UNMANNED GROUND VEHICLE WITH OBSTACLE DETECTION AND AVOIDANCE SYSTEM

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ABSTRACT
The goal of this article is to warn civilians and military people of probable terrorist attacks, particularly in military zones equipped with live detectable sensors. The two main concerns that have been highlighted in this research in terms of hardware, software, and communication settings are the design and development of a robotic car with obstacle detection and avoidance. The system was built using the Arduino platform, an Android application, and Bluetooth technologies. The design and use of a robotic automobile employing sensor programming is given in this work. This robotic device was created in collaboration with an Android-based smartphone. Arduino Uno is brain of the robot. Numerous hardware components are included in the robot which comprises a Bluetooth module, PIR sensor, ultrasonic sensor, and buzzers. An android operated mobile application was used as a computer program. The user of the robotic automobile can control the movement of the car by selecting the desired direction using a Bluetooth mobile application. The user can use his own intelligent device to control the robot's motions, or decide to put the robot in automatic mode and let it drive itself. In this way, the robot can avoid the obstruction while also detecting live object.

Keywords: *Android Devices, Robotic Car, Obstacle Detection, Bluetooth module, PIR Sensor.*

INTRODUCTION

Sensors were formerly employed with electronic equipment in a variety of applications. Energy forms are converted into electrical energy through sensors, Premkumar (2015). Ultra sonic and passive infra-red sensors (PIR) serve as links between the environment and numerous electronic equipment. Military bases, airports, factories, hospitals, and retail malls are examples of physical environments, whereas electronic devices include cellphones, robots, tablets, and smart clocks. These devices can be used to regulate, protect, photograph, and identify industrial processes in a variety of ways, Amareswar (2017). Sensors for

heat, pressure, obstacle, and human detection have all been developed as a result of technological advancements. It is feasible to create a new invention or application every day to make life easier. In this way, artificial intelligence algorithms are now used in the development of robot systems, Amir (2019). Cognitive perception happens to be the most crucial aspect of the robot. The ability of a robot to perceive its surroundings is critical to its design. Sensors, for example, can identify bombs or detect a terrorist in the combat field. A robot must be able to detect the existence of certain factors that inhibit temperature changes, understand the information, and act appropriately, Varshney (2014).

Bluetooth technology was used to establish a link between the robot and the Android handset. The incoming data will be evaluated by Arduino Uno, and robot action will be conducted based on the user's input value. The Bluetooth Android application has two major modes for controlling the robotic automobile. User control mode and automated mode are the two options, Aniket (2005). On the screen, there was a menu with buttons to pick the actions. These buttons will be used to drive the robotic car forward, backward, right, and left, as well as to stop it and switch it to automatic mode. By selecting automatic mode, the user relinquishes control of the robot, and the robot navigates itself without colliding with objects. The robot identifies and warns humans when they come into contact with living beings, Singh (2020). The robot navigates without colliding with anything, and when it comes to an impediment, it recognizes it and comes to a halt. It makes live detection with the temperature sensor at the same time issues a warning with the red LED on it.

A revolutionary vehicle that works in real time was developed in this study. Similar research has been investigated in recent years, and some of the methods and working concepts employed have been summarized. Robot for working families that could remotely monitor their children and speak with the camera was created, Pujari (2017). The robot uses Raspberry Pi 3, a camera module, Wifi, and Bluetooth technology. The heart of the Raspberry Pi was defined as the Robot, and it was coded in the Phyton language. A robotic vehicle was also created that uses microcontroller ESP 32 as the brain and the WIFI module, Mishi (2006). In this work, an Arduino Uno and a motor driver are utilized to drive a robot. The vehicle is controlled via a Bluetooth android platform and the distances between the obstruction and the robot were monitored. Robotic car was developed where data in the cloud was accessed without the need to be connected to the internet and managed by multi-motion system. It also uses sensors and Bluetooth technology to build and develop a robotic automobile, Chakraborty (2016). Communication was established between the robot and the smart device for industries keeping the ultrasonic sensor from clashing with the obstacle in the opposite direction and the

images captured by the camera on the robot were saved in a database and evaluated, Lee (2014). Autonomous robotic automobile was created with an Arduino Uno R3 as the brain, Amed (2018). Bluetooth module, ultrasonic sensor, Arduino Uno microcontroller, DC motors, a motor driver, ultrasonic sensor and a PIR sensor forms the key components in this design.

Godwin (2021) created a Raspberry Pi-controlled robotic arm. His main goal was to give the robot arm a human-like feature. The code for arm movement on the Raspberry Pi was built with Python programming language. The user manipulated the robot arm in the desired direction using the Android application. As a result, Wi-Fi connection was used to establish communication between the Android application and the Raspberry Pi. The robot arm was moved to the right and left as a result of this communication, Varma (2014). This study used a Bluetooth Android application to perform real-time obstacle identification and avoidance with a remote and autonomously controlled robotic car based on Arduino.

Road accidents are a big problem in many countries, with fast-moving cars causing the majority of collisions. Road breakers and traffic police or wardens usually control the flow of traffic to avoid collisions and accidents on the road.

This work is aimed at building a robotic vehicle that can navigate around a specific environment without colliding with impediments, to build a car that would be able to detect barriers in its path based on a predetermined threshold distance, to build a robot that would make an autonomous decision to shift its bearing to a reasonably open path, to develop a robot that would not require any external control and finally, to construct a robot that would be able to measure the distance between itself and an impediment in real time, as well as operate properly in an unfamiliar environment.

The overall idea was designed to provide a better solution to the high rate of road accidents by allowing the robot to sense the environment and avoid obstacles in its path. The wireless and autonomously operated robotic automobile that uses detectors and avoid obstacles can be used in industries to reduce human labor by preventing the robot from moving into obstacles.

MATERIALS AND METHODS

The graphic below shows a block diagram of the created robotic automobile with numerous sensors. The robotic automobile in this research has two modes: user control and automatic mode. Bluetooth technology is used to communicate between the robot and the Android mobile.

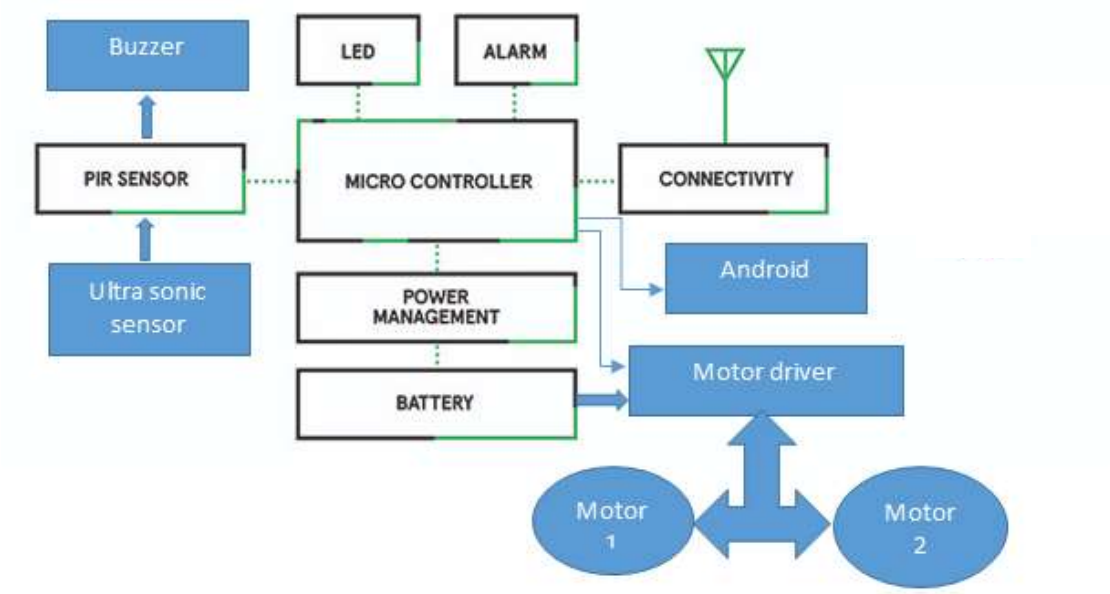

Fig 1: Block Diagram of the robotic vehicle

Arduino Uno Microcontroller Development Board

Arduino is an open source computer hardware and Software Company that creates single-board microcontrollers and microcontroller kits for making digital devices and interactive things that can sense and control objects in both the physical and digital worlds, Chakraborty (2016). A wide range of microprocessors and controllers are used in Arduino board designs. The boards have digital and analog input/output (I/O) pins that can be connected to a variety of expansion boards or breadboards.

Fig 2: Arduino Microcontroller

Bluetooth Module Hc-05

Figure 3 shows the HC-05 Bluetooth module, which allows communication between devices over a short distance of 10 to 20 meters, Varshney (2014). The Bluetooth serial communication is used to connect with Arduino universal synchronous asynchronous receiver transmitter microchip. Because the Bluetooth module can only reply to inbound connection requests, it is unable to initiate a connection with another Bluetooth module.

Fig 3: Hc-05 Bluetooth module

Buzzer Alarm Module

The buzzer is a gadget that can emit a variety of seismic waves depending on the voltage level. The buzzer's primary function is to create a sound that alerts the user to the identified circumstance. As a result, it accepts a variety of inputs and produces sound based on those inputs. The buzzer begins by converting the dc voltage from the input port into an oscillation signal has been boosted. The application of a piezo-discrete high voltage induces mechanical expansion and contraction. The inner metal plate bends in the opposite direction as a result of this action. The metal plate is twisted in the opposite direction all of the time, and the shrunk iceberg emits sound waves into the air.

Fig 4: Buzzer

Motor Driver L298

The L298 Motor Driver is a module that is designed to act as a switch, provide speed and steering mechanism for brushless direct current motor as well as meter the current driven to the motors.

Fig 5: Motor driver module

Brushless Direct Current Motor

An electric motor is a machine that transforms electrical energy into mechanical energy. When a current carrying conductor is put in a magnetic field, it experiences a mechanical force, which is the basic working principle of a DC motor. Fleming's left-hand rule determines the force's direction and F = BIL determines its magnitude. Where B denotes the magnetic flux density, I denote the current, and L is the length of the conductor within the magnetic field. Six elements make up the major components of DC motors. Windings, stator magnets, rotors, brushes, stator, and direct current source are the components. The DC motor's job in this study is to turn the wheels. To generate mechanical force, the armature is positioned in the magnetic field created by the coils and rotated using direct current.

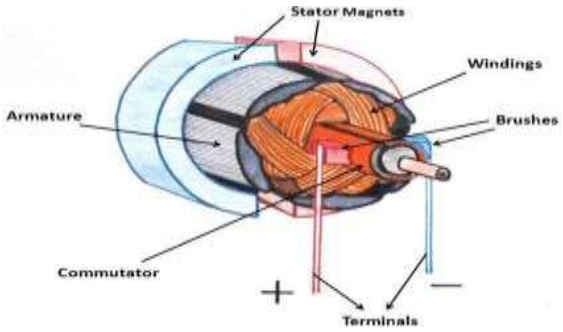

Fig 6: Dc Motor

Passive Infra-Red (PIR) Sensor

The temperature of a person can be detected using a PIR (Passive Infrared sensor). Because it does not emit any heat or energy, it is referred to as passive infrared. This signifies that the PIR sensor detects humans via infrared light. PIR cost is inexpensive, and the power consumption is minimal. Each of the two pin slots on the PIR sensor is infra-red sensitive. As a result, the sensor's visual distance is determined. When the sensor detects nothing, the infrared radiated by all items in the room is equal, and both slots are sensitive to the IR level. With the heat spread, living things such as humans enter the sensor's area of view. The temperature will

fluctuate as a result of this change and the hotness of the sensor changes if the body emits heat. As a result of this shift, the movement was observed.

Fig 7: PIR Sensor

HC-SR04 Ultrasonic sensor

The ultrasonic sensor calculates the distance to an object using Sonar (Sound Navigation and Variable). The distance between the robot and the obstacle is measured using sonar. It achieves the greatest results when measured between 20 and 400 cm. The frequencies of ultrasonic sound waves range from 20 to 500 kHz. Ultrasonic sensors emit ultrasonic sound waves and can calculate the distance between them by counting the time it takes for them to strike barriers.

Fig 8: Ultrasonic sensor

Ultrasonic sensors have a detection range of approximately to 30 meters in the right circumstances. Two transducers are used in ultrasonic sensors. One is an ultrasonic microphone, while the other is an ultrasonic speaker. The period between both the propagation of the sound wave from the ultrasonic loudspeaker and its recognition by the impediment and perception by the ultrasonic microphone is evaluated with the electrical circuits, and the spacing between the obstacle and the ultrasonic sensor is computed by dividing this time by the speed of sound.

The Robotic Car's Implementation

An Arduino Uno, HC-05 Bluetooth subsystem, Motor driver module, DC motor, Ultrasonic sensor HC-SR04, PIR sensor, buzzer, and 9V battery make up the robotic automobile. The Arduino Bluetooth application was downloaded from Google Play and installed. Bluetooth connection was established between robot and mobile device via a Bluetooth module (HC-05), allowing the root to provide

input signals. The Arduino Uno regulates incoming signals and determines which ones should be sent to the motor driver. As a result, the robot moves in a specific order based on the inputs. From their own intelligent device, the user may control the robot's basic movements, such as back and forward, right-left rotation, and robot halt motion. The operator can also put the robot in automatic mode and let it drive itself. If an obstacle is detected, the robot's red LED illuminates, the buzzer sounds an alarm, and the shortest distance to avoid the obstacle is calculated and followed. If the robot is confronted with an inanimate object, it calculates the shortest distance it can avoid and moves in a certain direction. Furthermore, when the robot reaches the edge of the cliff, it recognizes the chasm and comes to a halt.

RESULTS AND DISCUSSION

Obstacle detection and avoidance robotic car that moves around identifying and preventing objects in its path forms the basis of this work. Throughout the vehicle operation, the ultrasonic sensor sends an ultrasound wave to the front (90 degrees), right position (36 degrees), and left positions (144 degrees). When a wave hits an obstruction, it comes back, and the distance between the front, right, and left positions recorded. The microcontroller then analyzes the data using its algorithm to determine whether to proceed or change its course.

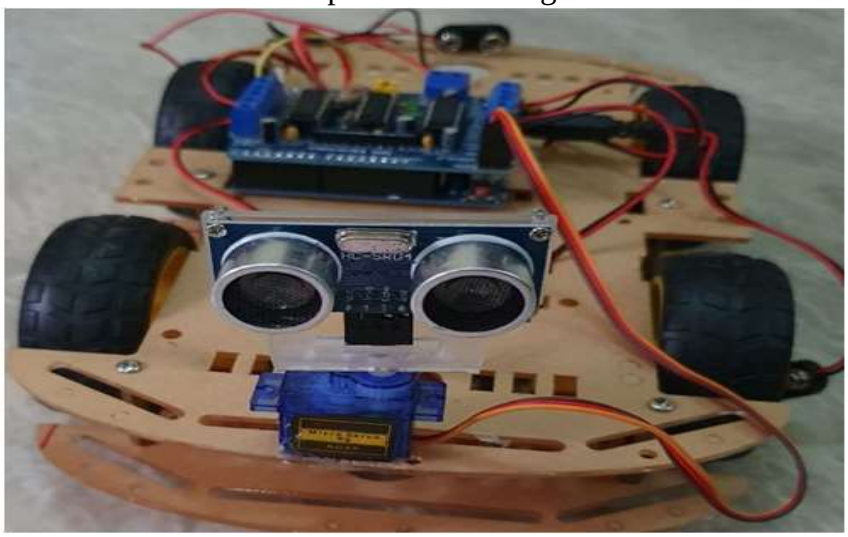

Fig 9: The implemented system

The ultrasonic sensor is a critical component in this design because the sensor's precision is crucial to the device's performance. The HY SRF04 has a 30 degree and 30m measurement range. It works by using one of its piezo-electric transducers to create a high-frequency sound wave (40 kHz) and another transducer to detect the returned pulses (echo). When impediments in the car's path were not inside this

30-degree angle, the sound waves released by the sensor could not be reached, making object detection impossible as seen in table 1. In the same scenario, the closer the obstacle is to the robot, the faster the reflection of the sound and the lower the frequency that is required to detect the impediment and vice versa.

Table 1: Distance measured between robot and obstacle

S/NO	FREQUENCY RANGE (KHZ)	ANGLE OF SENSOR (DEGREES)	DISTANCE TO IMPEDIMENT (M)
1	20	10	Out of range
2	50	20	Out of range
3	100	36	12
4	150	40	14
5	200	45	16
6	250	50	18
7	300	60	20
8	350	70	22
9	400	80	24
10	450	90	26
11	500	144	28

CONCLUSION AND RECOMMENDATIONS

The goal of this study was to create an obstacle avoidance system that could recognize and avoid obstructions in its path. The data processing portion of the Obstacle Avoidance system is programmed on the Arduino platform, and Bluetooth software counterpart assisted in communicating with the car to send parameters for guiding movement. Bluetooth Android application and the components used in this work could be used to inform the user (e.g. military personnel) about probable terrorist assaults on the field. The basic movements of the robot are given by collecting input from the Android application. The HC-SR04 ultrasonic sensor is used to keep the robot from colliding with obstacles at a height equal to the installed sensors. The ultrasonic sensor was utilized to estimate the distance between the robot's obstacles, as well as avoid obstacles in front of inanimate objects. PIR determine human simultaneous detection. In order to improve on the performance of this system, a high definition multimedia camera can be installed for image processing. Wireless technology can be added to the

current design to communicate with the car from a remote computer or operate it. A rotary encoder and an organic liquid crystal display can be installed on the wheels to calculate and specifically display the distance covered by the robot.

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