International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Hand Gesture Controlled Gaming Application

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Abstract - *The primary objective of this system shows how a computer game can be played by using human gestures. The secondary objective of this system is to create a system that makes a player to play a game without a physical controller. This system aims at developing an application, for gesture recognition. The camera or webcam connected to the system can be used to recognize the human hand gesture. Based on the analysis made by the application done on recognizing the human Hand Gestures, the operations on the Game will be performed with the game's default gaming controls. The application contains a set of instruction to recognize the human hand gestures. The gestures are to be done on the palms of the hands. The system will comprise of 3 module namely user interface, gestures recognition & analysis. The user interface module provides all the necessary graphical user interface to the user to register the arms positions which will be used to perform gestures. The gestures recognition module can be used to recognize the gestures. At last the analysis module will analyze the human hand gesture and perform game controls based on the calculated analysis. The system is also useful for players who may have injury or factures. The user can be able to perform multiple function using gesture with same gestures based on analysis. This will provide a better interaction and a better perception to players and make it more interesting to play the games. A completely robust hand gesture recognition system is still under heavy research and development. This system work can serve as small step towards an extendible foundation for future work.*

Key Words: *Hand Gestures, Gesture Recognition, Game*

1. INTRODUCTION

Computer technology has tremendously grown over the past decade and has become a necessary part of everyday live. The primary computer accessory for Human Computer Interaction (HCI) is the keyboard. The keyboard is not suitable for HCI in some real life situations, such as with Human Robot Interaction (HRI). The most natural and intuitive technique for HCI, that is a viable replacement for the computer keyboard is with the use of hand gestures [3]. This system is therefore aimed at investigating and developing a Computer Control (CC) system using hand gestures. In order to harness the full potential of a webcam, it can be used for vision based CC, which would effectively eliminate the need for a computer keyboard. The usefulness of a webcam can also be greatly extended to other HCI application such as a sign language database or motion controller. Over the past decades there have been significant advancements in HCI technologies for gaming purposes, such as the Microsoft Kinect and Nintendo Wii [1]. These gaming technologies provide a more natural and interactive means of playing video games. Motion controls is the future of gaming and it have tremendously boosted the sales of video games, such as the Nintendo Wii which sold over 50 million consoles within a year of its release. HCI using hand gestures is very intuitive and effective for one to one interaction with computers and it provides a Natural User Interface (NUI) [1]. There has been extensive research towards novel devices and techniques for cursor control using hand gestures. Besides HCI, hand gesture recognition is also used in sign language recognition, which makes hand gesture recognition even more significant [1].

1.1 Motivation

Gaming with the Computer accessories like keyboard, mouse, joystick, etc. has always been a repetitive thing for gamers and when for long hours of usage, it becomes a boring task. This ultimately affects in the game company's loss as gamers get fed up of all this. In order to make this gaming world more interactive, attractive & more enjoyable, it is necessary to make up a new way to play and use games. The failure of the gaming companies & the interactive vision of the gamers becomes a blasting motivation for us to build up a system that enables a gamer to play games without any frustrating & boring equipment. Ahead of all this it is necessary for a revolution to occur in order to make new developments, generate new opportunities for the gamers to play games in a new operational way.

We had chosen this system with an interest of learning the direct interaction of humans with the consumer electronic devices. This takes the user experience to a whole new level. The gesture control technology would reduce our dependence on the age old peripheral devices hence it would reduce the overall complexity of the system. Initially this technology was considered in the field of gaming (like Xbox Kinect), but the application of motion/gesture control technology would be more diverse if we apply it to our other electronics like computers ,televisions, etc., for our day to day purposes like scrolling , selecting, clicking etc. Our primary objective in doing this system was to build a device inspired from Leap motion. It is a device which recognizes hand gestures and can be used to virtually control a computer. In short, it provides a virtual screen with which we can interact

with the computer. But the required hardware for making a device on these lines was not feasible, in terms of budget and time frame provided.

2. LITERATURE REVIEW

Hand gesture recognition research is classified in two categories. First "Glove based Analysis" attaching sensor with gloves mechanical or optical to transduce flexion of fingers into electrical signals for hand posture determination and additional sensor for position of the hand. This sensor is usually an acoustic or a magnetic that attached to the glove [2]. Look-up table software toolkit provided for some applications to recognize hand posture. The second implementation is "Analysis of drawing gesture" use stylus as an input device. These drawing analysis lead to recognition of written text. Mechanical sensing work has used for hand gesture recognition at vast level for direct and virtual environment manipulation. Mechanically sensing hand posture has many problems like electromagnetic noise, reliability and accuracy. By visual sensing gesture interaction can be made potentially practical but it is most difficult problem for machines [5]. Full American Sign Language recognition systems (words, phrases) incorporate data gloves. Takashi and Kishino discuss a Data glove-based system that could recognize 34 of the 46 Japanese gestures (user dependent) using a joint angle and hand orientation coding technique.

It seems the test user made each of the 46 gestures 10 times to provide data for principle component and cluster analysis. The user created a separate test from five iterations of the alphabet, with each gesture well separated in time. While these systems are technically interesting, they suffer from a lack of training [1]. HUMAN COMPUTER INTERACTION (HCI) is the domain of computer science which deals with how users interact with their systems and how the user experience and the user interfaces can be optimized to improve user satisfaction [2]. The input channel used is the hand which is an object that is recognized by the interface through Computer Vision and its relative position is mapped at every instance of the way [2]. Movement of the said object causes a change in the relative motion of the snake drawn on top of the image captured through the webcam. Thus the interface is quick and responsive object recognition and color detection in computerized pictures has gotten one of the most significant applications for enterprises to ease client, spare time and to accomplish parallelism [2][4]. This is certainly not another method, yet improvement in object recognition is still required so as to accomplish the focus on target to be all the more productively and precise. The principle point of considering and investigating computer vision is to recreate the conduct and way of human eyes legitimately by utilizing a computer and later on build up a framework that diminishes human effort [5]. Computer vision is such sort of research field which attempts to see and speaks to the 3D data for world items [2].

3. SYSTEM ANALYSIS

The background of the implementation lies in the idea to develop an interesting gaming application for the children in which they can get immersed and have a fabulous experience. The aim was to deliver the following features to the user an accurate object recognition to prevent false results. A Negligible response time to react to object movement. The game should be addictive and provide a strong addiction to succeed and stay in the game. Every object class has its own special features that help in classifying the object. Object recognition is that sub-domain of computer vision which helps in identifying objects in an image or video sequence. Computer vision is such sort of research field which attempts to see and speaks to the 3D data for world items. Its fundamental reason for existing is remaking the visual parts of 3D protests in the wake of breaking down the 2D data extricated. Genuine 3D objects are spoken to by 2D pictures. The procedure of item discovery examination is to decide the number, area, size, position of the articles in the input image. With more efficient algorithms, objects can even be recognized even when they are partially obstructed from the direct view. Various approaches to this task have been implemented in the past years. HCI is the domain of computer science which deals with how users interact with their systems and how the user experience and the user interfaces can be optimized to improve user satisfaction. Hence the newer generations must be revealed to the newer technologies & enjoyments.

3.1 PROBLEM DESCRIPTION

There are generally two approaches for hand gesture recognition, which are hardware based, where the user must wear a device, and the other is vision based which uses image processing techniques with inputs from a camera. The proposed system is vision based, which uses image processing techniques and inputs from a computer webcam [2]. The input frame would be captured from the webcam and systems are generally broken down into four stages, Hand Pivot Position Region, Hand Tracking & Gesture Recognition, Hand Position Detection & Cursor Control. The hand position would then be found and used for hand tracking and gesture recognition [2]. Hand tracking would be used to navigate the computer cursor. The scope of the system would therefore be to design a vision based CC system, which can invoke the keyboard function previously stated.

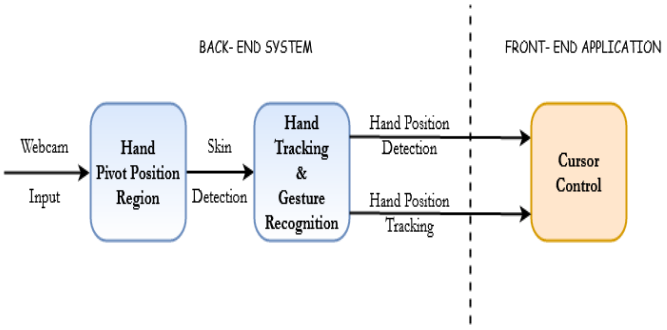

Fig -1: Flow of System

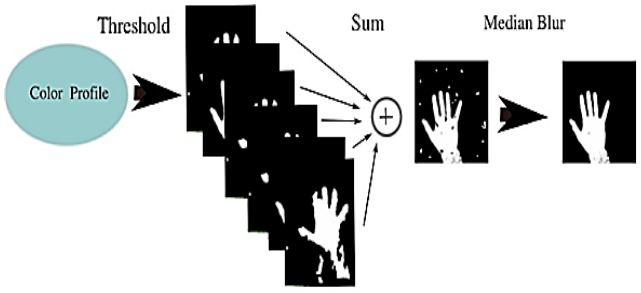

Fig -2: Hand Tracking

3.2 ISSUES & CHALLENGES

The first challenge is to correctly detect the hand with a webcam. We need a Computer Vision library for this purpose. Many are available but we decide to go ahead with Open CV as it is the most popular and has been ported to many languages and is supported on many operating systems from Android to Windows. It has a good collection of standard image processing functions. Then we have to first setup Open CV for our IDE (Python 3x Idle). We also have to learn some basic usage of Open CV. After learning Open CV, we have to understand skin detection techniques and image processing techniques like Background Subtraction, Image Smoothening, Noise Removal and Reduction. Now, after detecting the hand correctly and mapping the gestures, we have to get over with building the basic application based on it. As, high-end cameras and sensors are very costly we have decided to go with a simple webcam.

3.3 PROPOSED SYSTEM

The system can be broken down in four main components,

1. Hand Pivot Position Region
2. Hand Tracking & Gesture Recognition
3. Hand Position Detection
4. Cursor Control

Hand Pivot Position Region :
This is the region that will be marked for both the hands of the user to mark the pivot positions for the purpose of making a center point for the movement region of the hands. This region marked for both hands will be used for the entire task of tracking the hand movement gesture for performing the control over the front-end application.

Hand Tracking & Gesture Recognition :
On the entire system, this is the very important task to be done appropriately. The method used for finding the hand center has the advantage of being simple and easy to implement. The center of the hand is determined from the Hand Pivot Position Region's center. This center serves as the center of the hand to be tracked for gesture movement.

This process here will be using methods of pivoting the center positions [1][5]. The distance between the hand center and the pivot region's center was taken as the radius of the hand. The hand center is calculated for each successive frame and using the hand center, the pivot region's center is identified and used for hand tracking [4].

Hand Position Detection :
The position of the hand is tracked by the center of the pivot region & the hand itself. The direction to which the hand is moved will be detected by calculating the position of the hand center by the position of the pivot region's center i.e. locating does the hand center lie to the top / bottom and left / right of the pivot region's center. This position detection will identify the track of the hand movement gesture.

Cursor Control :
Once the hand gestures are recognized, it will be a simple matter of mapping different hand gestures to specific functions. The next step would be to determine if a hand gesture was performed. If a hand gesture is performed, the function is again used to control the front-end application by sending the input to the application. If there is no change in hand position, the loop is exited and it would be started again, when a change in hand position is detected.

4. SYSTEM DESIGN

The input design of the system is a very clean and simple approach for the cause of simplicity & endless enjoyment. The user just needs to have a PC installed with a Webcam or just a Laptop that has a built-in Webcam.

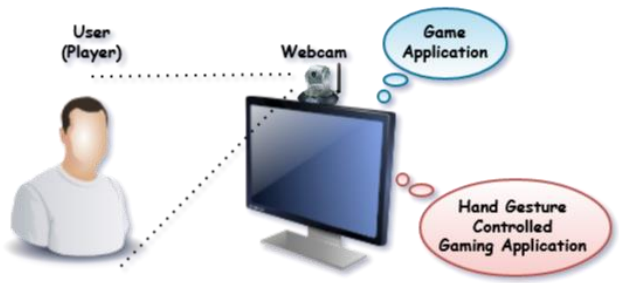

Fig -3: Input Environment

The input environment consists of only the User PC System, a properly installed Web Camera system & the Player (user) himself. Except of all this requirement, the user must have a game application (that supports keyboard game input) running alongside of the Hand Gesture Controlled Gaming application. The input to the system comprises of only the user's hand pivot positions & then the hand movement gestures. The rest of the entire system works in the background silently providing the user an endless enjoyable & addictive gaming experience.

The input to the system is the HCI Input i.e. the user's hand movement gesture. The input to the system is provided through a Webcam that captures continuous frames, creating a video, that tracks the center of the hand which moves away making a gesture. This same video frame is also displayed on the application UI. The webcam continuously captures frames, through which the motion of the user's hand gesture is tracked, & processed to map it to the keyboard cursor input for the alongside running game application.

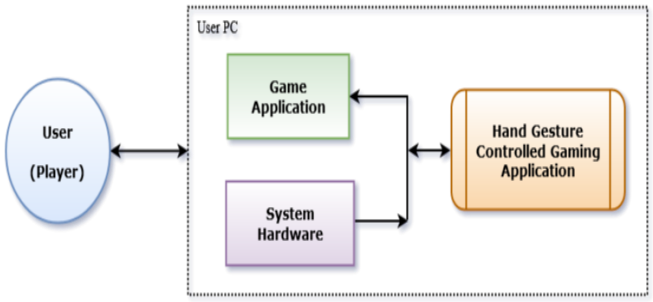

Fig -4: DFD - Level 0

4.1 CORE TASK

The operation command is processed in the HCI Logic Processing module. This module consists of logic statements that translate the co-ordinates to commands that are to be executed to the alongside running game. On generating these commands, the relevant output is given to the game application i.e. the appropriate keyboard cursor command is provided as an input to the standard game console. This is a very complicated mapping of the HCI Inputs to the computer operated command, which can be understood in a very detailed manner in the below shown Level 1 DFD figure.

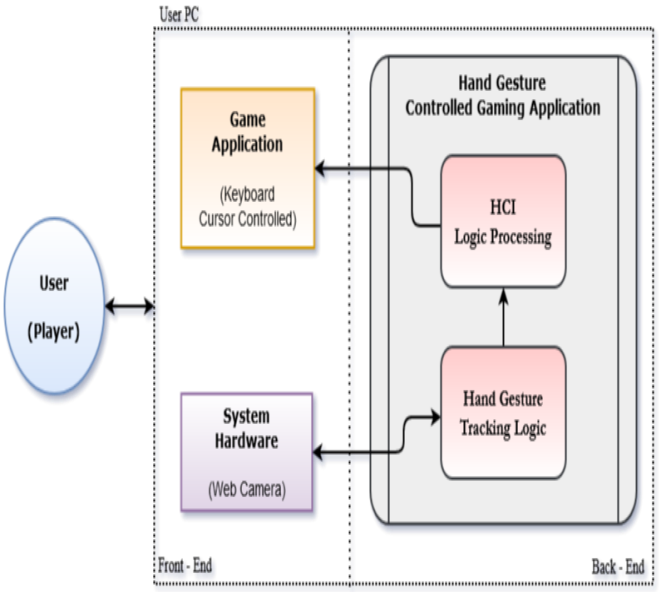

Fig -5: DFD - Level 1

The Python Open CV API provides a large number of tracking algorithms, each one of it developed as a better one of the previous algorithm. The CSRT Algorithm is the appropriate algorithm in the Open CV Library when it comes to a very appropriate performance of Real Time object tracking. This is the very reason that the application gains the most efficient, approximate & faster recognized gesture translations. Next, these tracked inputs are provided to the HCI Gesture Tracking Input Conversion Logic.

The HCI Gesture Tracking Input Conversion Logic consists of logic that calculates the exact position of the tracked Hand Gesture input. This position is tracked using the center of the hand position and the center of the hand pivot regions. This is done by tracing the distance between both centers using graph concepts, and locates the exact position of the hands. Now the HCI Tracking Input Conversion Logic translates the hand positions to matrixes and forwards it to the next block of the application.

The HCI Input to Keyboard ASCII Value Translation block, gets the input from Gesture Tracking Input Conversion logic. Now, this block accepts matrix values and generates the keyboard character value for the appropriate position of the HCI Hand Gesture input. According to the values, if the left hand position lies to the top of the screen, then it invokes the 'W' keychar and transmits a keyboard cursor control signal to the Game Application running alongside the system. Similarly, if the left hand position lies to the bottom of the screen, then it invokes the 'S' keychar and transmits the keyboard cursor control signal. Simultaneously, it checks for the Right Hand Gesture Track, if it lies to the left plot then it transmits the 'A' keychar keyboard cursor control signal to the Game Application. Opposite to this gesture, if the right hand gesture position lies to the right side plot, then the 'D'

keychar is initiated and the keyboard cursor control signal is sent to the game application alongside.

5. RESULTS & DISCUSSIONS

The major constraint of the system is that it must be operated in a well-lit environment. This is the main reason why the system cannot completely replace the computer keyboard, since it is very common for computers to be used in outdoor environments with poor lighting condition.

6. CONCLUSION

The machine vision based keyboard cursor control using hand gesture system is developed in the Python language, using the Open CV library. The system is able to control the movement of a keyboard cursor by tracking the users hand for playing a game. The keyboard cursor functions will perform by using different hand gestures. The system has the potential of being a viable replacement for the computer keyboard, however due to the constraints encountered; it cannot completely replace the computer keyboard. The accuracy of the hand gesture recognition can be improved, if the template matching hand gesture recognition method is used with a machine learning classifier. Open CV mostly stretches towards real-time vision applications and takes advantage of MMX (Multimedia Extension) and SSE (Streaming SIMD Extensions) instructions when available.

7. FUTURE SCOPE

This application can be considered as a starter to the HCI application grounds, therefore large upgradations can be done to it. This application can be extended out to the mouse cursor control also using some more HCI concepts & Open CV Algorithms. Much more accuracy can be obtained with the help of Neural Networks based logics. Tracking performance can be improved to ensure better results. The accuracy of the hand gesture recognition can be improved if the template matching hand gesture recognition method is used with a machine learning classifier. This will take a lot longer to implement, but the accuracy of the gesture recognition will improve.

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