Interactive Robot Control with The Help Of Leap Motion Controller.

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Abstract—Robot is amazing invention which is amazingly helpful in doing hardest task with ease. Nowadays robots are used in factories, military and medical area because of their accurate result and tendency to do repetitive and time-consuming task efficiently. To increase system performance we are using robots but in modern era controlling robotics system manually is less efficient .Aim is to develop a system which can be used in controlling robots manually from remote location This kind of system might be effective in military operation and space research .

Robot control using gesture is getting popular. In existing system of sixth sense technology 2D camera is used which is less accurate .To remove anomalies like background conflict and light intensity problem we are using 3D leap motion controller for hand gesture recognition. Where gesture recognition in 3D is very accurate and it has great improvement on the speed .Where robot receive signal after getting gestures from user and robot will start making move accordingly.

Keywords: **Leap Motion Controller , emb , Image Processing , Robot control .**

I. INTRODUCTION

A robot is a 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 work 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 users task.

Multiple hand gesture detection methods are available. Human interaction with system based on gesture recognition and gesture detection. There multiple types of gesture like iconic, swipe, circle and tap gesture. 2D and 3D camera are used to detect gesture.

In 2D system uses image processing .Image detected by camera is processed internally. Color bands are used in system. The camera detect color bands and separate color band for each finger.[1]

Some gesture detection system 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. Advantage of system is it does not use glove to track the gesture.

Some system uses Karhunen-Loeve Transform[2].In hand detection system it separates palm portion from hand portion. Gesture detection uses functions such as skin filtering, palm cropping which extract palm portion from entire hand. K-L transform is used for image processing. K-L transform eliminates correlated data.

HCI is used for interaction between Human and Robot. 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].

II. EXISTING SYSTEM

We are making improvement in two type of existing system.

1. Touch Screen Technology
2. Sixth sense technology

1) Touch Screen technology:

It is a popular technology used as user interface. Where touch screen can be simple single touch or multi touch. In this technology it avoids use of mouse and input devices. Advantage of this system is it gives accurate information and interaction and small movement of finger can make large movement.

Disadvantage of this system is
a) Screen will get dirty and it takes lot of efforts to button pressing
b) Handicapped people might be not able to use this system
c) If we use wet finger for interaction then it will give inaccurate result and feeling of little electric shock

2) Sixth sense technology:

It is a device act as a wearable gesture interface used to interact with physical world to display digital information. The device is made up of projector, a camera and a mirror. All this component integrated into an object and can be used as a mobile device where projector and camera connected to the mobile devices.

In this system we are using color markers to recognise the hand gesture given by the user. Now 2D camera detect the color marker and find the location of this finger and projector display the information on physical object.
Advantages of this system is it is small and light weight . It helps to access mobile data from any place.

Disadvantage is
a)It is using 2D camera which have less accuracy than 3D camera.
b)If the color band is of same as color of background then it will not detect the finger and will give wrong result.
c)if the light intensity is less then it gives inaccurate results.

3) Comparison between Kinect and Leap motion controller:

Kinect is a motion sensor by Microsoft which is launched in 2010.The user interaction with the system is in the form of gesture and spoken commands. It is used for full body motion sensing. It has large sensor region.

Disadvantages of Kinect :
It require additional power supply and space. The gesture detection is very slow and also give very slow response. Sometimes spoken commands do not work properly.
It is Costly.

III. proposed system

What is a Leap Motion :

Leap motion controller have 2 HD VGA Camera and 3 Infrared LED. The VGA Camera tracks each finger individually and also detects difference between the fingers. Camera uses Stereoscopy where the left camera detect different angle of image and right camera detect different angle of image and then both camera combine the image with high similarity. Stereoscopy minimise the error and provide accuracy.

Where in IR LED emit light in infrared range. It can be used in low light condition which is advantage over 2D camera. We cannot see light with naked eyes. Where IR measures the heat coming from object it works also in no light condition. Where the hardware view contain interaction space of 8cubic feet and also forms shape of inverted pyramid. Range of Leap is upto 2 feet above controller

Operation perform on leap image are data is taken in the form of gray scale near IR spectrum .the data now separated in the left and right camera. The image is then streamed into computer .Where Leap motion services software process image where it adjust environmental lighting .After adjusting lighting image are analyzed to reconstructed a 3D representation of what device see. Now in tracing layer matches the extracted data and check if a hand holding tool & finger and finds the position of an object. After this smoothing technique is applied on image . Then the result is expressed in in the form of frames which contain all tracking data.

Leap motion invented in 2010 by David Holz and Michel Buckwald.

It is connected with the system using USB port. It sense hand movement very accurately. 3D object can controlled with the help of hand and finger. It track individual finger movement and hand movement in 1/100th of mm. It precisely detect and track tools like pen ,pencil . It work well with navigating webpages using zoom gesture.

Advantages of Leap:

1) It is a portable require less wiring and it is helpful in any situation. It shows high resolution output more accurately.
2) It is a cheaper.
3) It has free SDK .
4) The best part is it can track movement of hand in 200 frames /second.
5) It consumes only 1-2% of CPU.
6) It is a plug and play device.
Development tools:
Development tools work well with leap motions C++ , python ,java , java script , c#.
Leap motion supports windows , Mac OS , Linux.

Applications of leap motion:

a) Leap Motion is trending in gaming field because of it accuracy and it can work in HD environment. Leap motion gives quick response which provides better experience to user.
b) Leap motion also work well in robotic because it provide function like self navigation and it can mimic human movement.
c) In Electronic music field Leap Motion is used for playing and learning instruments .
d) It also used to view patients report and manipulate medical information.
e) Creation of painting, cartoon , art is better using leap motion than mouse.
f) Google endorses leap motion with the latest version of google earth.

Project Connection:

1) Connect leap Motion Controller to the Pc using USB and register the controller in PC.
2) Register Robot to Pc using USB and max232.
3) Register defined gesture to Leap Motion
4) User should interact with leap using visualizer
5) Add listener to detect the event like gestures given by user to leap.

6) Get the frame data like Hand properties ,holding tools, Gestures, Finger properties.
7) Give signal to user according to gesture and make move

Working Of Leap:

Leap is using right handed Cartesian coordination . Where x-axis(running parallel with edge of object/device) and z-axis lie on horizontal plane(orientation toward user) and y-axis is on vertical plane(upwards orientation).

Right handed Cartesian coordination is used by leap .When x-axis is running horizontally / parallel along with the device .X-axis also known as Roll. Its positive values are start increasing from left side to right. The y-axis is lies vertical and also has upward orientation where its positive values are increasing upwards. Y-axis is also known as Pitch. The z-axis is on horizontal plane which is perpendicular to x-axis and its values increasing positively towards the user. Z-axis is known as Yaw.
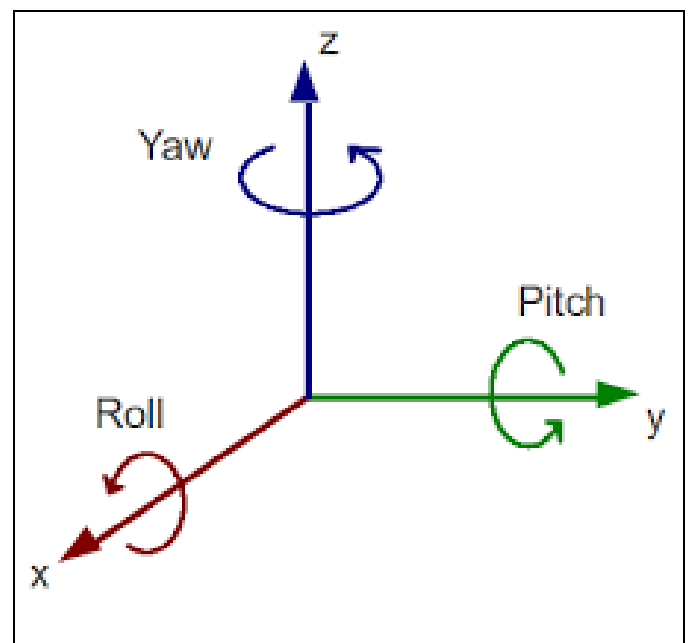

Figure 1:Leap motion working

When Sensor data generated by leap camera it is send to leap motion software .When leap sensor data contain information of hand, finger and arms where the internal human hand model inside the leap software is now compared with the real hand's sensor data. The sensor data is finger identification, hand identification is then analyzed frame by frame. Now the extracted frame information is send

to leap software. Now all extracted tracing data is provided to the controller to make decision.

IV. Working
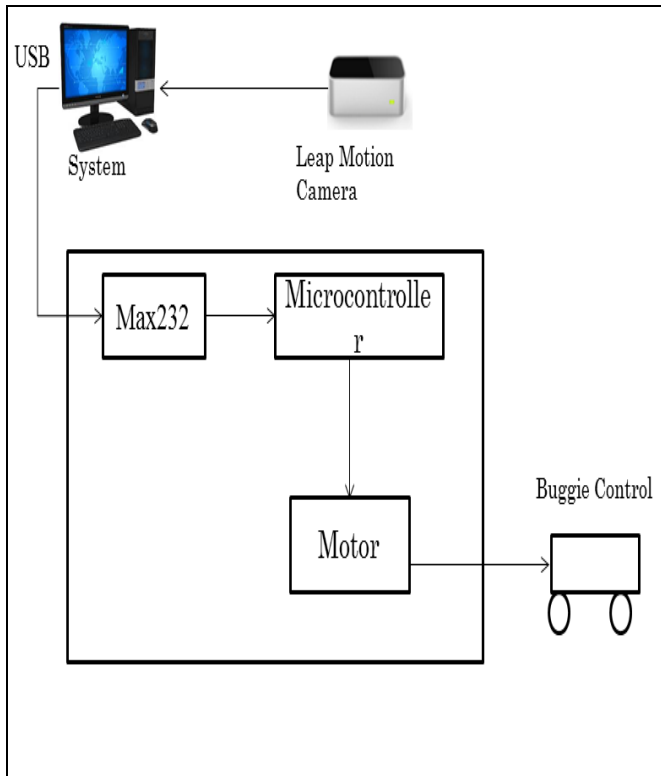
Proposed system:

Figure 2: Proposed System

Project system made up of three parts

1) Peripheral
USB connection to Leap Motion controller
USB connection to Robot
2) SDK driver
Leap motion software and Leap SDK
3) Robot Connection

Steps of development:

1) Coordinate Gesture:
There are multiple types of gestures like swipe, iconic, tapping, framing , pointing and circle gesture
This gestures are used to give gesture to the robot.
2) Mapping Algorithm

Distance Measure Algorithm

Step 1: Camera interfacing with system
Step 2: Hand point detection for right hand for each finger using Leap SDK
Step 3: Check if the fingers of right hand are extended
Step 4: If extended go to step 5 else go to step 12
Step 5: Calculate pitch of hand
Step 6: Feature Extraction
Step 7: Yaw, Roll and Direction calculation
Step 8: Normalization
Step 9: Threshold of pitch and direction
Step 10: Gesture recognition
Step 11: Post Processing
Step 12: End

Pseudo code:
If pitch<-60
Then move forward,
If pitch>90
Then move backward,
If pitch<40 && pitch>-40
Then stop,
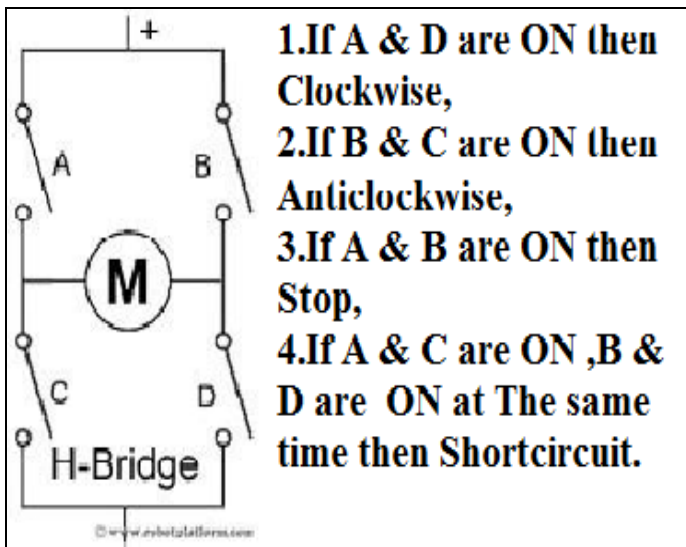If direction(x)<-50
Then move left,
If direction(x)>50
Then move right.

3) Robot Connection

V. Hardware And Software Interface

Hardware Requirement:

1. L293D Motor driver IC

It is integrated chip specially built for controlling motors in automated robot. The advantage is it can be worked on low voltage .L293D can act as interface between the microprocessor and the Robot's motor. In project we are using 2 motors at the backside of wheels. It uses the H-bridge

1.If A & D are ON then Clockwise,
2.If B & C are ON then Anticlockwise,
3.If A & B are ON then Stop,
4.If A & C are ON ,B & D are ON at The same time then Shortcircuit.

2. RS232

It is USB serial Adapter .It is used connecting robot to the PC using USB port . Which allow to drive robot by attaching it to PC.

Software Requirement:

Netbeans IDE is used for developing application .IDE provides interaction with robot .Netbeans used to communicate with the Robot . we import the library files for leap controller and Implementing code for collecting information from Leap using java language. All these data collected from Leap then send to the microcontroller to motors .

A. Netbeans IDE:

It let you create ,edit java project . IDE helps in building application and also helps in debugging and profiling. IDE let you test project /application by providing tools like JUnit . and analyse code using code analysis.

B. Leap Motion SDK:

Leap Motion SDK is used for service providing .Which allow to connect leap motion controller to PC using USB bus. Information is extracted from leap is in the form of Frame which contain information of parameter of hand like hand Id, palm Position , Stabilized palm position, Palm normal vector, Palm direction vector, List of fingers of particular hand, and finger parameters like Finger ID, Tip position, Stabilized tip position, Finger direction vector, Finger length,

There are main two type of API which contain
1. Native interface
2. Web Socket Interface

1) A Native API:

In C++ and java it uses dynamic loaded library which provide data and leap services where it collect data from leap motion using USB. It sends the processed information to leap application.

2) Web Socket API:

It is used for communication with web client library . It uses socket connection

Leap motion controller connected to the PC using USB. Robot connected to PC using serial communication .Leap calculate position of hand ,fingers and arms using Distance Measure Algorithm. Image taken by Leap is processed is in PC using Leap SDK. The calculated attributes of the hand, fingers is send to microcontroller as a signal. Then signal is send to Robot's motor from microcontroller. According to signal Robot will move to right, left, forward and stop .
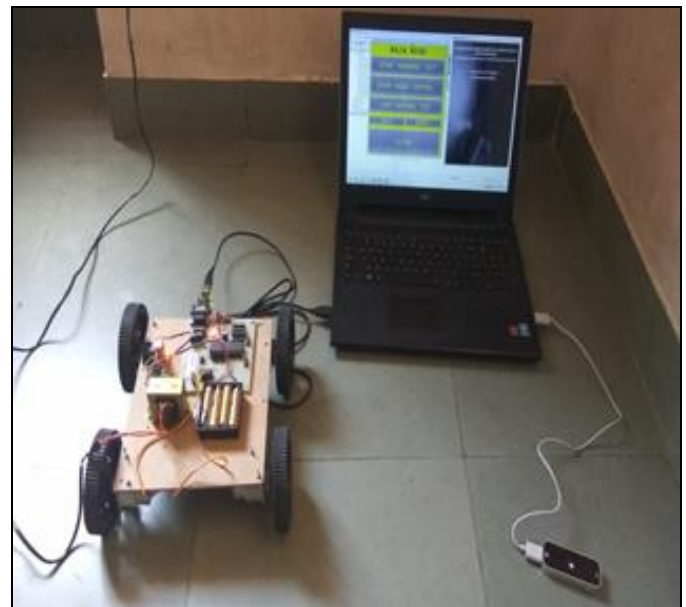

Figure 3: Robot control using Leap Motion

VI. CONCLUSION

Trending technology of Gesture control is used in project which is simple and used to control complicated robot control. Proposed technology is using Distance measure

algorithm and mathematical formulas to reduce human effort and to gain better understanding of robots. Overcoming on 6th sense technology and multi-touch technology because of less accurate result. This system is overcome on issues like lighting variation and hand orientation. It calculate real time data of object using X,Y and Z coordinates .Revolutionary product leap control used to achieve synchronization between human and robot. Because Leap Motion is having small and compact size and give better accuracy than other gesture control sensor. This system can be used in research field and military area.   Due to popularity of robots we can use simple interactive robotic controller to control robot. Hence the Gesture control will be perfect and revolutionary product in future.

VII.   REFERENCES

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