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I-Robot: An Interactive Robot Control Using Hand Gesture Recognition and Leap Motion

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***Abstract*—**The robot architecture control through gesture using the leap motion controller which helps to control the robot using HCI. It studies new possibilities and a new way to control device and gestures interface emerged with leap motion sensors. System using Leap motion camera is a 3D motion capturing device which helps to tracking hands an**d fingers**. The leap controller uses it's built in camera to track the users hand motions which take input as a gesture. It send input to the microcontroller and give output as a robot movement. System uses J2SE and SDK to interact with robot using captured gesture and translate them to control the motion of robot.

Keywords: 3D Hand Gesture, Leap Motion, Image Processing, emb, Robot Control

I. INTRODUCTION

A robot is combination of software, embedded system and mechanics. It is brilliant machine that take instruction and act upon it. The main aim of robot control is to save human labour and reduce cost. Human cannot continuously work but robot can 24 hours in less cost. It can work faster and save time and human cannot risk their life for difficult task like working in mining, machinery that is dangerous for eg. Presses, winders. This system explains how to control the robot using gesture. Leap Motion controller is used for recognition of gesture and controlling robot using algorithm for gesture. We can control the motion of the robot through the human gestures. There are types of human interface like GUI, but nowadays many project using HCI based on pointing device. This types of interaction limit the natural way of manipulation using hands. Hence we are using Leap Motion for simplification of user's task.

II. LITERATURE SURVEY

Multiple amount of information is present which describe multiple method of hand detection. There are many gesture recognition methods. We can use Image Processing for Hand detection or use color based hand detection system. [1] Uses dynamic gesture for detection of hand, it take 2D video as input where it detect hand location tracking it and analyze hand position. In hand detection Image splits in two parts. System uses skin tone for Hand detection and Remove non-skin region from moving object, then combine motion and skin pixels, then track hand and find the center of hand.

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Advantage of system is it does not use glove to track the gesture. Some system uses Karhunen-Loeve.Transform [2].The system uses five methods for hand detection such as skin filtering, palm cropping which extract palm portion from entire hand. K-L transform is used for image processing. HCI is used for interaction between Human and Robot.

A. GESTURE TECHNIQUE

1) Contact type contain gloves, electromagnetic tracking system.
2) Non-contact type contain vision based system, speech recognition. [3]

B.CLASSIFICATION OF GESTURE

A) Pointing
It is used to indicate the direction or pointing to the location or object.

B) Semaphoric
This consist dynamic gesture and posture to convey specific meaning[1].Example of static semaphoric is Hand posture in shape of V indicate Victory and dynamic semaphoric represent swipe gesture or stroke like movement [3].

C) Iconic
Used to perform shape size like entities as example forming triangle using thumb and four fingers. This is used to show the characteristic of sign using figure movement.

D) Pantomimic
Show the gesture of performing specific task without any tool. For example action of cutting onion with knife.

E) Manipulation
It is used to control position, rotation of an object. A system uses digital music instrument which is interactive artifact for musical purpose where the sound of finger hitting on the table is captured and the delay is measured between sound of hitting on table and sound played by software. In this system gesture made by upper body through arm, elbow where gesture is made like playing piano where required short and precise gestures to ne played which is detected by the Leap Motion Camera[4]. Glove based method is popular method for the hand recognition .Gloved based method overcome on color bands because it gives less precision. In this method mechanical gloves having sensors which directly measure the distance of the hand and joints. Gloves uses combination of hand position and the arm which reduces the error. Disadvantage of glove-based method is it requires light and camera angles to measure it. Because of gloves we cannot make hand movements freely. Here in this paper it uses live video to capturing the gesture which requires proper light. For extracting gestures it uses image processing techniques like image acquisition, Extraction of hand gestures, determine gestures by pattern and generation of instruction [10].

To overcome on devices like joysticks, remote control it uses gesture control where signal to robot is send wirelessly when robot receive signal it will work accordingly. Robot using AVR microcontroller to receive signals. There are different gesture recognition methods. In vision based method uses camera to detect the user's gesture which involve both hand and arm. But it having constrain of proper light. Second method is motion based gesture recognition where the robot is controlled wirelessly using accelerometer based system. Third method is Accelerometer-based Gesture Recognition which is having low cost and also small size which can detect not only hands but whole body gestures [11]. To hand detection it use accelerometer based gesture recognition system .Where the accelerometer attached with the human hand which capture gesture and movement of hand. Some system use wireless communication by RF module [12].

C. COMPARISION BETWEEN KINECT AND LEAP

To process depth Image information produced by four arm some process using Microsoft Kinect for windows where Kinect contain RGB camera, IR sensor, filtering Motor and four microphones. Kinect used to track the body parts like face, hand and legs movement. It mostly used in gaming system which uses VGA and resolution 1280*960 having dimension 28*8*8. It having distance of 40 to 350 and field of view 57° 47°. Leap motion having distance 7 to 25 and field of view 140°. It can work on Java, C++, Python, and JavaScript. Leap Motion is of dimension 8*3*1.

Leap Motion can also be used for teaching sign language to deaf and hard listening students .Where the movement of hand making sign language is detected and converted into the correct action. For eg. Movement of hands like alphabet A will performed action of display apple hence it will teach deaf student perfect meaning. Advantage of leap is that the leap API having accurate level of detail. It easily track smallest movement of hands hence can be used for sign language recognition .Disadvantage of leap is it gives problem when hands is not in direct contact of leap and if position of palm is perpendicular to surface and if two fingers pressed together gives inaccuracies.[6]

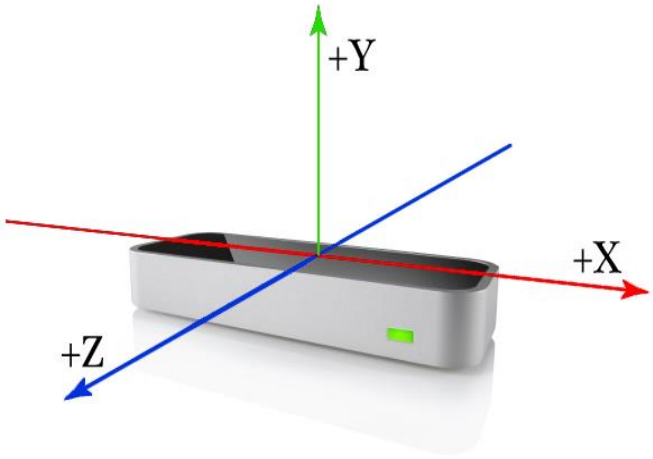

Figure 1. Leap Motion Camera

III. OVERVIEW OF LEAP MOTION CONTROLLER

Leap Motion Controller is motion sensors used for tracking hands, fingers and joints in 3D space with more accuracy. Controller is connected to devices using USB cable. Which can be placed on the physical desktop facing upward and onto virtual reality devices like gaming devices. In previous many implementation Microsoft Kinect is used which costly, easily hacked and having privacy issues hence implementing project in leap motion sensors. Leap having small observation area and high resolution help to differentiate the system from Kinect.

IV. HARDWARE PERSPECTIVE OF LEAP MOTION

Leap motion having two monochromatic IR camera's which generate 200 frames per seconds of reflected data. And Three IR LED's generate pattern-less Infrared light and having wavelength of 850 nm. The accuracy of the controller is 0.7 mm. The generated data from Leap is sent to the host computer through USB cable which is analyzed by Leap motion software.

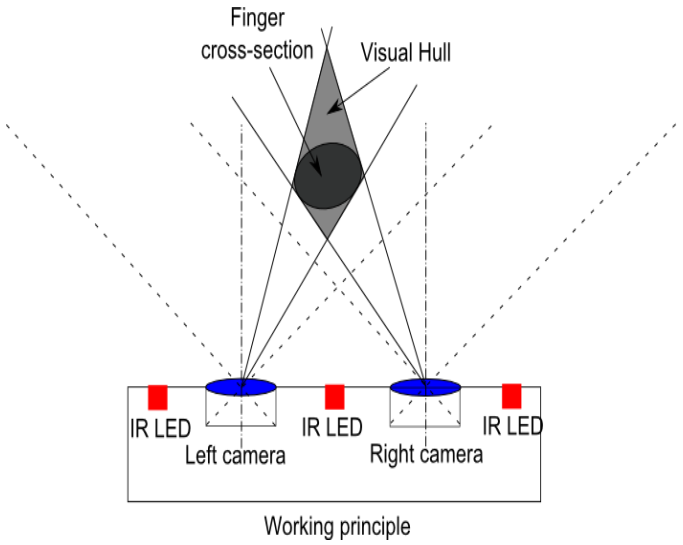

Figure 2. Working of Leap Motion

Leap having wide angle lenses .It having large interaction space of 8 cubic feet . The interaction with camera takes shape of inverted pyramid and gives view like binoculars camera. The view range of camera is up to 2.6 feet because sometimes it becomes harder to capture hand position beyond particular distance.

V. EXISTING SYSTEM

In Existing system the drone is controlled using human gesture. Where the drone can be used for videography and performing acrobatics task. It uses leap motion camera and drone. The drone is connected to the wi-fi system. For implementation parrot AR drone 2.0 is used. The system uses python programming for interfacing Leap Motion and for controlling drone. In drone ARM cortex A8 microcontroller is used. It uses ROS for implementation of leap motion. ROS is a platform.

A. ROS(Robot Operating System)

It runs on ARM cortex A8 processor microcontroller. It is used for message passing between different processes. It is an embedded operating system. It can be operated on Ubuntu and Unix OS. It is a platform where programming for Leap is done to control Drone. It uses "rospy" as a client API.

B. LISTENER AND TALKER METHOD

The communication between the nodes can be established using listener and talker method where talker publish message(gesture) to drone through wi-fi system as a gesture where listener perform the action according to message means drone make movement as per gesture. This method used to communication between on different ROS Platform.

C. ESTIMATION BASED ON HAND POSOTION AND DIRECTION

The Hand Gestures converted into linear and angular displacement stored in the array. The displacement stored in the queue uses first in first out rule and it is converted in ROS message then the message is send to Drone and then drone act accordingly. The algorithms are used to calculate the displacement and hand position and direction. Actions for Hand gestures defined in two types: folding of the hand and Unfolding of the Hand

VI. PROPOSED SYSTEM

Leap Motion sensor connected to Host System using USB. Robot is composed of Microcontroller, DC Motor and Wheels for movement. The Leap SDK and Drivers are installed on host PC so that Leap Motion support to Host PC.

A. Software Technologies

System uses Java Language for development of the project. JDK development kit used to compile java program. When NetBeans provide an integrated development environment for java. We are using RxTx serial port interface. An using Robot API in case we need a keyboard or mouse to give input to user.

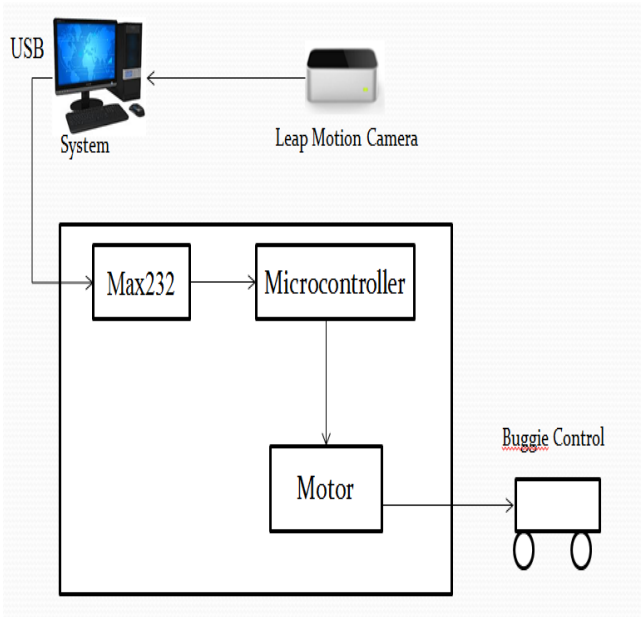

Figure 3.Proposed System

B. Serialized Database

Java collecting APIs use data structure like vectors and list then we declare our own classes using this data structure.

Example a class employee to hold all employee information then this classes precompiled and called within java application as library. The object of the class converted in bytes so that it can be stored on hard drive. For this we are using serialization where the object can be read or write on the file.

C. **Working**

The Gesture captured by Leap Motion then the generated frame of Gesture processed on Host System using Java language. Which is given to microcontroller. Microcontroller generate particular signal for the robot. After receiving signal from microcontroller robot start moving Left, Right, Up, Stop accordingly.

VII. CONCLUSION

In this work system receives user Gestures through Leap Motion Camera. The gesture recognized by leap motion camera which helps to control robot to move forward, right left and stop.

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