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WIRELESS GESTURE CONTROLLED ROBOT

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Abstract - Gesture Controlled Robot is a robot which can be controlled by simple gestures. The user just needs to wear a gesture device which includes a sensor. The sensor will record the movement of hand in a specific direction which will result in the movement of the robot in the respective direction. The robot and the gesture device are connected wirelessly via radio waves. The wireless communication enables the user to interact with the robot in a more friendly way.

1. INTRODUCTION

Recently, strong efforts have been carried out to develop intelligent and natural interfaces between users and computer based systems based on human gestures. Gestures provide an intuitive interface to both human and computer. Thus, such gesture-based interfaces can not only substitute the common interface devices, but can also be exploited to extend their functionality. A **Robot** is usually an electro-mechanical machine that can perform tasks automatically. Some robots require some degree of guidance, which may be done using a remote control or with a computer interface. Robots can be autonomous or remotely controlled. An important aspect of a successful robotic system is the **Human-Machine interaction**.[3] In the early years the only way to communicate with a robot was to program which required extensive hard work. With the development in science and robotics, gesture based recognition came into life. A **Gesture** is an action that has to be seen by someone else and has to convey some piece of information. Gesture is usually considered as a movement of part of the body to express an idea or meaning. Our motivation to work on this project came from a disabled person who was driving his wheel chair by hand with quite difficulty. So we wanted to make a device which would help such people drive their chairs without even having the need to touch the wheels of their chairs. Our objective is to make this device simple and cheap so that it could be mass produced and can be used for number of purposes.

GESTURE CONTROLLED ROBOT

Gesture recognition technologies are much younger in the world of today. At this time, there is much active research in the field and little in the way of publicly available implementations. Several approaches have been developed for sensing gestures and controlling robots. Glove based technique is a well-known means of recognizing hand gestures. It utilizes a sensor attached to a glove that directly measures hand movements. A gesture controlled robot is a kind of robot which can be controlled by hand gestures and not the old fashioned way by using buttons. The user just needs to wear a small transmitting device on his hand which includes a sensor which is an accelerometer in our case. Movement of the hand in a specific direction will transmit a command to the robot which will then move in a specific direction. The transmitting device includes [4]a comparator IC for assigning proper levels to the input voltages from the accelerometer and an Encoder IC which is used to encode the four bit data and then it will be transmitted by an RF transmitter module.

At the receiving end an RF Receiver module will receive the encoded data and decode it by using a decoder IC. This data is then processed by a microcontroller and passed onto a[5] motor driver to rotate the motors in a specific configuration to make

the robot move in the same direction as that of the hand.

Applications of GC Robot:

- Through the use of gesture recognition, remote control with the wave of a hand of various devices is possible.
- Gesture controlling is very helpful for handicapped and physically disabled people to achieve certain tasks, such as driving a vehicle.
- Gestures can be used to control interaction for entertainment purposes such as gaming to make the game player's experience more interactive or immersive.

2. LITERATURE REVIEW

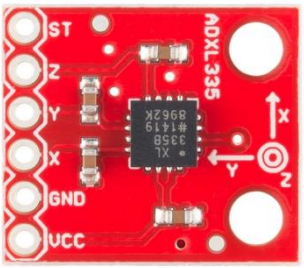
1) **Prajwal Ashwin Jawalekar** has developed a gesture controlled robot which is controlled by human gestures. The features of the project have been explained in the paper "**ROBOT CONTROL BY USING HUMAN HAND GESTURES"[7]** which is proposed in the conference held in **2018.** He used accelerometer, Arduino, Motor Driver, RF Transmitter and Receiver in his project.
2) **Altaf Ganihar** has developed an android based wireless gesture controlled robot and has explained its features in the paper **"Android based wireless gesture controlled robot"** and published it in the IEEE conference held in the year **2014**.

3. HARDWARE DESCRIPTION:

The major components in this project are accelerometer, RF Transmitter and Receiver, Arduino, Encoder and Decoder, Motor driver, Dc motor.

Accelerometer:

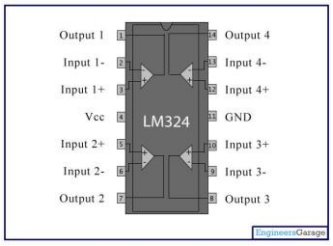
The **ADXL335** is a small, low power, complete 3-axis **accelerometer[8]** with signal conditioned voltage outputs. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. An accelerometer is an electro mechanical device that measures acceleration forces. These forces may be static or dynamic. It is a kind of sensor which record acceleration and gives an analog data while moving in X, Y, Z direction or may be X, Y direction only depending on type of the sensor.



PIN NO.	SYMBOL	FUNCTION
1	ST	Sets the sensitivity of the accelerometer
2	Z	Records analog data for Z direction
3	Y	Records analog data for Y direction
4	X	Records analog data for X direction
5	GND	Connected to ground for biasing
6	VCC	+3.3 volt is applied

Comparator IC LM324

The LM324 [6]operational amplifier IC can be worked as a comparator. This IC has 4 independent operational amplifiers on a single chip. This a Low Power Quad Operational Amplifier and it has high stability, bandwidth which was designed to operate from a single power supply over a wide range of voltages. The quad amplifier can operate at supply voltages as low as 3.0 V or as high as 3.2 V with quiescent currents about one fifth of those associated with the MC174.



PIN NO.	SYMBOL	FUNCTION
1	Output 1	Output of 1st Comparator
2	Input 1-	Inverting Input of 1st Comparator
3	Input1+	Non-Inverting Input of 1st Comparator
4	VCC	Supply Voltage; 5V (up to 32V)
5	Input 2+	Non-Inverting Input of 2nd Comparator
6	Input 2-	Inverting Input of 2nd Comparator
7	Output 2	Output of 2nd Comparator
8	Output 3	Output of 3rd Comparator
9	Input 3-	Inverting Input of 3rd Comparator
10	Input 3+	Non-Inverting Input of 3rd Comparator
11	Ground	Ground (0V)
12	Input 4+	Non-Inverting Input of 4th Comparator
13	Input 4-	Inverting Input of 4th Comparator
14	Output 4	Output of 4th Comparator

ENCODER IC PT2262

PT2262 is a remote control encoder paired with PT2272 utilizing CMOS Technology. It encodes data and address pins into a serial coded waveform suitable for RF or IR modulation. PT2262 [9]has a maximum of 12 bits of tri-state address pins providing up to 531,441 (or 312) address codes; thereby, drastically reducing any code collision and unauthorized code scanning possibilities.

PIN NO.	SYMBOL	FUNCTION
1-8	A0-A7	Address pins
9	Vss	Ground pin
13-10	D0-D3	Output pins
14	TE	Enables the transmission
15-16	Osc1-Osc2	Rosc of 470K ohm is connected
17	Dout	Output for transmission
18	Vcc	5V supply voltage

RF MODULE (Rx/Tx)

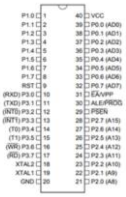
Radio frequency is a rate of oscillation in the range of about 3Khz to 300 Ghz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals. Although radio frequency is a rate of oscillation, the term “radio frequency” or its abbreviation RF are also used as a synonym for radio as opposed to communication via electric wires.

DECODER IC (PT2272)

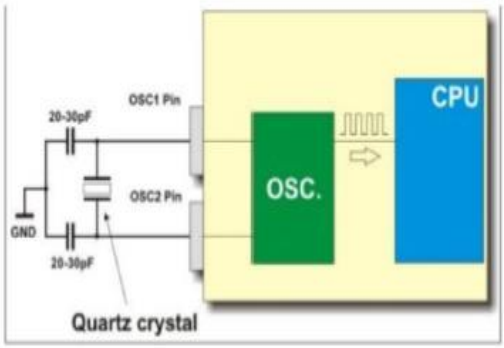
PIN	FUNCTION
VCC	5V supply
GND	Ground pin
Data	Output to pin 14 of PT2272 for data transmission
Ant	A wire attached here works as an antenna

PT2272 is a remote control decoder paired with PT2262 utilizing CMOS [10]Technology. It has 12-bit of tri-state address pins providing a maximum of 531,441 (or 312) address codes; thereby, drastically reducing any code collision and unauthorized code scanning possibilities. PT2272 is available in several options to suit every application need: variable number of data output pins, latch or momentary output type.

MICRO CONTROLLER (AT89C51)



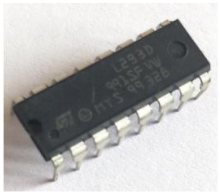
The **AT89C51** is an age old 8-bit microcontroller from the Atmel family. It works with the popular 8051 architecture and hence is used by most beginners till date. It is a 40 pin IC package with 4Kb flash memory. It has four ports and all together provide 32 Programmable GPIO pins. It does not have in-built ADC module and supports only USART communication. Although it can be interfaced with external **ADC IC** like the ADC084 or the ADC0808



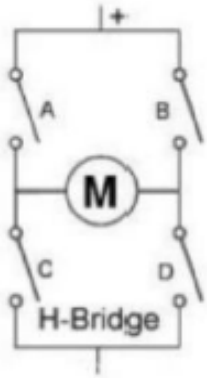
A crystal oscillator is attached to the pins 18 and 19 of the microcontroller. The oscillator creates an electrical signal of a very precise frequency which is used to keep track of time. Two capacitors are connected in parallel with the oscillator to remove unwanted frequencies.

MOTOR DRIVERS (L293D):

The L293D is a popular 16-Pin **Motor Driver IC**. As the name suggests it is mainly used to drive motors. A single **L293D IC[11]** is capable of running two DC motors at the same time; also the direction of these two motors can be controlled independently. So if you have motors which has operating voltage less than 36V and operating current less than 600mA, which are to be controlled by digital circuits like Op-Amp, 555 timers, digital gates or even Micron rollers like Arduino, PIC, ARM etc.. this IC will be the right choice for you.



Turning a motor ON and OFF requires only one switch to control a single motor in a single direction. We can reverse the direction of the motor by simply reversing its polarity. This can be achieved by using four switches that are arranged in an intelligent manner such that the circuit not only drives the motor, but also controls its direction. Out of many, one of the most common and clever design is a H-bridge circuit where transistors are arranged in a shape that resembles the English alphabet "H".



As seen in the image, the circuit has four switches A, B, C and D. Turning these switches ON and OFF can drive a motor in different ways.

- When switches A and D are ON, motor rotates clockwise.
- When B and C are ON, the motor rotates anti-clockwise.
- When A and B are ON, the motor will stop.
- Turning OFF all the switches gives the motor a free wheel drive.
- Turning ON A and C at the same time shorts the entire circuit. So, never try to do it.

DC MOTORS:

A **DC motor** is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current in part of the motor.

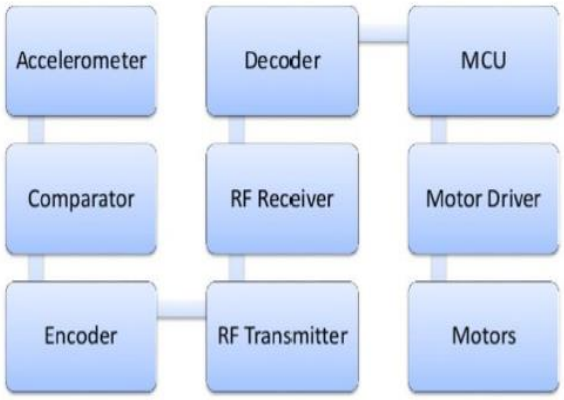
DC motors were the first form of motor widely used, as they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are currently used in propulsion of electric vehicles, elevator and hoists, and in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

DC GEAR MOTOR:

A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output. The most important parameters in regards to gear motors are speed (rpm), torque (lb-in) and efficiency (%). In order to select the most suitable gear motor for your application you must first compute the load, speed and torque requirements for your application. ISL Products offers a variety of Spur Gear Motors, Planetary Gear Motors and Worm Gear Motors to meet all application requirements. Most of our DC motors can be complimented with one of our unique gearheads, providing you with a highly efficient gear motor solution. The speed of the motor is counted in terms of rotations of the shaft per minute and it is termed as RPM[12]. The gear assembly helps in increasing the torque and dropping the speed. Using the correct arrangement of gears in a gear motor, its speed can be reduced to any required figure. This concept of reducing the speed with the help of gears and increasing the torque is known as gear reduction. Reducing the speed put out by the motor while increasing the quantity of applied torque is a important feature of the reduction gear trains found in a gear motor. The decrease in speed is inversely relative to the increase in torque.

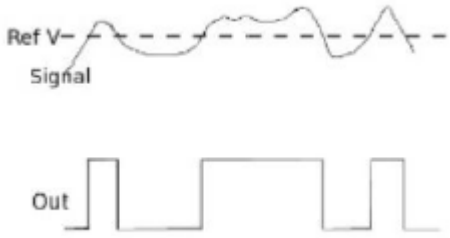
Figure 3 - DC Gear Motor

BLOCK DIAGRAM



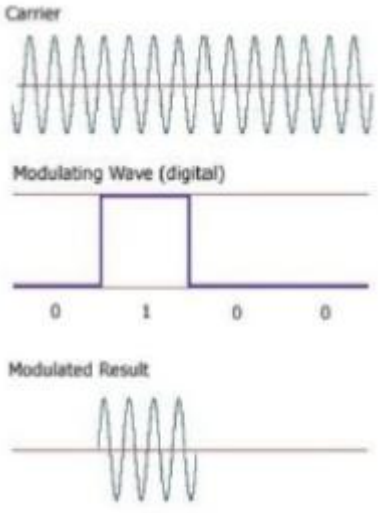
4. IMPLEMENTATION

The accelerometer records the hand movements in the X and Y directions only and the outputs constant analog voltage levels. These voltages are fed to the comparator IC which compares it with the references voltages that we have set via variable resistors attached to the IC. The levels that we have set are 1.7V and 1.4V. Every voltage generated by the accelerometer is compared with these and an analog 1 or 0 signals is given out by the comparator IC.

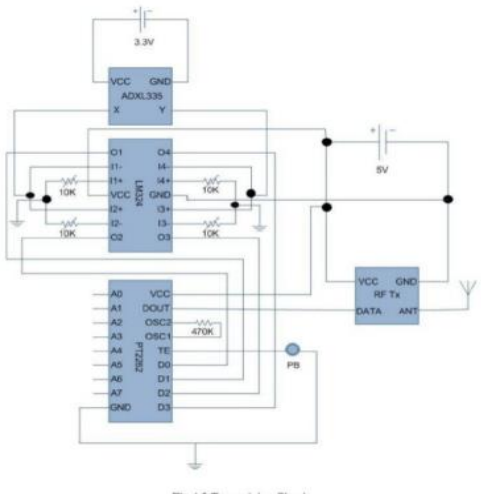


The analog signal is the input to the encoder IC. The input to the encoder is parallel while the output is a serial coded waveform which is suitable for RF Transmission. A push button is attached to pin 14 of this IC which is the Tansmission Enable(TE) pin. The coded data will be passed onto the RF module only when the button is pressed. This button makes sure no data is transmitted unless we want to. The RF transmitter modulates the input signal using Amplitude Shift Keying(ASK) modulation. It is the form of modulation that represents digital data as variations

in the amplitude of a carrier wave. The following figure shows the modulated output of the RF module:



The RF module works on the frequency of 315 Mhz. It means that the carrier frequency of the RF module is 315Mhz. The RF module enables the user to control the robot wirelessly and with ease.

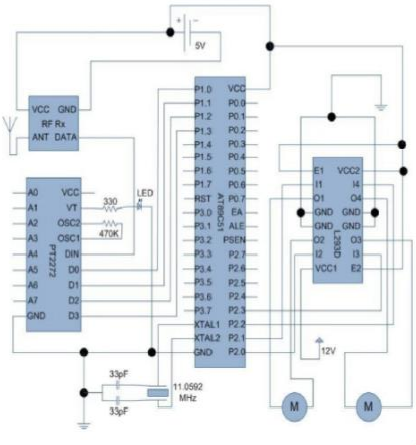


The transmitted signal is received by the RF receiver, demodulated and then passed onto the decoder IC. The decoder IC decodes the coded waveform and the original data bits are recovered. The input is a serial coded modulated waveform while the output is parallel. The pin 17 of the decoder IC is the 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 port1 of the mirocontroller. 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 is used as the output port. Output bits from this port are forwarded to the motor driver IC which drives the motors in a specific configuration based on the hand movements.

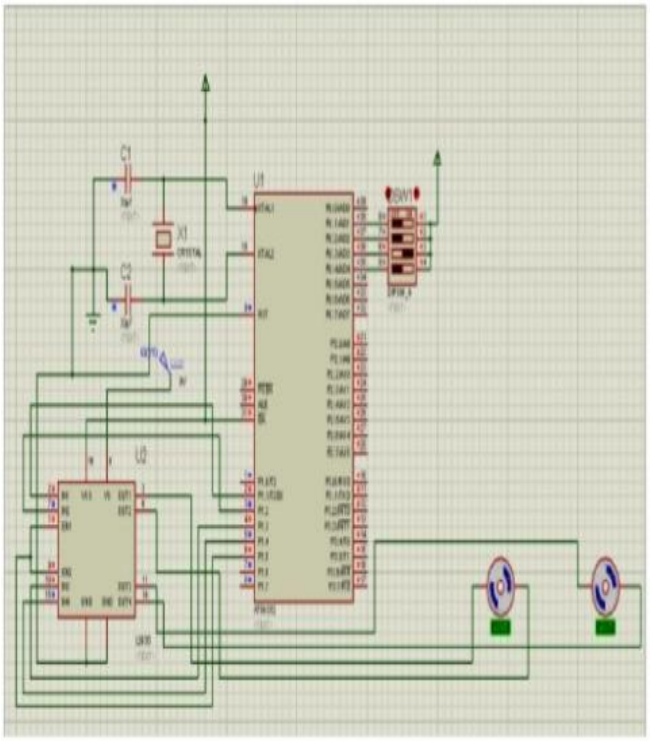
At a dead stop, a motor produces no voltage. If a voltage is applied and the motor begins to spin, it will act as a generator that will produce a voltage that opposes the external voltage applied to it. This is called Counter Electromotive Force (CEF) or Back Electromotive Force (Back EMF). If a load stops the motors from moving then the current may be high enough to burn out the motor coil windings. To prevent this, flyback diodes are used. They prevent the back emf from increasing and damaging the motors.

The schematic of receiving end can be seen below:



5. SIMULATION

We performed a simulation of our project in PROTEUS and the code was written in C language using KEIL MICROVISION.



6.CONCLUSION:

We achieced our objective without any hurdles. The robot is showing proper responses whenever we move our hand. Different hand gestures to make the robot move in specific directions are:

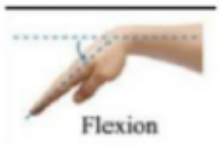


Fig 5-1 Move Forward

Fig 5-2 Move Backward

Fig 5-3 Move Right

Fig 5-4 Move Left

DIRECTION	ACCELEROMETER ORIENTATION
Forward	+y
Backward	-y
Right	+x
Left	-x
Stop	Rest

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