Arduino-Based Hand Gestures Controlled Vehicle using HC 12 Transmitter & Receiver for Fire Detection

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Abstract: *In this project, a DHT11 sensor is used to combine a fire detection system with an Arduino-based hand gesture-controlled car that uses HC-12 modules. Sensors pick up hand motions, which are then wirelessly sent to the remote control via the HC-12. To find any fire threats, the fire detection system uses smoke and temperature sensors. The car is capable of real-time fire detection and autonomous navigation. For effective emergency response, this device integrates wireless communication and gesture control. It offers a creative way to keep an eye on and control areas that are prone to fire. By combining intelligent vehicle control and fire detection, the concept improves safety and provides a proactive approach to hazard management.*

Keywords: DTH11 sensor, HC-12 sensor, Arduino UNO, MPU6050.

I. Introduction

Using hand gestures, users may control an automobile with the Hand Gesture-Controlled Vehicle with Fire Detection project, which is based on Arduino. HC-12 Transceiver Modules are used in the technology to provide wireless communication between the controller and the vehicle. The car may be controlled by the controller using a gesture sensor, which can identify hand movements like forward, backward, left, and right. The vehicle's DC motors are driven by a motor driver module. The vehicle and controller also have a DHT 11 fire detection sensor, which will halt the vehicle, sound an alert, and spray water if a fire is detected. Applications that are ideal for this technology include remote vehicle control, search and rescue operations, and locations that are prone to fire.

A. Goal & Objective

To design Arduino based Hand Gestures Controlled Vehicle Using HC 12 Transmitter & Receiver for fire detection.

- To implement a wireless communication system using the HC12 module. To do literature survey.
- To study the MPU6050, DTH 11 sensor for accurate gesture detection and fire detection.

- To test the sensors individually interfacing with Arduino. To learn about how to prepare circuit connections to achieve the main goal of our project.
- To develop knowledge about writing a perfect report for the project, preparing posters and IEEE paper format.
- To improve the troubleshooting skills of electronic circuits.

B. Working of the project

In order to detect hand movements, this project uses an Arduino-based controller equipped with a gesture sensor, such as an accelerometer. These gestures are subsequently transformed into movement orders (such as forward, backward, left, and right) by the HC-12 Transceiver Module, which then wirelessly broadcasts them. The automobile receives these orders from an Arduino and motor driver, then utilizes DC motors to move in response. Additionally, the vehicle and controller are equipped with flame sensors that continuously detect the presence of fire. If the car detects a fire, it can stop or take precautionary measures. The HC-12 ensures that the vehicle and the controller are in real-time communication. This technology allows for hands-free vehicle control with integrated fire safety features.

II. Methodology

An Arduino microcontroller and an Android smartphone are used in the Gesture-Controlled Robot that was designed by Swarnika Shruti, Savita Kumari Verma, Shrishti Singh, and Tanya Gupta [1]. This cutting-edge technology can react to our requests and identify our hand signals. A camera records your hand gestures, and the current and past hand motions are compared using image processing algorithms. Through a ZigBee wireless connection, the robot will receive the proper command based on the comparison result. This method of image processing consists of three phases. Capture, signaling, and comparison. The webcam on the system is usually used to do the capture process. The use of standard hand gestures to operate a robot and carry out desired activities is covered in this study. A transmitter in the project, created by Surya Raj Sinh T. Vala [2] using Arduino, delivers impulses in response to the accelerometer's position and the user's hand gesture. These impulses are subsequently sent to the receiver, which moves the robot in the appropriate direction. The Arduino Uno (Atmega32) serves as the robot's brain. A series of codes are fed into it. The accelerometer (ADXL335) is a gadget that measures acceleration and can identify hand gestures and motions. An accelerometer, an Arduino UNO, an encoder HT12E, and an RF transmitter unit are used in the transmitter portion. The 4-bit data is sent by the receiver to the Decoder IC, which decodes it and transmits. Prof. Azhari, P F A Azis [3], MPU-6050, T I Nasution acts as a movement medium in the robot's electronic system, which is controlled by the MPU-6050 to move the robot to the right, left, up, and down. In the robot system, which consists of the MPU-6050, Motor Driver L298N, and NRF24L01, the Arduino Nano serves as a controller. The NRF24L01 acts as a conduit for communication between the hand gesture movement system and the robot system movement. In response to the signal sent by the MPU-6050 sensor, Motor Driver L298N moves. A DC motor is connected to the Motor Driver L298N, which serves as an output medium. When the MPU-6050 module sends a signal, Motor Driver L298N will tell the DC motor to move.
We discovered several similarities between our project's concept and methods and those of other models. But compared to other works, ours used fewer elements. It is thought that our project is the simplest to set up and acquire the necessary hardware, including an Arduino Uno, an MPU 6050, a DTH 11 sensor, and two HC 12 modules that are connected to the Arduino Uno and one of which functions as a transmit and the other as a receive. It is therefore thought to be the simplest, most cost-effective, and most efficient way to prevent fires by sprinkling water.

III. Block Diagram & Explanation

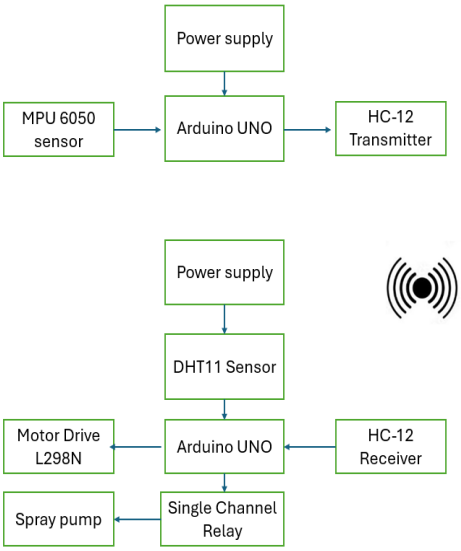

Figure 1: Block Diagram

Arduino based Hand Gestures Controlled Vehicle Using HC-12 Transmitter & Receiver for fire detection includes the following elements:

1. Arduino UNO
2. MPU6050 sensor
3. HC-12 sensor

4. DHT11 sensor
5. Buzzer
6. Motor Drive L298N
7. Single Channel Relay
8. Water Spray Pump
9. DC motor
10. Battery

IV. Circuit Diagram

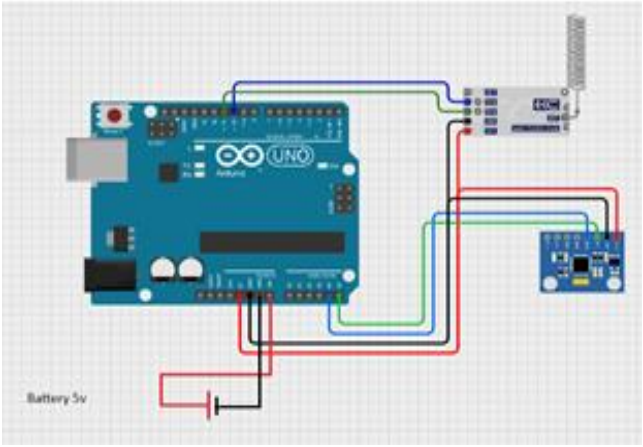

Figure 2: Circuit Diagram (Transmitter Side)

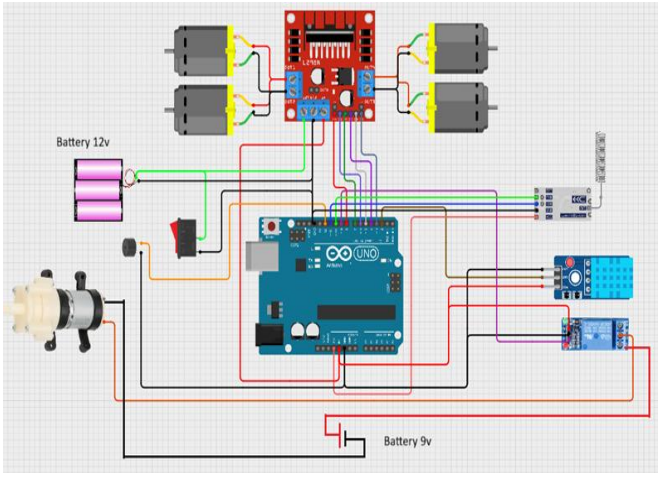

Figure 3: Circuit Diagram (Receiver Side)

The functioning of a hand gesture-controlled robot car is demonstrated by this circuit schematic, which combines transmitter and receiver components. The system uses an MPU6050 (Gyroscope and Accelerometer module) on the transmitter side to identify the direction and movement of the hands. Roll, pitch, and yaw readings are among the data that are transferred to an Arduino Uno, which uses an HC-12 module to wirelessly send the data. An additional HC-12 module on the receiving end transmits the signal to a second Arduino Uno, which interprets the data and provides the proper control commands to an L298N motor driver. With the help of this driver, the robot may move forward, backward, or pivot in response to hand movements from the user. Three different batteries power the system: one on the transmitter side powers the Arduino Uno and HC-12 module, and two on the reception side power the Arduino and HC-12 module as well as the motor driver and motors. The arrangement also contains a DHT11 Temperature & Humidity Sensor, which emits digital readings that microcontrollers can easily comprehend. A water spray pump is controlled by a single-channel relay module that receives these readings and functions as an electromechanical switch. The pump's main function is to transport or eliminate extra water, giving the system an extra environmental control element.

V. Result and Discussion

Table 1: Results

Gesture Type	*Motor Response*	*Car Direction*
Forward (Hand Up)	Both Motor Forward	Moves Forward
Left (Hand turned Left)	Left motor reverse, right motor forward	Turns Left
Right (Hand turned Right)	Right motor reverse, Left motor forward	Turns Right
Reverse (Hand Down)	Both motors Reverse	Moves Backward

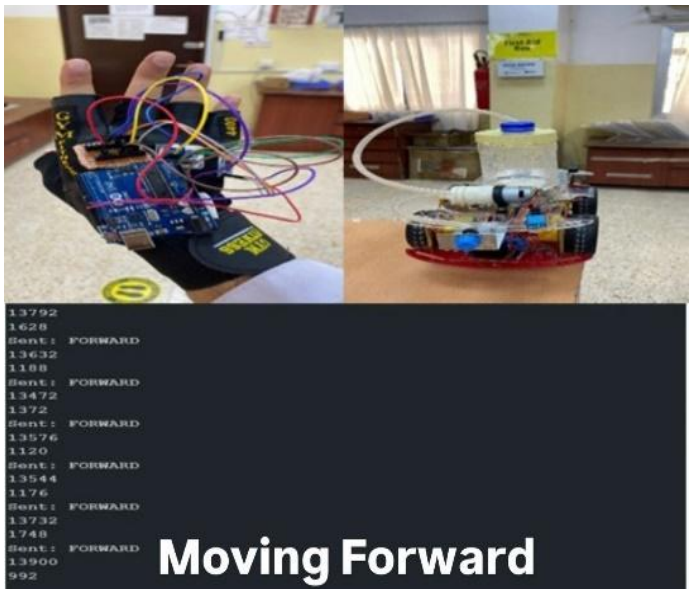

Figure 4: Vehicle Moving Forward Direction

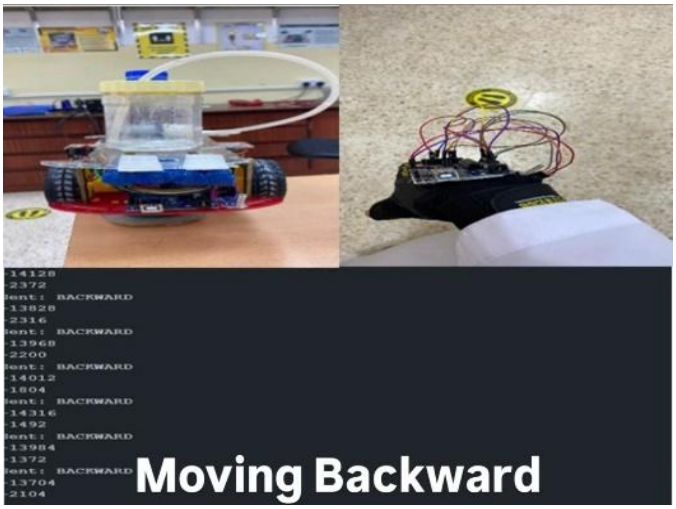

Figure 5: Vehicle Moving Backward Direction

Figure 6: Vehicle Moving Left Direction

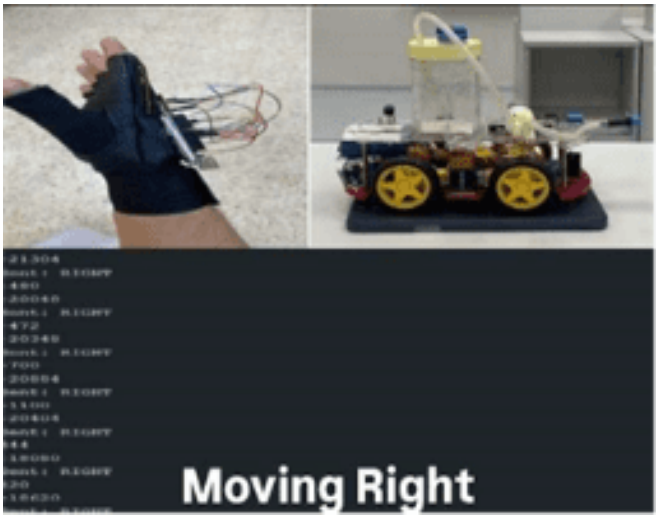

Figure 7: Vehicle Moving Right Direction

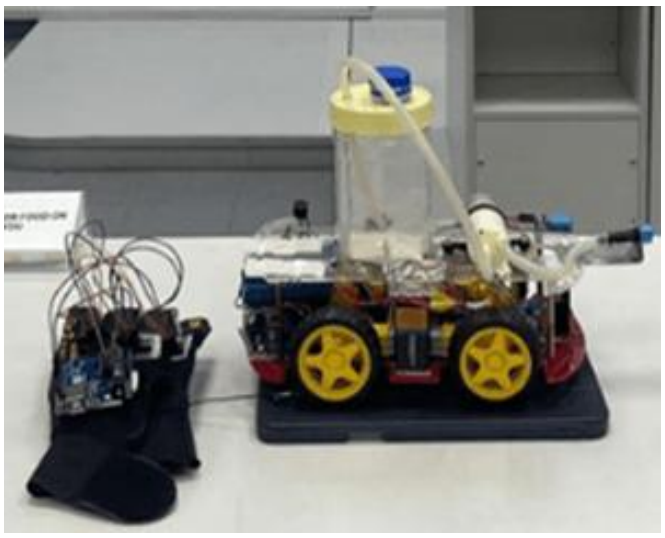

Figure 8: Final Product transmitter & receiver side

A. Discussion

Gesture Accuracy: Every testing gesture was well received by the robot. When the hand was raised upwards in the forward gesture, both motors turned in that direction, causing the robot to advance. Likewise, the robot turned left when the left motor slowed down and the right motor accelerated for the left gesture. The robot could turn right by reversing the motor speeds with the right gesture, and backward with the reverse gesture (hand pointing down). Although the gesture recognition was generally correct, there were a few minor lags or misinterpretations, particularly when the movements were made at particular angles or too quickly. These were very minor problems that might be resolved with enhanced MPU6050 sensor calibration and gesture recognition algorithm development.

Motor Response: The two DC motors were smoothly controlled by the L298N motor driver. Each direction (forward, reverse, left, and right) was accomplished accurately based on the matching hand motion, and the motors responded as anticipated. During turns, the robot demonstrated good stability by smoothly varying the speed of each motor for turns to the left and right. The robot's performance was dependable overall, but when it had to respond to a more complicated or quick motion, its motor response was a little slower. Future improvements in responsiveness might be possible by fine-tuning the motor driver and increasing the Arduino's processing speed.

System Performance: The HC-12 wireless communication module kept the transmitter and receiver Arduinos connected steadily, resulting in an overall good performance from the system. Despite the wireless transmission, the robot was able to travel in

the right direction with little delay. Although the user's hand position and the distance between the sensor and the hand may have an impact on the accuracy, the MPU6050 sensor detected hand motions with high accuracy. Better gesture filtering and smoothing algorithms could fix instances when gestures executed too quickly or with less accuracy (such as abrupt jerks or extreme angles) caused a little delay or inaccurate interpretation. Short-distance wireless communication was reliable, but occasionally misinterpretations might have occurred due to interference or signal noise. The HC-12 modules' antenna configuration can be improved, or the baud rate can be changed for more dependable transmission. The fire was located by using the buzzer to create a sound and the DHT11 to detect it.

VI. Conclusion & Future Scope

A. Conclusion

The use of an Arduino-based hand gesture-controlled car with integrated fire detection and HC-12 wireless connection shows promise as a means of improving safety and remote operation in dangerous situations. Traditional remote controllers and personal interaction are no longer necessary thanks to this system, which enables users to control the car with simple hand gestures. Fire detection sensor integration adds a crucial safety feature by facilitating early fire detection and prompt alerts, which is especially helpful during rescue operations or in areas that are prone to fire. Overall, the study demonstrates how well gesture recognition, wireless communication, and environmental monitoring can be integrated into a small, multipurpose robotic system.

B. Future Scope

AI-based gesture recognition can improve user interaction by enabling more varied and accurate hand motion detection. Real-time video input is provided by a live-streaming camera module, which facilitates navigation, particularly in dangerous or complex areas. GPS integration enables accurate tracking and navigation over wider areas, while autonomous navigation with obstacle recognition enables the vehicle to function without human input. Long-range, dependable communication is ensured via sophisticated wireless modules or mesh networks. The car can detect and put out small flames on its own by adding a fire extinguisher module. Users can remotely operate the car and view sensor data in real time via a web interface or smartphone app. Solar panel integration extends operating time in distant areas by providing a sustainable power supply. The system's safety, dependability, and general efficiency are greatly increased by these improvements, which also make it smarter, more independent, and eco-friendly.

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