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A Study on Gesture Control Arduino Robot

Pradeep NR*1, Gagan K *2, Sandeep S H *3, Sharath A U *4
*1,2,3,4,5VTU University, Department Of Mechanical Engineering, BIET College, Karnataka, India.

ABSTRACT: Gesture Controlled Car is a robot which can be controlled by simple human gestures. The user just needs to wear a gesture device in which a sensor is included. The sensor will record the movement of hand in a specific direction which will result in the motion of the robot in the respective directions. The robot and the Gesture instrument are connected wirelessly through radio waves. User can interact with the robot in a more friendly way due to the wireless communication. We can control the car using accelerometer sensors connected to a hand glove. The sensors are intended to replace the remote control that is generally used to run the car. It will allow user to control the forward, backward, leftward and rightward movements, while using the same accelerometer sensor to control the throttle of the car. Movement of car is controlled by the differential mechanism. The mechanism involves the rotation of both forth & rear wheels of left or right side to move in the anticlockwise direction and the other pair to rotate in the clockwise direction which makes the car to rotate about its own axis without any kind of forward or backward motion. The main advantage of this mechanism is the car with this mechanism can take sharp turn without any difficulty. The design and implementation of a gesture control robotic arm using flex sensor is proposed. The robotic arm is designed in such a way that it consists of four movable fingers, each with three linkages, an opposing thumb, a rotating wrist and an elbow. The robotic arm is made to imitate the human hand movements using a hand glove.

Keywords*: Robotic Arm, Flex Sensor, Wireless Module, Accelerometer*

1. INTRODUCTION

Gesture-Controlled Robotic Arm is a robotic system that uses hand gestures to control its movements. This technology has the potential to revolutionize various industries, including healthcare, manufacturing, and education, by providing a more intuitive and natural way of interacting with robots. With the ability to recognize and interpret hand gestures, the robotic arm can perform tasks with precision and accuracy, improving efficiency and productivity. This project aims to design and develop a Gesture-Controlled Robotic Arm that can be used in various applications, providing a innovative solution for human-robot interaction.

1.1 Problem statement

The traditional wired buttons controlled robot becomes very bulgy and it also limits the distance the robot goes. The Wireless Hand controlled Robot will function by a wearable hand glove from which the movements of the hand can be used as the input for the movement of the robot. The basic idea of our project is to develop a system (Robot) which can recognize the Human Interaction with it to accomplish the certain tasks assigned to it. In our project we will design a wearable Hand Glove which will contain the sensors mounted on it to capture the movement of the hand and convert the raw mechanical data into electrical form. This data will be further processed and converted into an understandable format for the lilypad mounted on the Glove. This lilypad will act as a transmitter of the data for wireless communication purpose. Once the transmitted data is received by the receiver module which will be connected to the Microcontroller, it will be processed and further sent to the Microcontroller. Microcontroller will deduce the commands and accordingly it will actuate the motor drivers to control the Motors for various tasks on the robot.

1.2. Objectives

The aim of the project is to develop a human machine interface used for control robot arm. Our objective is to make this device simple as well as cheap so it can be produced and used for number of purposes. The objective of this project is to build a car that can be controlled by gesture wirelessly. In this project user is also able to control motions of the car by wearing controller glove and performing predefined gestures. This can be also used in many potential applications such as wireless controller car racing etc.

1.3. Scope

- Wireless controlled robots are very useful in many applications like remote surveillance, military etc.
- Hand gesture controlled robot can be used by physically challenged in wheelchairs.
- Hand gesture controlled industrial grade robotic arms can be developed.
- **Entertainment applications** – Most videogames today are played either on game consoles, arcade units or PCs, and all require a combination of input devices. Gesture recognition can be used to truly immerse a players in the game world like never before.
- **Automation systems** – In homes, offices, transport vehicles and more, gesture recognition can be incorporated to greatly increase usability and reduce the resources necessary to create primary or secondary input systems like remote controls, car entertainment systems with buttons or similar.
- **An easier life for the disabled** – One of the biggest challenges faced today is providing separate and equally non cumbersome services to the differently abled and handicapped. While there are special provisions around the world, there's still huge room for improvement to bring all lives on equal footing. Gesture recognition technology can eliminate a lot of manual labor and make life much easier for those who aren't as fortunate as most of us are.

These are just a handful of the places and situations in which gesture recognition technology can be implemented, and as is evident, can totally change the way we interact with the world around us, not only at home, but in commercial venues as well. In fact, a South African company had come up with an innovative machine placed at the Tambo International Airport that detected travellers who yawned or looked sleepy and dispensed free cups of coffee. Although it used only basic facial and gesture recognition technology, it is nonetheless an interesting look into what can be done with this technology. Currently, there aren't too many gesture recognition applications available for public use, but interestingly, despite its potential for real world applications, gesture recognition technology is actually dominated by the videogame industry. Electronics giants Microsoft and Sony, makers of the Xbox and PlayStation line of consoles respectively, have incorporated gesture recognition to an extent into their entertainment systems, via extra hardware. Called 'Kinect' in the case of Microsoft and the 'PlayStation Eye/Camera' in the case of Sony, these amazing devices bring us one step closer to the future. While Microsoft in 2014 has gone ahead and included the Kinect 2.0 camera with the Xbox One, their latest gaming console and made gesture and voice control an integral part of it, Sony has left the PlayStation Camera as an accessory for the PlayStation 4, instead focusing on traditional input methods.

So far you came to know about Hand Gesture Controlled Robot that completely moves according to moments of your hand (sign of input to the device).

1.4. Methodology

Methodology for communication signal Transmitter Module

An RF transmitter module is a small PCB ie, printed circuit board sub-assembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which is transmitted. RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics and band edge requirement.

Receiver modules

An RF Receiver module RF433-RX is 433 MHz radio receiver receives the modulated RF signal, and then it demodulates. There are two types of RF receiver module. Super-regenerative modules are usually of low cost and low power designs using a series of amplifiers use to extract modulated data from a carrier wave. Super-regenerative modules are generally imprecise as their frequency of operation varies in a fair amount with temperature and power supply voltage. Super heterodyne receivers having a performance advantage over super-regenerative; they offer increased an accuracy and stability over a large voltage and temperature range. This stability comes from a fixed crystal design which in turn leads to a comparatively more expensive product. Radio receiver which receives the transmitted coded from the remote place these codes are converted to digital format and output is available to the pin no 2 of the ic2 master microcontroller; this is the pin of inbuilt art of the microcontroller. We Based on the input codes master will give command to slave microcontroller and robot will behave as follows.

•Moves in forward direction

•Moves in reverse direction,

•Speed controls in both the direction

•It can even turn left or right while moving forward or in reverse direction.

•In case of bump, moves reverse turn left or right and wail for the next instruction.

•On the spot left or right turn to pass through the narrow space

•We have also added head light, back light and turning lights to left a right .

Methodology for Motion Control

L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers as they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. In common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction. The motor operations of two motors can be controlled by input logic. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state. This project controls a remote robot through RF. The ordinary 433 MHz RF modules are used in this project. AT89C51 microcontroller is used in this project.

This robot can perform their operations without direct human guidance. They are used basically for industrial applications and can be made laser guided. Navigation is achieved by one of the several means, including following a path defined by buried inductive wires, surface mounted magnetic or optical strips; or alternatively by the way of laser guidance. This is an improved version of my previous robot which we designed years ago. Intelligent spy robot project has been designed for the spying purpose .it is radio controlled and can be operated at a radial distance of 100m radius. Most probably our army youth need to venture into the enemy area just to track their activities.

Which is often a very risky job and may cost precious life? Such dangerous job could be done using small spy robot all the developed and advance nations are in the process of making it, a robot that can fight against enemy. Our robot us just a step towards similar activity.

This robot is radio operated which is, self powered, and has all the controls like a normal car. A laser gun has been installed on it so that it can fire on enemy remotely whenever required; this is not possible until a wireless camera is installed. Wireless camera will send real time video and audio signals which could be seen on a remote monitor and 224 action can be taken accordingly. Being in size small of it, will not be tracked by enemy on his radar. Robot silently enter into enemy canopy or tent and send us all the information through its' tiny camera eyes. It can also be used for suicide attack, if required. Heart of our robot is microcontroller 8051 family, we are using at89C51 In two microcontrollers where first microcontroller which acts as master controller, decodes all the commands received from the transmitter and give commands to slave microcontroller. Slave microcontroller is responsible for executing all the commands received from the master and also generating pulse width modulation pulses for the speed control driver circuit which drives 4 nos. of motors. Two no bumper switch is added bmp 1 and bmp2 so that in case of accident our battery dose not drains out.

Both the motors will stop instantly and after few second robots will move in opposite direction take turn to left or right direction and stops and stop. Navigation and Dead Reckoning, Tilt Compensation in inertial sensors, 3D-Gaming. transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps- 10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitted.

Transmission through RF (Radio frequency) is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line Of sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (TX/RX) pair operates at a frequency of 433MHz an RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps-10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the tran

Fig.1.0 Movement Signs

2. Literature Review

Moniruzzaman Bhuiyan and Rich Picking in Centre for Applied Internet Research (CAIR), Glyndŵr University, Wrexham, UK,proposed a review of the history of Gesture controlled user interface (GCUI), and identifies trends in technology,application and usability. Their findings conclude that GCUI[1]affords realistic opportunities for specific application areas, and especially for users who are uncomfortable with more commonly used input devices. They have tried collated chronographic research information which covers the past 30years. They investigated different types of gestures, its users, applications, technology, issues addressed, results and interfaces from existing research. They consider the next direction of gesture controlled user interfaces as rich user interface using gestures seems appropriate for current and future ubiquitous and ambient devices. Moniruzzaman Bhuiyan, Rich Picking of Institute of Information technology, University of Dhaka, Dhaka, Bangladesh; Centre for Applied Internet Research, Glyndwr University, Wrexham, United Kingdom on September 2011 in Journal of Software Engineering and to meet the challenges of ubiquitous computing, ambient technologies and an increasingly older population, research-ers have been trying to break away from traditional modes of interaction. A history of studies over the past 30 years reported in this paper suggests that Gesture Controlled User Interfaces (GCUI) now provide realistic and affordable opportunities, which may be appropriate for older and disabled people. They have developed a GCUI prototype application, called Open Gesture, to help users carry out everyday activities such as making phone calls, controlling their television and performing mathematical calculations. Open Gesture uses simple hand gestures to perform a diverse range of tasks via a television interface. They describes Open Gesture and reports its usability evaluation. They conclude that this inclusive technology offers some potential to improve the independence and quality of life of older and disabled users along with general users, although there remain significant challenges to be overcome. Stefan Waldherr, Roseli Romero, Sebastian Thrun describes a gesture interface for the control of a mobile robot equipped with a manipulator. The interface uses a camera to track a person and recognize gestures involving arm motion. A fast, adaptive tracking algorithm enables the robot to track and follow a person reliably through office environments with changing lighting conditions. Two alternative methods for gesture recognition are compared: a template based approach and a neural network approach. Both are combined with the Viterbi algorithm for the recognition of gestures defined through arm motion (in addition to static arm poses). Results are reported in the context of an interactive clean-up task, where a person guides the robot to specific locations that need to be cleaned and instructs the robot to pick up trash.

3. Simulation Work

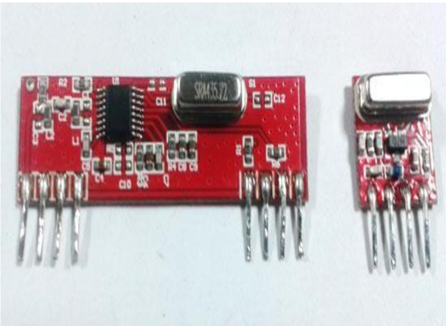

Fig.2.0 Picture of Object

3.1. RF pair

A gesture controlled robot is controlled by using hand in place of any other method like buttons or joystick. Here one only needs to move hand to control the robot. A transmitting device is used in your hand which contains RF Transmitter and accelero-meter. This will transmit command to robot so that it can do the required task like moving forward, reverse, turning left, turning right and stop. All these tasks will be performed by using hand gesture.

Here the most important component is accelerometer. Accelerometer is a 3 axis acceleration measurement device with +-3g range. This device is made by using polysilicon surface sensor and signal conditioning of this device is Analog in nature and proportional to the acceleration. This device measures the static acceleration of gravity when we tilt it. And gives an result in form of motion or vibration.

According to the datasheet of adxl335 polysilicon surface-micromachined structure placed on top of silicon wafer. Polysilicon springs suspend the structure over the surface of the wafer and provide a resistance against acceleration forces. Deflection of the structure is measured using a differential capacitor which incorporate independent fixed plates and plates attached to the moving mass. The fixed plates are driven by 180° out-of-phase square waves. Acceleration deflects the moving mass and unbalances the differential capacitor resulting in a sensor output whose amplitude is proportional to acceleration. Phase-sensitive demodulation techniques are then used to determine the magnitude and direction of acceleration**.**

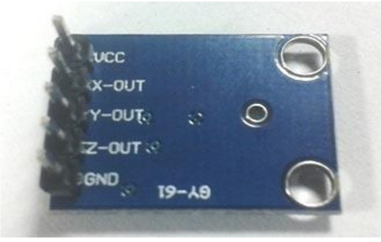

Fig.3.0 accelerometer

Pin Description of accelerometer

1. Vcc 5 volt supply should connect at this pin.
2. X-OUT This pin gives an Analog output in x direction
3. Y-OUT This pin give an Analog Output in y direction
4. Z-OUT This pin gives an Analog Output in z direction
5. GND Ground
6. ST This pin used for set sensitivity of sensor

3.2. Circuit Diagram and Explanation

Gesture Controlled Robot is divided into two sections:

1. Transmitter part
2. Receiver part

In transmitter part an accelerometer and a RF transmitter unit is used. As we have already discussed that accelerometer gives an analog output so here we need to convert this analog data in to digital. For this purpose we have used 4 channel comparator circuit in place of any ADC. By setting reference voltage wegets a digital signal and then apply this signal to HT12E encoder to encode data or converting it into serial form and then send this data by using RF transmitter into the environment. At the receiver end we have used RF receiver to receive data and then applied to HT12D decoder. This decoder IC converts received serial data to parallel and then read by using arduino. According to received data we drive robot by using two DC motor in forward, reverse, left, right and stop direction.

3.3. Working of Model

Gesture controlled robot moves according to hand movement as we place transmitter in our hand. When we tilt hand in front side, robot start to moving forward and continues moving forward until next command is given. When we tilt hand in backward side, robot change its state and start moving in backwards direction until other command is given. When we tilt it in left side Robot get turn left till next command. When we tilt hand in right side robot turned to right. And for stopping robot we keeps hand in stable.

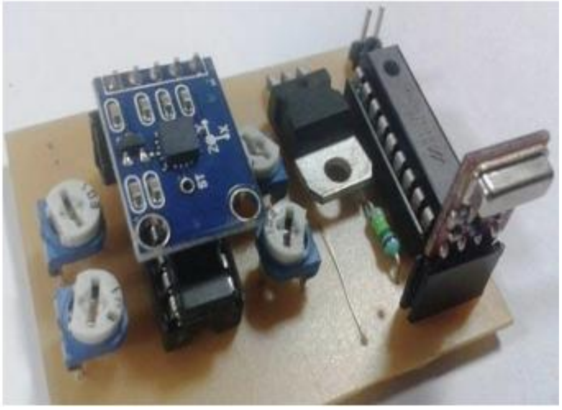

Fig.4.0Transmitter

3.4. Receiver circuit.

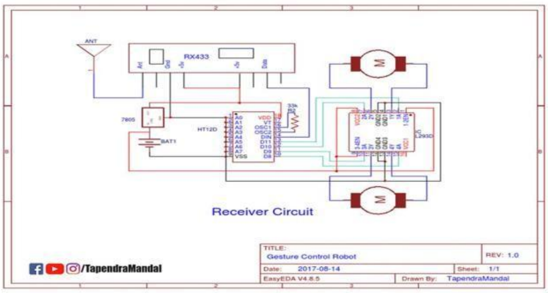

Fig. 5.0 Receiver Circuit

3.5. Transmitter circuit

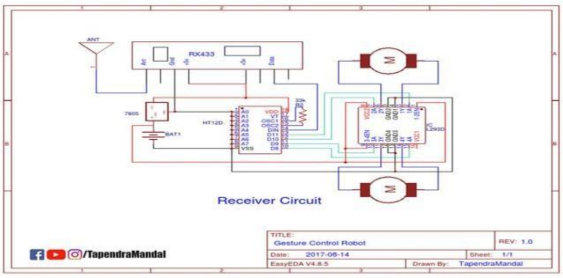

Fig. 6.0 Transmitter circuit

This transmitted signal is received by the RF receiver, demodulated and then passed onto the decoder IC. The decoder IC decodes the coded waveform and the original data bits are recovered. The input is a serial coded modulated waveform while the output is parallel. The pin 17 of the decoder IC is the Valid Transmission (VT) pin. A led can be connected to this pin which will indicate the status of the transmission. In the case of a successful transmission, the led will blink. The parallel data from the encoder is fed to the port 1of the microcontroller. This data is in the form of bits. The microcontroller reads these bits and takes decisions on the basis of these bits. What the microcontroller does is, it compares the input bits with the coded bits which are burnt into the program memory of the microcontroller and outputs on the basis of these bits. Port 2 of the microcontroller is used as the output port. Output bits from this port are forwarded to the motor driver IC which drives the motors in a special configuration .Gesture controlled robot works on the principle of accelerometer which records hand movements and sends that data to the comparator which assigns proper voltage levels to the recorded movements. That information is then transferred to an encoder which makes it ready for RF transmission. On the receiving end, the information is received wirelessly via

RF, decoded and then passed onto the microcontroller which takes various decisions based on the received information.These decisions are passed to the motor driver IC which triggers the motors in different configurations to make the robot move in a specific direction. Task was divided into two parts to make the

movements in the X and Y directions only and outputs constant analog voltage levels. These voltages are fed to the microcontroller which processes the input and encodes the data into digital form which is suitable to be transmitted through the xbee serial transmitter. Circuit for this hand gesture controlled robot is quite simple. As shown in above schematic diagrams, a RF pair is used for communication and connected with arduino. Motor driver is connected to arduino to run the robot. Motor driver's input pin 2, 7, 10 and 15 is connected to arduino digital pin number 6, 5, 4 and 3 respectively. Here we have used two DC motors to drive robot in which one motor is connected at output pin of motor driver 3 and 6 and another motor is connected at 11 and 14. A 9 volt Battery is also used to power the motor driver for driving motors.

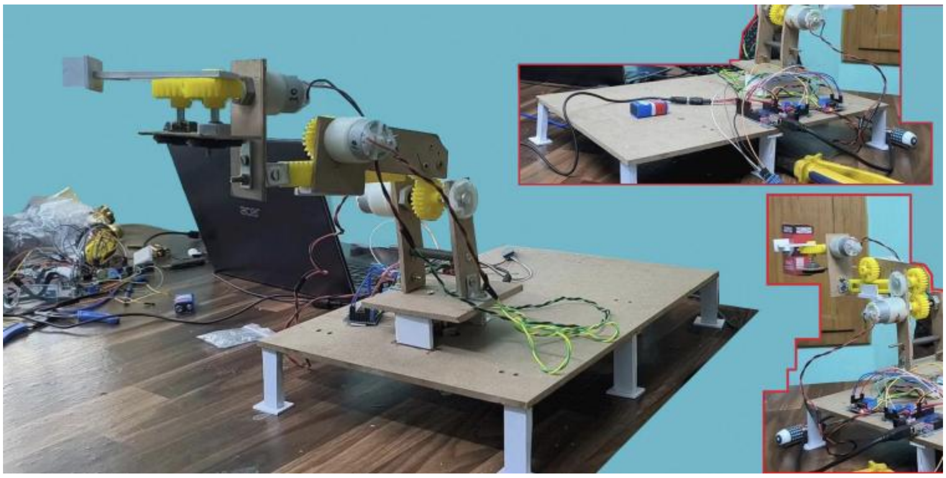

Fig. 7.0 Ready Model

4. CONCLUSION

The purpose of project is to control a toy car using accelerometer sensors attached to a hand glove. The sensors are intended to replace the remote control that is generally used to run the car. It will allow us to control the forward and backward, and left and right movements, while using the same accelerometer sensor to control the throttle of the car. based on the hand movements. By using the above mentioned components the hardware was setup, thus resulting in the formation of a robot. In order to implement the experiment a Dell laptop was used, whose web camera acted as the input device for capturing the video. The software part was developed in Java for image processing wherein the hand gestures were analyzed to extract the actual direction. Eclipse Ide was used for developing the java code. The direction thus identified was send as characters to the robot with the help of Zigbee. XBee S2 version of Zigbee was used for enabling the communication. The final movement of the robot can be concluded as follows: At the beginning the robot was in a stop mode. As the hand moved from bottom to top, the robot moved in the forward direction. As the hand moved from top to bottom, the robot moved in the backward direction. As the hand was shown as an acute angle towards the left, the robot moved towards the left direction. As the hand was shown as an acute angle towards the right, the robot moved towards the right direction. As the hand is kept stationary with respect to the environment, the robot was in the stop mode. From the experiment, about 80% of the implementation worked according; the remaining was less due to background interference which is a negative marking to the implementation. Hand Gesture Controlled Robot System gives a more natural way of controlling devices. The command for the robot to navigate in specific direction in the environment is based on technique of hand gestures provided by the user. Without using any external hardware support for gesture input unlike specified existing system, user can control a robot from his software station.

Future Scope

1) The on board batteries occupy a lot of space and are also quite heavy. We can either use some alternate power source for the batteries or replace the current DC Motors with ones which require less power.

2) The proposed system is applicable in hazardous environment where a camera can be attached to the robot and can be viewed by the user who is in his station. This system can also be employed in medical field where miniature robot are created that can help doctors for efficient surgery operations For more efficient response, threshold values can be used to detect gesture and advanced features such as finger counts that provide different functional commands can be used.

3) **Entertainment applications** – Most videogames today are played either on game consoles, arcade units or PCs, and all require a combination of input devices. Gesture recognition can be used to truly immerse a players in the game world like never before.

4) **Automation systems** – In homes, offices, transport vehicles and more, gesture recognition can be incorporated to greatly increase usability and reduce the resources necessary to create primary or secondary input systems like remote controls, car entertainment systems with buttons or similar.

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