ABSTRACT

INTRODUCTION

A Robot is an electro-mechanical system that is operated by a computer program. Robots can be autonomous or semi-autonomous. An autonomous robot is not controlled by human and acts on its own decision by sensing its environment.

One of the frequently implemented motion controlled robot is a Hand Gesture Controlled Robot. In this project, a hand gesture controlled robot is developed using MPU6050, which is a 3-axis Accelerometer and 3-axis Gyroscope sensor and the controller part is Arduino Nano.

Instead of using a remote control with buttons or a joystick, the gestures of the hand are used to control the motion of the robot. The project is based on wireless communication, where the data from the hand gestures is transmitted to the robot over RF link (RF Transmitter – Receiver pair).

PRINCIPLE

In order to understand the principle of operation of Hand Gesture Controlled Robot, let us divide the project into three parts.

- The first part is getting data from the MPU6050 Accelerometer Gyro Sensor by the Arduino. The Arduino continuously acquires data from the MPU6050 and based on the predefined parameters, it sends a data to the RF Transmitter.
- The second part of the project is the Wireless Communication between the RF Transmitter and RF Receiver. The RF Transmitter, upon receiving data from Arduino (through the Encoder IC), transmits it through the RF Communication to the RF Receiver.

- Finally, the third part of the project is decoding the Data received by the RF Receiver and sending appropriate signals to the Motor Driver IC, which will activate the Wheel Motors of the Robot.

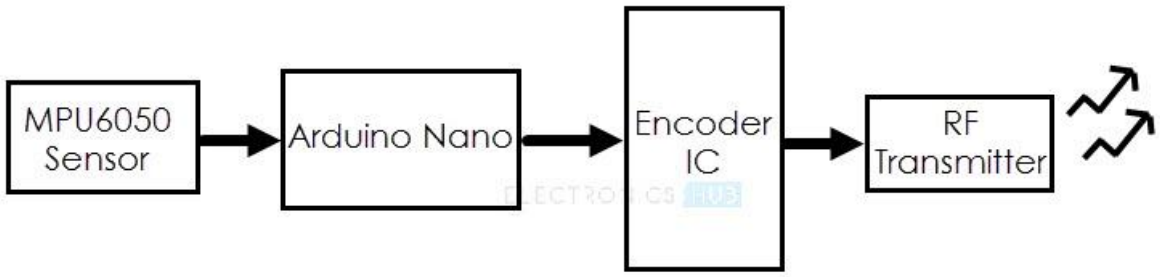
CIRCUIT DESIGN

The Circuit Design of the Hand Gesture Controlled Robot consists of two sections namely

- Transmitter Section
- Receiver Section

TRANSMITTER SECTION

The following image shows the simple block diagram of Hand Gesture Controlled Robot for Transmitter.



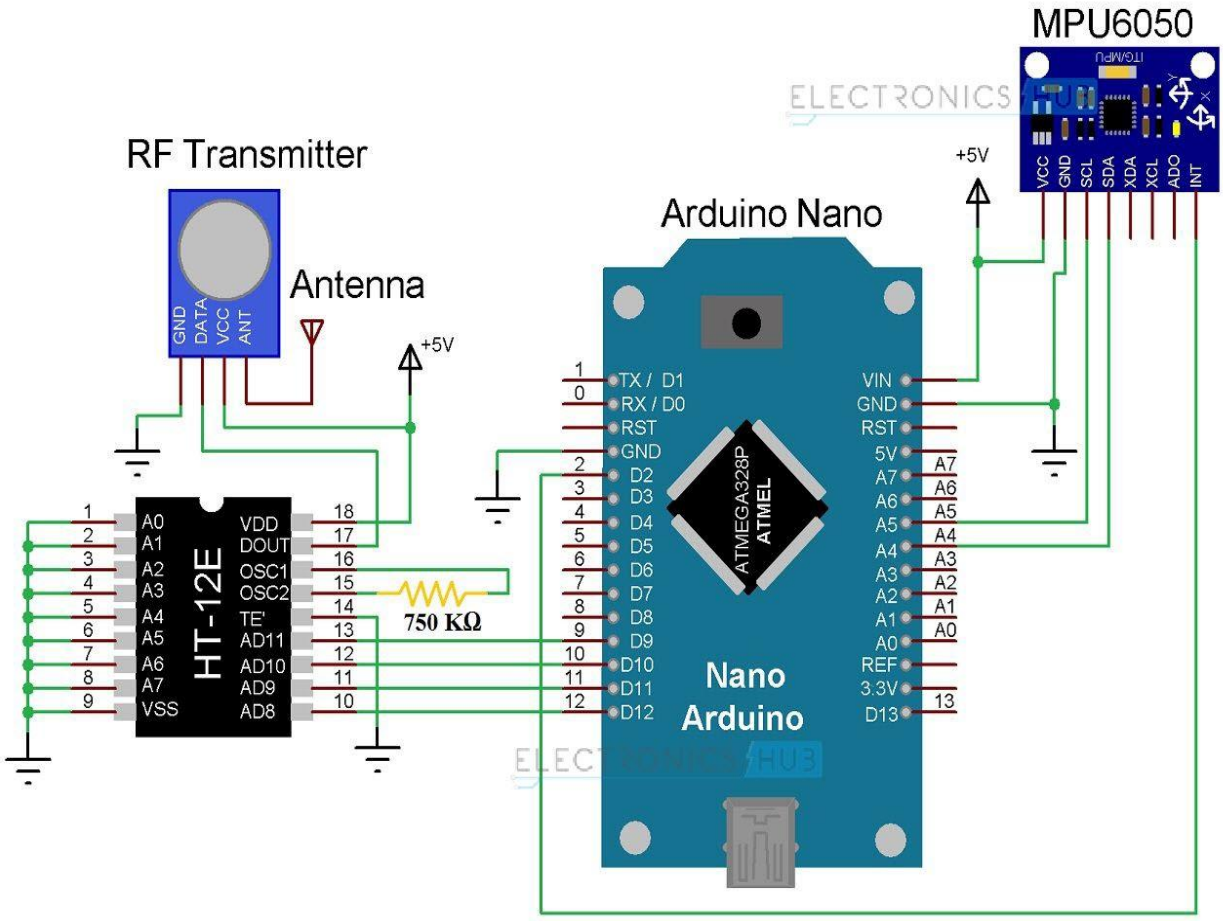
Majority of the industrial robots are autonomous as they are required to operate at high speed and with great accuracy. But some applications require semi-autonomous or human controlled robots. Some of the most commonly used control systems are voice recognition, tactile or touch controlled and motion controlled.

This is a kind of robot which can be controlled by your hand gestures. You just need to wear a small transmitting device in your hand which includes an acceleration meter. This will transmit an appropriate command to the robot so that it can perform according to our instructions.

The Transmitter Section of the robot mainly consists of the following components

- Arduino Nano
- 434MHz RF Transmitter
- HT-12E Encoder IC
- MPU6050 Accelerometer
- 750kΩ Resistor

The Circuit Diagram of the Transmitter Section is as shown below

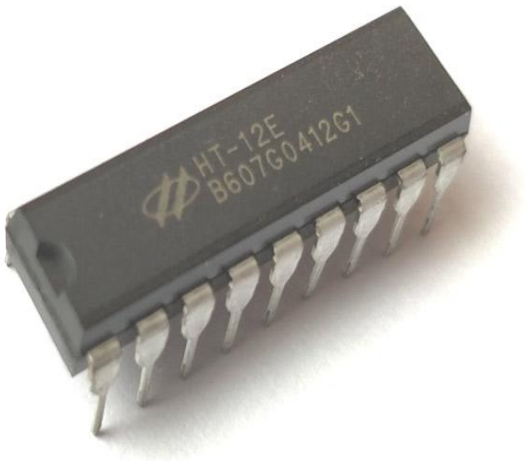


The Component description of the Transmitter Section is as follows

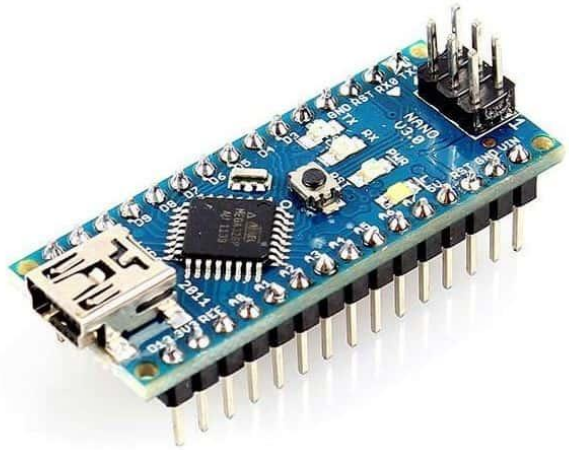
- **MPU6050:** The MPU6050 is one of the most commonly used Sensor Modules by hobbyists and enthusiasts. It consists of Accelerometer and Gyroscope on the same IC and provides 6 Degrees of Freedom (3-axis of Accelerometer and 3-axis of Gyroscope).

- **RF Transmitter:** The transmitter draws no power when transmitting logic zero while fully suppressing the carrier frequency thus consume significantly low power in battery operation. When logic one is sent carrier is fully on to about 4.5mA with a 3volts power supply. The data is sent serially from the transmitter which is received by the tuned receiver.

- **HT-12E:** HT12E is an encoder integrated circuit of 2^{12} series of encoders. They are paired with 2^{12} series of decoders for use in remote control system applications. Simply put, HT12E converts the parallel inputs into serial output. It encodes the 12 bit parallel data into serial for transmission through an RF transmitter. These 12 bits are divided into 8 address bits and 4 data bits.



- **Arduino Nano:** The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328P (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.



The Construction of the Transmitter Section is as follows

- The Transmitter Section of the robot consists of Arduino Nano board, MPU6050 Sensor, HT-12E Encoder IC and an RF Transmitter. The communication between Arduino and MPU6050 Sensor takes place through I2C Interface. Hence, the SCL and SDA pins of the MPU6050 Sensor are connected to A5 and A4 pins of the Arduino Nano. Additionally, we will be using the interrupt pin of the MPU6050 and hence, it is connected to D2 of Arduino Nano.

- HT-12E is an encoder IC that is often associated with RF Transmitter module. It converts the 12-bit parallel data to serial data. The 12-bit data is divided into address and data bits. A0 to A7 (Pin 1 to Pin8) are the address bits and they are used for secure transmission of the data. These pins can be either left open or connected to ground (Vss). In this circuit, Pin 1 to Pin 9 (A0 – A7 and Vss) of HT-12E are connected to ground.

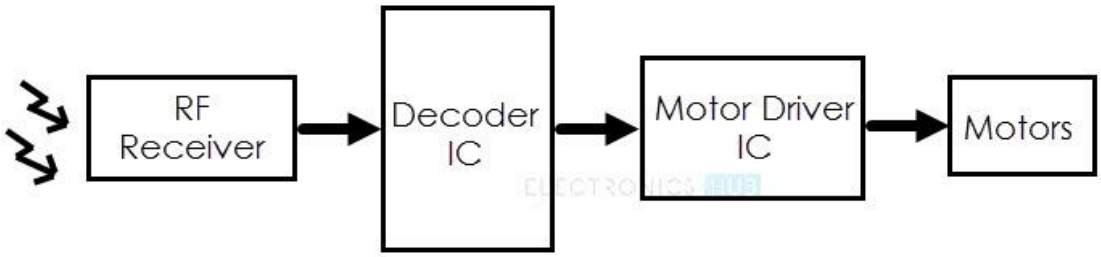
- Pins 10 to 13 (AD8, AD9, AD10 and AD11) are the data pins of HT-12E. They receive the 4 word parallel data from external source like a microcontroller (Arduino Nano in this case). They are connected to the pins D12, D11, D10 and D9 of Arduino Nano respectively.

- TE' is the transmission enable pin and it is an active low pin. The data is transmitted as long as the TE' is low. Hence, Pin 14 (TE') is also connected to ground.

- The encoder IC has an internal oscillator circuit between the pins 16 and 15 (OSC1 and OSC2). A 750KΩ resistor is connected between these pins to enable the oscillator. Dout (Pin 17) is the serial data out pin. It is connected to the data in pin of the RF Transmitter.

RECEIVER SECTION

The following image shows the simple block diagram of Hand Gesture Controlled Robot for Receiver.



The Receiver Section of the robot mainly consists of the following components

- L293D Motor Driver IC
- HT-12D Decoder IC
- 434MHz RF Receiver
- 2 Geared Motors with Wheels
- Robot Chassis

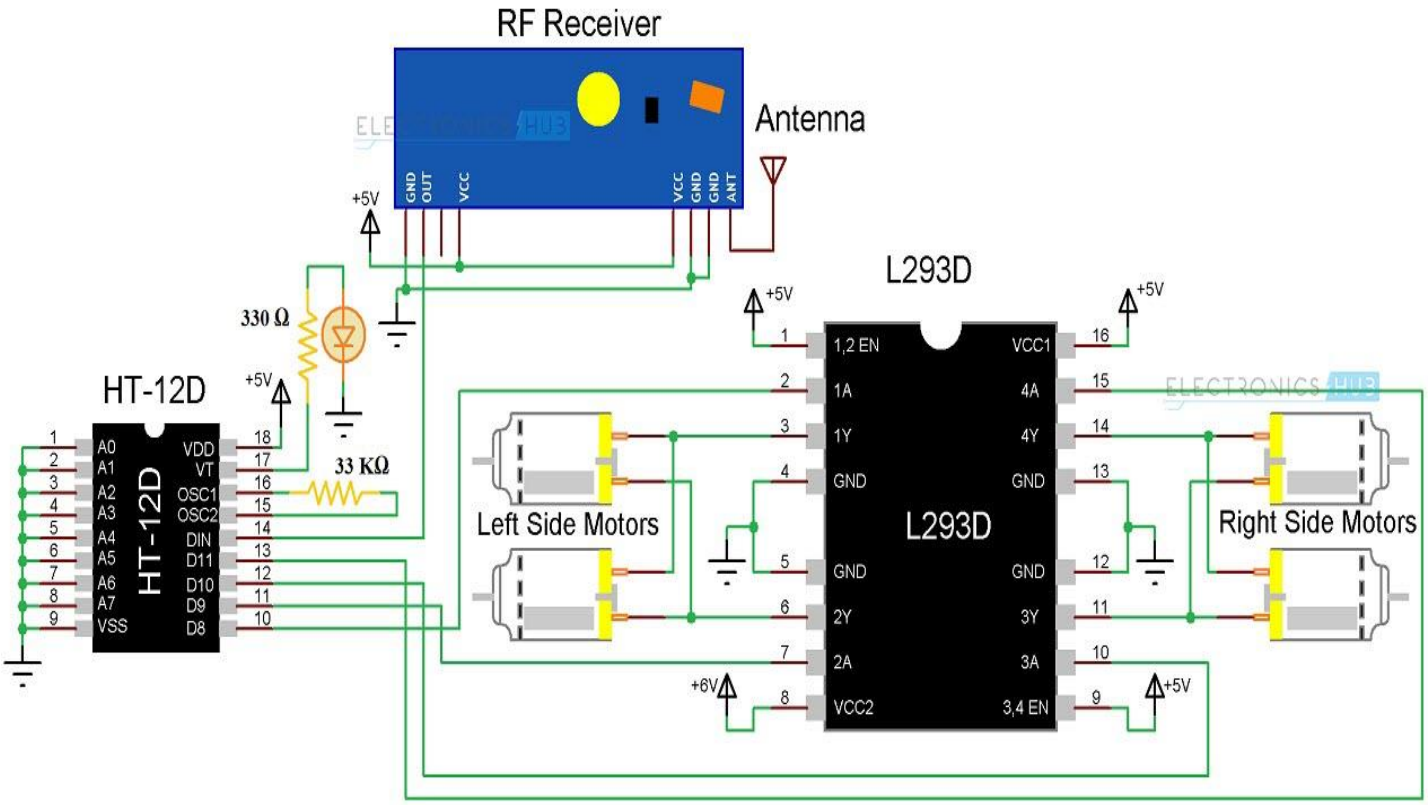
The Component description of the Receiver Section is as follows

- **RF Receiver:** An RF module is a small electronic device used to receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. For many applications the medium of choice is RF since it does not require line of sight.

- **HT-12D:** HT12D is a 2^{12} series decoder IC (Integrated Circuit) for remote control applications manufactured by Holtek. It is commonly used for radio frequency (RF) wireless applications. By using the paired HT12E encoder and HT12D decoder we can transmit 12 bits of parallel data serially.

- **L293D:** L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers since 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 its common mode of operation, two DC motors can be driven simultaneously, both in forward and reverse direction.

The Circuit Diagram of the Transmitter Section is as shown below



The Construction of the Transmitter Section is as follows

- The receiver section of the robot consists of an RF Receiver, HT-12D Decoder IC, L293D Motor Driver IC and a robot chassis with four motors connected to wheels.

- HT-12D is the decoder IC that is often associated with RF Receiver. It converts the serial data received by the RF link into parallel data. A0 to A7 (Pin 1 to Pin 8) are the address pins and must be matched with the address pins of the encoder.

- Since the address pins of encoder (HT-12E) are grounded, the address pins of decoder must also be grounded. Hence, pins 1 to 9 (A0 – A7 and Vss) are connected to ground. The serial data from the RF Receiver is given to Din (Pin 14) of the decoder IC.

- HT-12D has an internal oscillator and an external resistor of 33KΩ is connected between OSC1 and OSC2 (Pins 16 and 15). Pin 17 (VT) indicates a valid transmission of data and this pin will be high when a valid data is present on the data pins. An LED in series with a 330Ω resistor is connected to this pin to indicate a valid data transmission.

- Pins 10 to 13 (D8, D9, D10 and D11) of HT-12D are the parallel data out pins. They are connected to the input pins of the L293D motor driver IC (Pins 2, 7, 10 and 15 respectively).

- L293D motor driver IC is used to provide the necessary current (for both forward and reverse directions) to the motors. Pins 1 and 9 are the enable pins and are connected to VCC (+5v) along with Pin 16 (which is the logic supply). Pins 3 – 6 and 11 – 14 are the outputs and are connected to the four motors.

- Pin 8 is the Motor Supply Pin and is connected to a separate power supply. Hence, you will need two batteries in the Receiver Section; one for the Circuit and one for the motors.

- 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.

WORKING PRINCIPLE

In this project, a mobile robot that is controlled by the gestures made by the hand, is designed. The working of the robot is explained here

- As mentioned earlier, the gesture controlled robot is a wireless operated robot and has two parts: Transmitter and Receiver. When the robot is powered on, the transmitter part, which consists of Arduino, MPU6050, Encoder and RF Transmitter, will continuously monitor the MPU6050 sensor.

- This data is captured by the Arduino, which then transmits a corresponding data to the Encoder, based on the orientation of the MPU6050 Sensor. The parallel data received by the encoder is converted into serial data and this serial data is transmitted by the RF Transmitter.

- At the receiver section, the RF Receiver receives the serial data and transmits it to the Decoder IC. The Decoder will convert the serial data to parallel data and this parallel data is given to the motor driver IC. Based on the data, the movement of the motors, and hence the movement of the robot is defined.

- Gesture Controlled Robot moves according to hand movement as we place transmitter in our hand. When we tilt hand in front side robot starts to move forward and continues moving forward until next command is given.

- When we tilt hand in backward direction, Robot changes its state and starts moving in backward direction until otherwise. Similarly tilt the hand left and right side to change its direction. To stop the robot, we keep the hand in stable position.

APPLICATIONS

- 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.

CONCLUSIONS

The Gesture controlled robot designed in this work has many future scopes. The robot can be used for surveillance purpose. The robot can be applied in a wheelchair where the wheelchair can be driven by the movements of rider's hand. Wi-Fi can be used for communication instead of Bluetooth to access it from a greater distance. Some camera can be installed which can record and send data to the nearby computer or cell-phone. It can be implemented on a watch, or in any home appliances like Room heater.

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