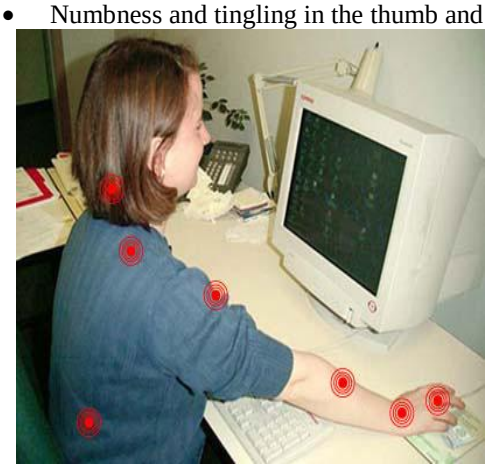

Fig 9: Problems due to excessive usage of mouse [6]

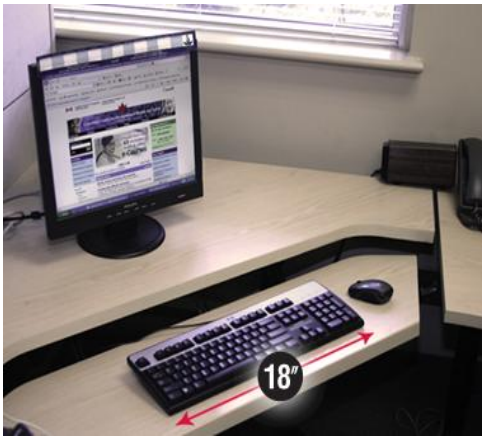

Fig 10: Wrong placement of mouse [6]

The second reason using a computer mouse can be hazardous is that the placement of the mouse can make it awkward to reach. Many computer workstations have limited space; since the keyboard is already directly in front of the person using the computer, most times the mouse is placed around the upper right hand corner of the keyboard and toward the back of the desk (Fig 10). When the mouse is in this position (Fig 10), it is out of 'easy reach': it is beyond the safe distance range for comfortable hand movements [6].

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(ii) Repeated motion injuries-

It is caused due to excessive use of touch screens. It is commonly known as RSIs, for repetitive stress injuries, these ailments result from recurrent large or small movements that affect joints, muscles, tendons, and nerves. For example, people who frequently use their thumbs to type text messages on cell phones sometimes develop de Quervain syndrome, a painful affliction that involves the tendons that move the thumb [8].

(iii) "Gorilla arm" problem-

"Gorilla arm" was a side-effect of vertically-oriented touch-screen or light-pen use [5]. In periods of prolonged use, users' arms began to feel fatigue and/or discomfort. This effect contributed to the decline of touch-screen input despite initial popularity in the 1980s.

(iv)"Mouse shoulder"-

It is a syndrome arising from prolonged elevation and bracing of the shoulder to accommodate an inappropriately positioned mouse, or performing short range movements of the mouse, or (usually) both [7].

(v) "Computer back"-

A very common postural syndrome in modern society involves excessive rearward curving of your lower, middle, and upper back; forward drawn head; rounded shoulders; and excessive forward curving of your upper neck [7].

Thus, gesture recognition technology is something can be helpful and non-hazardous at the same time especially for frequent computer users. It further leads to freedom of movement and posture to person operating as the person operating the computer can sit at a huge amount of distance and still manage to operate the applications with great ease (Gestures can be easily recognized even from the distance of 5 to 6 feet), thus, eliminating posture related serious problems and the problems stated above.

VI. CONCLUSION

In this paper, we have proposed a method based on hand tracking and gesture recognition from extracted hand features using background subtraction. The system's performance evaluation results have shown that this low-cost interface can be used by the users to substitute traditional interaction metaphors. The experiments have confirmed that continuous training of the users results in higher skills and, thus, better performances. More applications can be controlled using hand gestures in future using this method. These applications include Paint, slide shows, multi-player games and many more.

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AUTHOR BIOGRAPHY

Radhika Bhatt, pursuing B.E in INFORMATION TECHNOLOGY, Vidyalankar Institute Of Technology, Mumbai University, was part of the group that secured 1st place in college project exhibition for the project titled 'VISION BASED HAND GESTURE RECOGNITION FOR HUMAN COMPUTER INTERACTION'

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Nikita Fernandes, pursuing B.E in INFORMATION TECHNOLOGY, Vidyalankar Institute Of Technology, Mumbai University, was part of the group that secured 1st place in college project exhibition for the project titled 'VISION BASED HAND GESTURE RECOGNITION FOR HUMAN COMPUTER INTERACTION'

Archana Dhage, pursuing B.E in INFORMATION TECHNOLOGY, Vidyalankar Institute Of Technology, Mumbai University, was part of the group that secured 1st place in college project exhibition for the project titled 'VISION BASED HAND GESTURE RECOGNITION FOR HUMAN COMPUTER INTERACTION'