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Final Project Report (J-Component)

HUMAN GESTURE CONTROLLED ROBOT AND ITS APPLICATION IN EARTHQUAKE DISASTER MANAGEMENT

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ABSTRACT

Earthquakes are one of the most common and fatal natural disasters that cause massive damage to human lives and property. The aftermath of the earthquakes is just as brutal as the natural calamity itself but there are still chances of saving lives if there are survivors left and they are rescued from the property ruins before something worse happens. But it is quite difficult for humans to penetrate the building ruins to get to the survivors. It is even more difficult of knowing if there are any survivors at all. We have designed a robot that can be controlled by hand gestures that can pass through the cracks and ruins and reach the survivors. This gesture-controlled robot unit can be used to monitor the inside of the ruins by attaching a camera to the robot. The robot can also be fitted with an ultrasonic distance sensor to get an estimate of the approximate positions of the survivors. Our project will comprise two units: a remote unit and a mobile robotic car unit. This mobile robotic car unit will be controlled by the remote unit through hand gestures and will enter the ruins to reach the survivors. Arduino Uno, Arduino Nano, MPU - 6050, and HC-05 Bluetooth modules will be involved to make this project.

Keywords: Earthquakes, Gesture controlled robot unit, Arduino Uno, Arduino Nano, Bluetooth Module, MPU -6050

INTRODUCTION

Robots have proved themselves to be an integral and indispensable part of everyday life. There are a vast number of robots that have been designed to perform specific tasks. The main purpose of robots is to make the lives of humans easier. That also includes sacrificing themselves to protect the lives of human beings. Their purpose is to perform dangerous, dull, and difficult tasks while ensuring that the lives of human beings are not at stake. Our project is a human gesture-controlled robot that consists of two parts: a remote unit and a mobile robotic car unit. We will be using two HC-05 Bluetooth modules in our system. First, these two Bluetooth Modules need to be configured so that they can automatically bind with each other after the power is switched on. The first Bluetooth Module will act as a slave device and will be mounted on the robotic car unit. This will receive signals from the remote unit. The other Bluetooth Module will be a master device that will act as a transmitter unit and send data to the slave device. The master device will be connected to the remote unit. We are also using the MPU – 6050 which consists of a three-axis accelerometer and a three-axis gyroscope. This will detect human movement through which we can control the direction of the robotic car unit using the remote unit. We have used L-293D Motor Driver that is used to power the stepper motors. Two wheels are attached to the stepper motors. We will be using a glove on which we will mount our remote unit. The robotic car unit will use Arduino Uno R3 as its microcontroller powered by a 9V battery. The remote unit will use Arduino Nano R3 as its microcontroller and will also contain the MPU-6050 gyro sensor. The Arduino Nano R3 will also be powered by a 9V battery. The motor driver will receive power through a power bank that will be mounted upon the robotic car unit.

The coding has been done in Arduino C which originated from C and C++ language that can work efficiently on several platforms. This software allows easy, comprehensible, and clear programming. Arduino libraries play a vital role in easier and simplified programming by providing a wider range of libraries. Most of the in-built libraries are available in this Arduino IDE software. There will be two separate codes, one code for the robotic car unit that will be uploaded in the Arduino Uno R3 and the other code will be uploaded in the Arduino Nano R3 that is mounted on the remote unit.

LITERATURE REVIEW:

Roy Chaoming Hsu, Po-Cheng Su, Jia-Le Hsu, and Chi-Yong Wang proposed a gesture and emotion-based human-to-robot interaction using the aid of a Kinect sensing device. This system was proposed for use in the elderly care sector. [1] Kishore Konda, Achim Königs, Hannes Schulz, and Dirk Schulz proposed a human-robot interaction system based on convolutional neural networks. Depth images taken up by the robot are processed and fed to the convolutional neural network which is trained to interpret and recognize hand gestures and movement. [2] Robert Codd-Downey and Michael Jenkin proposed a robotic interaction system that recognizes hand gestures underwater. Body parts of divers are recognized using a very fast RCNN model trained on the COCO dataset. [3] Jonathan Morón, Thomas DiProva, John Reaser Cochrane, In Soo Ahn, and Yufeng Lu proposed an EMG-based control system for home-based service robots. Myo wave sensor was used to amplify the EMG signal and an ANN was used to classify it. Commands were transmitted through Wi-Fi to the robot based on hand gestures and movements. [4] Ankita Saxena, Deepak Kumar Jain, and Ananya Singhal proposed an image-processing approach that can be used for hand gesture recognition in robots through android devices. Android camera captures images after which edge detection is done after which noise removal is done using thinning. [5] Controlling Mobile Robot Using IMU and EMG Sensor-Based Gesture Recognition by Seong-Og Shin; Donghan Kim; Yong-Ho Seo: In this paper, the authors propose a system that controls a mobile robot by understanding the user's gestures. in the following system, they apply a hidden Markov model (hmm) using an inertial measurement unit and a single electromyography (EMG) sensor. hmm is like a rich formula system, which can be applied to many applications including gesture recognition. hmm is not just a gesture, but it also can be applied to human-robot interaction (HRI) effectively hence, this paper uses the hmm to generate a familiar interaction between the user and a mobile robot. [6] Hand gesture-based control strategy for mobile robots by Hang Zhao; Jiangping Hu; Yuping Zhang; Hong Cheng: In this paper, we propose a hand gesture-based control design for mobile robots. mobile robots move in accord with the signals encoded by hand gestures. the gesture region is then segmented from the complicated background and those gestures can be recognized by using various techniques like image processing, image filtering processing, image contour processing, etc. [7]The research and design of a Smart mobile robotic arm based on gesture controlled by Hongli He; Yongping Dan: In this paper, the authors have proposed a design of a smart mobile robotic arm based on gesture control, which is constituted of a remote-control smart car with a robotic arm equipped on the car. The gesture recognition sensor is the Leap Motion module which uses the Processing API function on the PC to locate the position information of both hands in 3D space and convert it into various control data. [8] Controlling a remotely located robot using hand gestures in real-time: A DSP implementation by Jagdish Lal Raheja; Gadula Arun Rajsekhar; Ankit Chaudhary: This paper discusses a method of controlling a robot over the network from a distant location. A DSP board TMS320DM642EVM is used to implement image pre-processing and speeding up the system. A DSP board TMS320DM642EVM is used to implement image pre-processing and speeding up the system. A DSP board TMS320DM642EVM is used to implement image pre-processing and speeding up the system. classification information was sent over the network in the experiment. this method is powerful and could be used to control any kind of robot over a distance. [9]

Lavanya K N, Ramya Shree D, Nischitha B R, and T Asha designed a monitoring system in real-time through which human beings can interact with robots in the form of gestures. They implemented this system by navigating the robot through various gestures. This was an attempt to help improve the lives of differently-abled people. [10] U. Rajkanna, M. Mathankumar, and K. Gunasekaran designed a system that was segregated into a gesture unit and a mobile robot unit. The PIC Microcontroller which is included in the mobile remote unit involves flex sensors and XBee-S1 for reading gestures. This system was designed to provide better efficiency at a lower cost. [11] Sofiane TChoketch Kebir, Mounir Bouhedda, Slimane Mekaoui, Mohamed Guesmi, and Abderrahim Douakh have incorporated an algorithm in their project that is based on the circular Hough transform that clearly defines the desired targets. In this system, the generated control signals are sent to the robot through a Wi-fi connection to make the robot follow the desired path. Their system can be improved further by enhancing the actuator control systems and using better-resolution images. [12] S. Gokul, R. Dhiksith, S. Ajith Sundaresh, and M. Gopinath proposed a cost-effective solution that eliminates optical image sensing that was previously used in weed removal robots. They developed an automatic robot that helped in the removal of unwanted weed on agricultural fields, using gestures to control a robotic arm consisting of three axes to do the necessary deed. The arm is supposed to perform a repetitive motion with a gesture using a hand glove. [13] Robert Kristof, Valentin Ciupe, Cristian Moldovan, Inocentiu Maniu, Magdalena Banda, and Ana-Maria Stoian have proposed possibilities for controlling a mobile robot through an innovative myoelectric sensing device known as Myo. As Myo is able to interpret hand gestures, these can be used to control mobile robots. Their final objective was to enable real-time control of the robot through direct visual feedback. [14] Gesture control robot using an accelerometer by Rashmi Vashisth; Akshit Sharma; Shantanu Malhotra; Saurabh Deswal; Aman Budhraja: In this paper, the authors have designed a robot with adxl335 which is a gesture-controlled 3-axis accelerometer with an atmega16 microcontroller. The gestures are interpreted from physical movement/condition. [15]

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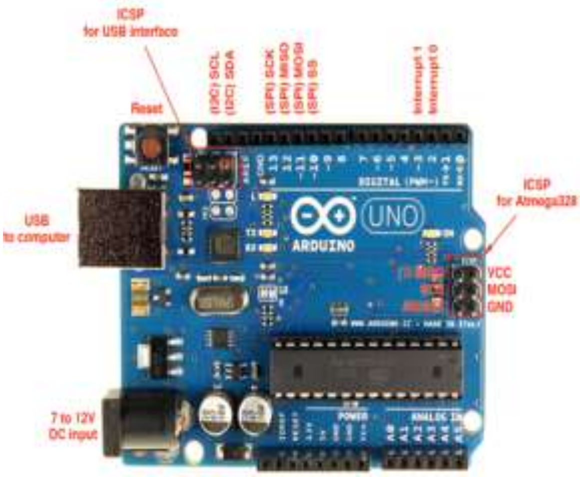
COMPONENTS REQUIRED:

1. ARDUINO UNO R3 - 1
2. ARDUINO NANO - 1
3. Car Chassis-1(plastic/wood)
4. Bluetooth module - 2
5. 9V batteries - 2
6. Power bank - 1
7. Jumper wires
8. Breadboard - 2
9. Stepper motor - 2
10. Wheels - 3
11. Gloves - 1 pair
12. Motor driver - 1 (L293D)
13. MPU6050 - 1

THEORY:

ARDUINO UNO R3

Arduino UNO R3 based on **ATmega328P** is a highly used and popular microcontroller board. It consists of 14 digital I/O pins, out of which 6 pins are utilized like PWM outputs. A USB port is present for power connection a 16Mhz frequency resonator, a button for resetting the microcontroller, and an ICSP header. Arduino UNO R3 can be programmed using the ARDUINO IDE. To power, up the Arduino, we just need to supply power to it using an AC-DC adapter or battery, and then it can be plugged into a PC using a USB B-type cable in order to program it. Arduino UNO has a lot of applications and is used in various systems like home automation, industrial automation, embedded systems, etc



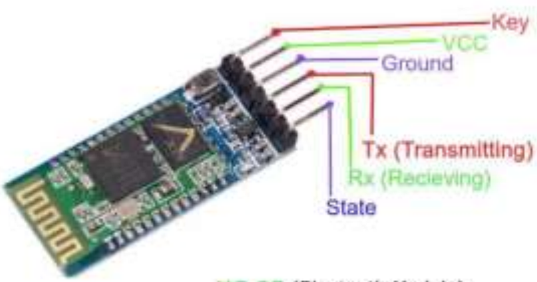
HC-05 BLUETOOTH MODULE

HC-05 is a Bluetooth module device that is used for the purpose of wireless communication. This module is generally used in the master and slave pattern or configuration
This module consists of 6 pins

1. **KEY**: If the pin is set to high (1) the module works in command mode, if set to low (0) it works in data mode.
2. **GND**: Ground pin
3. **VCC**: Power supply pin. Usually, a voltage of 5V or 3.3V is given o this pin.
4. **TXD**: Transmission of data serially is done through this pin.
5. **RXD**: Data is received serially through this pin.

6. **STATE**: Tells whether the module is connected or not.

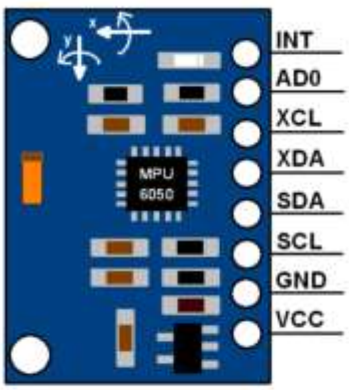
HC-05 has a humongous range of applications. It is used in headsets, game controllers, wireless mouse, wireless keyboards, etc. It uses the concept of serial communication to transmit and communicate with other devices. Communication is done through a serial port (USART).



HC-05 (Bluetooth Module)

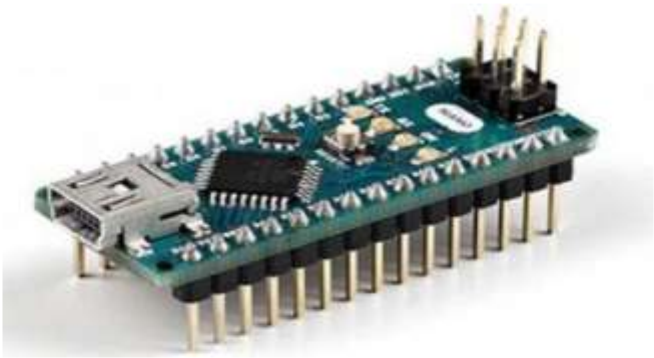
MPU - 6050:

MPU - 6050 is basically a device that uses 6 axes for the purpose of motion tracking. It consists of 3 axis gyroscope and the other 3-axis accelerometer. It also comes with an additional temperature sensor and 12C bus interface in order to communicate with microcontroller units. MPU - 6050 is also capable of 9-axis motion tracking, this is only possible if a 3-axis magnetometer is connected to the 12C auxiliary bus.

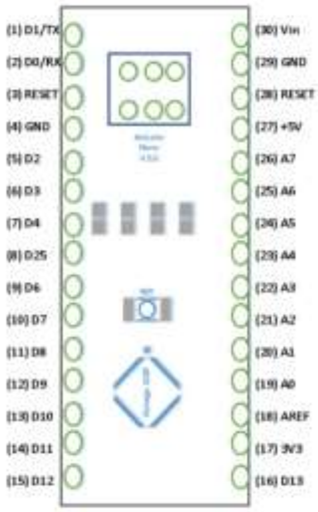


ARDUINO NANO R3:

Arduino Nano is a type of microcontroller board that is designed by Arduino. cc. Uno is built using a microcontroller like atmega328. Atmega328 is the same microcontroller that is used in Arduino UNO. It is a small-size board and is flexible with a wide variety of applications. Uno has many functions and features which are similar to Arduino duemilanove board. however, this board is different in packaging. It doesn't have any dc jack so the power supply can be given using a micro-USB port, otherwise, we can directly connect to the pins like VCC & GND. Arduino nano can be supplied with 6 to 20 volts using a mini-USB port on the board. The basic reason why it's used is because it is small, portable, and flexible with various applications. So basically, it's an Arduino Uno just ½ its size and with 8 I/O pins.



PIN DIAGRAM:



MOTOR DRIVER:

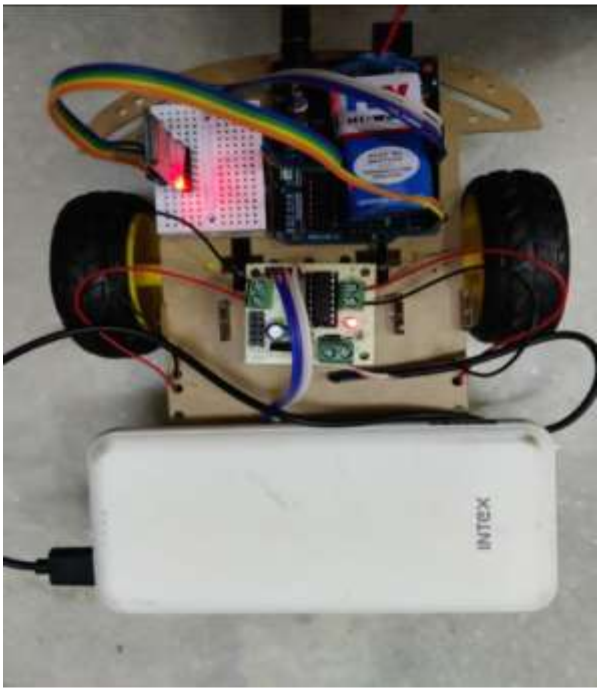
A motor driver acts as an interface between the motor and the control circuit. The motor draws a lot of current while the control circuit is working with a low-current signal. So, the function of the motor driver is to take a low current control signal and convert it to a high current signal that can drive the motor.

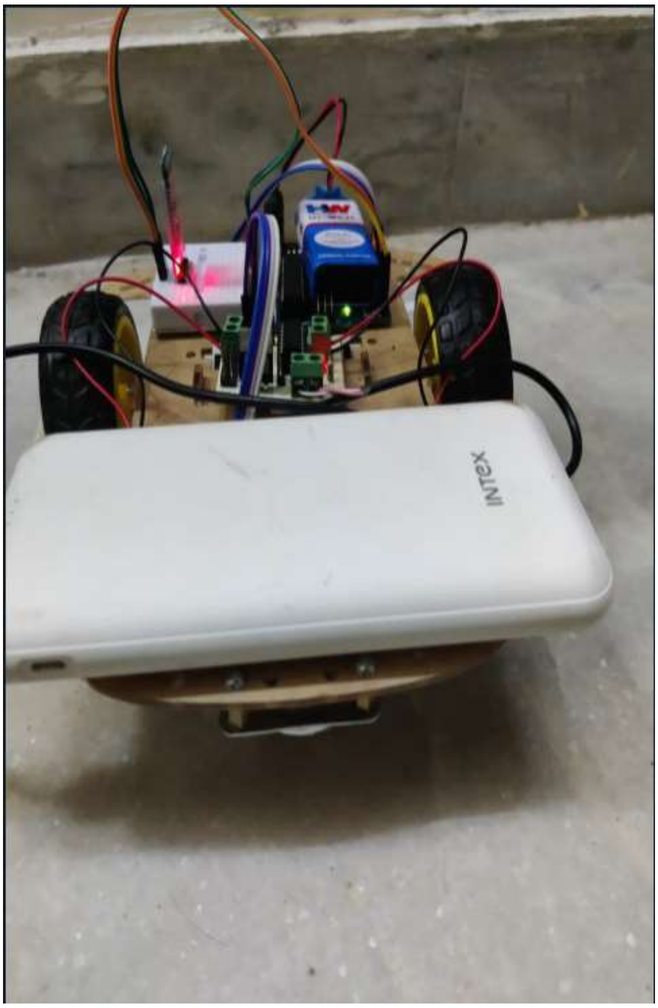
L393D ARDUINO MOTOR DRIVER

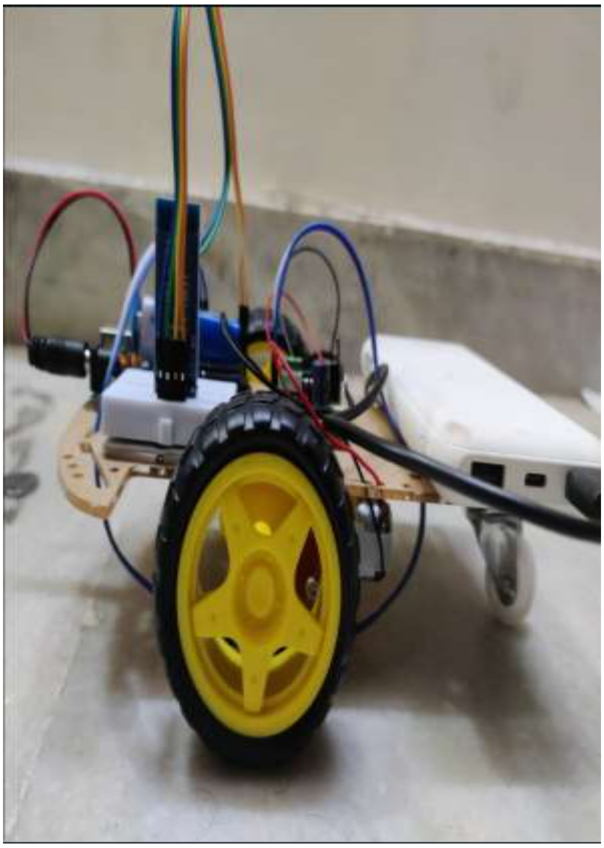
The L293D IC receives signals from the microprocessor and sends appropriate signals to the motors. There are two voltage pins, one is used to draw current to run the L293D and the other is used to apply voltage to the motor.

HARDWARE IMPLEMENTATION:

(MOBILE ROBOTIC CAR UNIT)

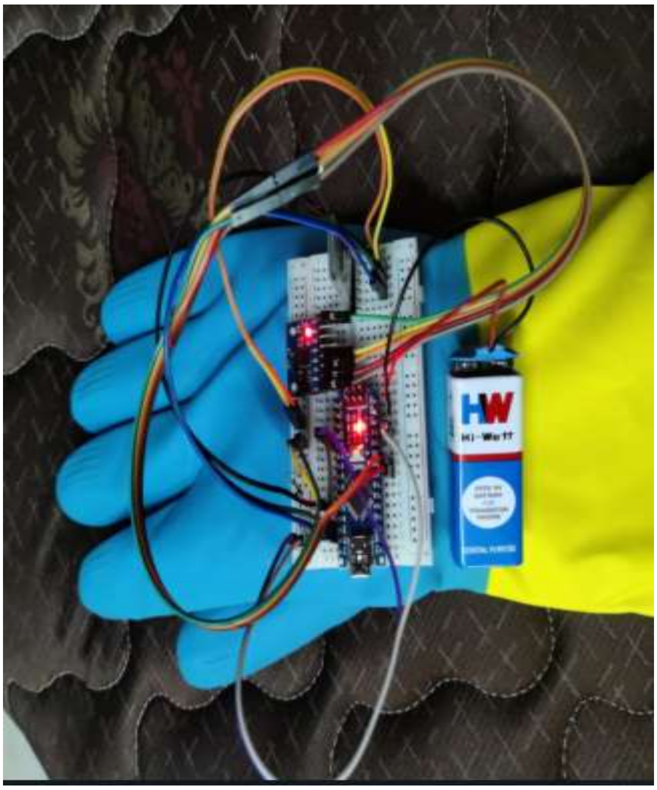






All connections are properly shown in the figure given above. We have a motor driver that powers the 2 stepper motors onto which the wheels are attached. The motor driver draws voltage from the power bank attached in front. The Bluetooth Module over here is the slave device or the receiver and the microcontroller used here is the Arduino Uno R3 which is powered by a 9V battery.

(REMOTE UNIT)



For the Remote Unit, we have the MPU – 6050 which is the gyro sensor that is used to detect motion and human movement. The microcontroller used is the Arduino Nano R3 which is being powered by a 9V battery. The Bluetooth Module connected here is the master device or the Transmitter that transmits or sends data to the receiver or slave device that is connected to the robotic car unit.

CONCLUSION AND RESULTS:

Thus, we have managed to successfully design what we had intended to do. The robotic car unit is fully functional and can move in various directions based on the movement of the hand. The Bluetooth devices are working properly even though there is a delay in the reception of the signal. The motor driver needs a lot of power to function, hence we used a power bank as 9V batteries were not enough. The MPU – 6050 allows the detection of human movement and the car unit moves in that direction. This system can be improved and enhanced further in order for it to be employed as a tool for earthquake disaster management.

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