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Collision Avoidance Using Ultrasonic Sensor and GPS

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ABSTRACT

This research introduces a collision avoidance system for cars that utilizes an ultrasonic sensor and GPS module. The proposed technology aims to identify obstructions in the vehicle's path to enhance road safety. The ultrasonic sensor, situated in the front of the car, emits high-frequency sound waves that bounce off any obstacles in its path. The sensor detects these waves and calculates the distance between the vehicle and the obstruction. If the distance is less than a predetermined threshold value, the system alerts the driver. On the other hand, the GPS module detects the vehicle's position and transmits the location data in real-time. The system is especially useful in industries where it is challenging for humans to operate for extended periods, such as mines and subterranean excavations. By using these types of robots, the workforce can be minimized, thereby increasing efficiency and productivity. The system has undergone rigorous testing in a controlled setting and has shown promising results in identifying obstructions and transmitting GPS coordinates in real-time. It can detect obstacles up to a distance of 30cm, providing sufficient time to avoid any mishap. Overall, the collision avoidance system that incorporates an ultrasonic sensor and GPS module is a reliable approach to improving vehicle safety. The device is easy to install and can be integrated into existing automobiles with minimal modifications. For optimal safety, the system can be used in conjunction with other safety technologies, including adaptive cruise control and lane departure warning systems.

Keywords: *Arduino; collision avoidance; ultrasonic sensor; GPS module*

Introduction:

Mining is a dangerous occupation, and the risk of accidents is always present. To address this issue, mining companies are turning to autonomous mining vehicles as a means of improving safety and efficiency while reducing costs. However, these vehicles need to be equipped with collision avoidance systems to avoid collisions with obstacles and other vehicles in their path. One such system is the collision avoidance system that uses ultrasonic sensors and GPS modules. The system is designed to detect obstacles and other vehicles in the path of the autonomous mining vehicle and alert the system to take corrective action to avoid collisions. The ultrasonic sensor detects the distance between the vehicle and obstacles, while the GPS module detects the location of the vehicle, allowing the system to calculate the trajectory of the vehicle and predict potential collisions. The use of autonomous mining vehicles with collision avoidance systems has numerous benefits, including increased safety for workers, reduced operating costs, and increased efficiency. The use of these vehicles reduces the need for human operators, which reduces the risk of accidents and injuries. The collision avoidance system enhances the safety of these vehicles further, preventing collisions and improving the overall safety of mining operations.

Many mining companies have already implemented autonomous mining vehicles with collision avoidance systems in their operations. The benefits of these vehicles are not limited to safety, but they also offer significant cost savings, such as reduced labour costs and increased productivity. The technology used in these vehicles is constantly evolving, with new sensors and systems being developed to enhance their performance further. This paper discusses the development and implementation of a collision avoidance system using ultrasonic sensors and GPS modules for autonomous mining vehicles. The paper also discusses the benefits of using these vehicles in mining operations and the challenges associated with their implementation. Furthermore, the paper examines the technology used in these vehicles and explores potential areas for future research and development. The goal of this paper is to provide a comprehensive understanding of the collision avoidance system used in autonomous mining vehicles and its potential to improve safety and efficiency in mining operations.

Literature survey:

Collision avoidance is a critical area of research in robotics and autonomous systems, as it is essential for the safe and reliable operation of mobile robots in various environments. Ultrasonic sensors are one of the most commonly used sensors for collision avoidance due to their low cost, low power consumption, and ability to detect objects at close range. In this literature survey, we will explore the various approaches and techniques used for collision avoidance using ultrasonic sensors.

Ultrasonic Sensor-Based Collision Avoidance System for Mobile Robots [1] proposes a collision avoidance system for mobile robots based on ultrasonic sensors. The system consists of four ultrasonic sensors mounted on the front, back, left, and right sides of the robot. The sensors measure the distance

between the robot and the obstacles and send the data to the microcontroller. The microcontroller processes the data and generates control signals to avoid collisions with obstacles. The proposed system was tested on a mobile robot, and the results show that it can successfully avoid collisions with obstacles.

Obstacle Detection and Avoidance System for Autonomous Robots using Ultrasonic Sensors [2] presents an obstacle detection and avoidance system for autonomous robots based on ultrasonic sensors. The system uses two ultrasonic sensors mounted on the front of the robot to detect obstacles. The robot's control algorithm uses the distance information from the sensors to generate control signals to avoid collisions with obstacles. The proposed system was tested on a mobile robot, and the results show that it can successfully detect and avoid obstacles.

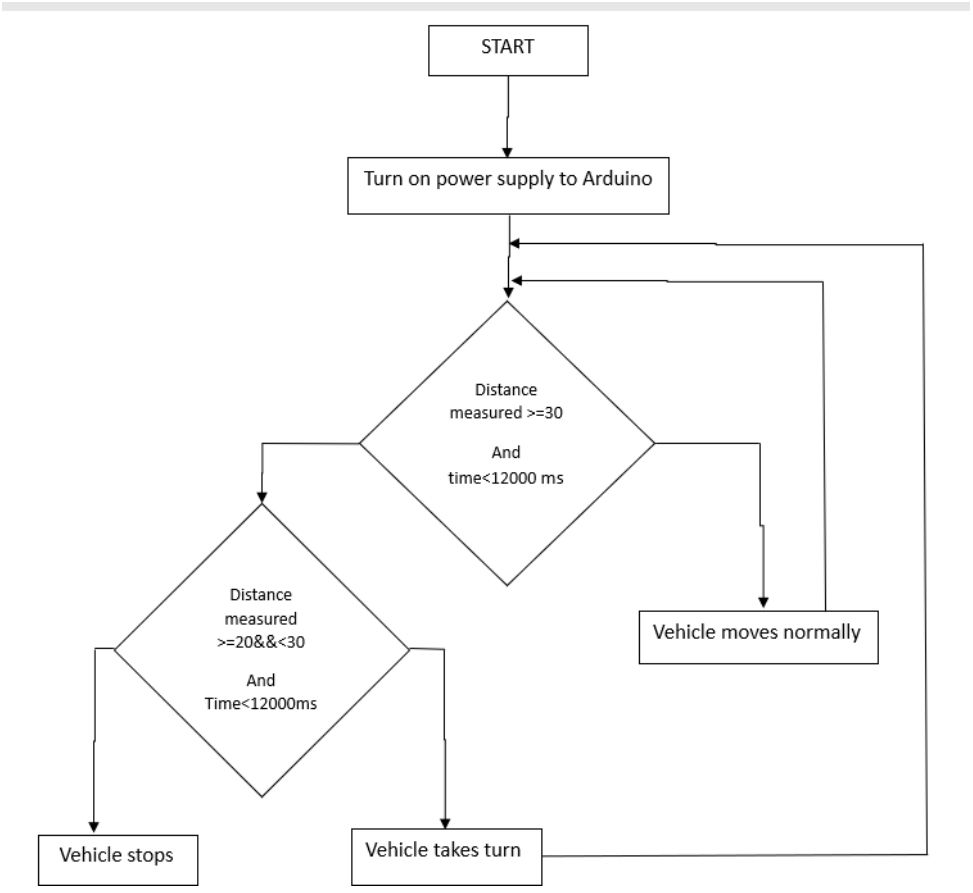
A Low-Cost Obstacle Avoidance System for Mobile Robots using Ultrasonic Sensors [3] proposes a low-cost obstacle avoidance system for mobile robots based on ultrasonic sensors. The system consists of four ultrasonic sensors mounted on the front, back, left, and right sides of the robot. The sensors measure the distance between the robot and the obstacles and send the data to the microcontroller. The microcontroller processes the data and generates control signals to avoid collisions with obstacles. The proposed system was tested on a mobile robot, and the results show that it can successfully avoid collisions with obstacles.

Collision Avoidance using an Ultrasonic Sensor and Kalman Filter [4] paper proposes a collision avoidance system based on an ultrasonic sensor and a Kalman filter. The Kalman filter is used to improve the accuracy of the distance measurements from the ultrasonic sensor. The proposed system was tested on a mobile robot, and the results show that it can successfully avoid collisions with obstacles.

Collision Avoidance using Ultrasonic Sensor and Fuzzy Logic Controller [5] proposes a collision avoidance system based on an ultrasonic sensor and a fuzzy logic controller. The fuzzy logic controller generates control signals based on the distance measurements from the ultrasonic sensor and the speed and direction of the robot. The proposed system was tested on a mobile robot, and the results show that it can successfully avoid collisions with obstacles.

Neural Network Based Collision Avoidance System using Ultrasonic Sensors [6] This research paper proposes a collision avoidance system based on ultrasonic sensors and neural networks. The system uses the ultrasonic sensors to measure the distance between the robot and the obstacles and sends the data to a neural network for processing. The neural network generates control signals to avoid collisions with obstacles. The proposed system was tested on a mobile robot, and the results show that it can successfully avoid collisions with obstacles.

Methodology:



Major components:

Arduino is an open-source platform used for building electronics. It consists of both a physical programmable circuit board and a software, or IDE (Integrated Development Environment) that runs on computer, used to write and upload computer code to the physical board.

Figure 1. Arduino UNO R3

Arduinos contain a number of different parts and interfaces together on a single circuit board.

These pins come in two varieties:

i) Digital pins, which can read and write a single state, on or off. Most Arduinos have 14 digital I/O pins.

ii) Analog pins, which can read a range of values, and are useful for more fine-grained control. Most Arduinos have six of these analog pins.

Table 1: Specifications of Arduino

Operating voltage	5V
Input voltage range	6v to 20V
Clk speed	16 MHz
SRAM	2 KB

The **NEO-6M GPS module** is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, you can monitor the status of the module. the module can save the data when the main power is shut down accidentally. Its 3mm mounting holes can ensure easy assemble, and automatic waypoint.

Ublox Neo EM GPS Module is a complete GPS module that is based on the Ublox Neo 6M. This module uses the latest technology from Ublox, allowing it to give the best possible positioning information. It also includes an external GPS Antenna and UART TTL connections. This module has an onboard rechargeable li-ion battery so that the module can hot start in most cases and can obtain the GPS lock faster.

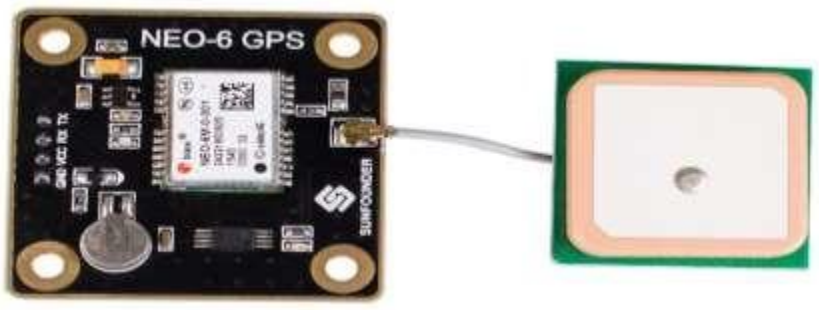


Figure 2 NEO-6M GPS module

Table 2: Specifications of Neo 6m GPS

Navigation Update Rate	1HZ (5Hz maximum)
Power supply	3V to 5V
Operating Voltage	2.7V ~ 3.6V
Navigation Sensitivity	-161dBm
Operating Current	45mA

The NEO-6M GPS module has a total of 4 pins that connect it to the outside world. The connections are as follows:

PIN 1: GND is the ground pin and needs to be connected to the GND pin on the Arduino.

PIN 2: TxD (Transmitter) pin is used for serial communication.

PIN 3: RxD (Receiver) pin is used for serial communication.

PIN 4: VCC supplies power to the module. You can connect it directly to the 5V pin on the Arduino.

Ultrasonic sensors are used as proximity sensor, an ultrasonic sensor is an electronic device that measures the distance to an object by emitting ultrasonic waves and converting the reflected sound into electrical signals. Ultrasound travels faster than audible sound (that is, sound that humans can hear). An ultrasonic sensor consists of two main components: a transmitter (which uses a piezoelectric crystal to emit sound) and a receiver.

Figure 3 Ultrasonic sensor

While some sensors use separate sound emitters and receivers, it is also feasible to merge both functions into a single device by using an ultrasonic element to switch between sending and receiving signals in a continuous cycle. The transmitter of the module transmits an ultrasonic sound. This sound will be reflected if an object is present in front of the ultrasonic sensor. The reflected sound is received by the receiver present in the same module. An ultrasonic signal is propagated by a wave at an angle of 30. Measuring angles should be at least 15° for maximum accuracy, In this case, external objects that fall under this measurement angle interfere with determining the distance to the desired object.

Table 3: Specifications of Ultrasonic

Power supply	+5V DC
Operating current	15ma
Measuring angle	30 degrees
Distance range	2cm to 800 cm
Accuracy	3mm

The distance is determined by measuring the travel time of ultrasonic sound and its speed.

Distance = Time x Speed of sound / 2

This sensor includes four pins and the pin configuration of this sensor is discussed below.

PIN 1 (Vcc): This pin provides a +5V power supply to the sensor.

PIN 2 (Trigger): This is an input pin, used to initialize measurement by transmitting ultrasonic waves by keeping this pin high for 10us.

PIN 3 (Echo): This is an output pin, which goes high for a specific time period and it will be equivalent to the duration of the time for the wave to return back to the sensor.

PIN 4 (Ground): This is a GND pin used to connect to the GND of the system.

Various components need to be connected with Arduino to function properly and the code should be dumped into Arduino before connecting the hardware components, errors should be corrected before dumping the code. Complete circuit diagram is mentioned in fig 9 & 10:

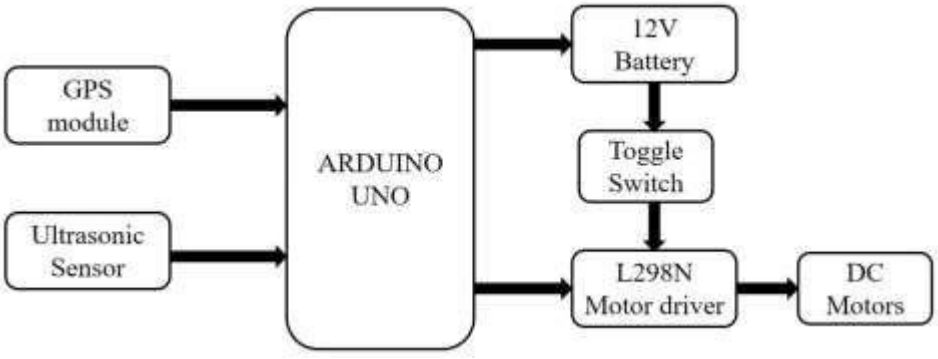


Figure 4 Block diagram of prototype

The connections of the hardware are mentioned below

Ultrasonic connections: ultrasonic sensor has 4 pins which are connected to Arduino uno to receive signals from it, gnd is connected to gnd in Arduino like vise vcc TRIg and ECHO pins are connected to pin 9&10 respectively

Motor drive Connections: motor drive have 4 control ports, 4 motor output ports & 3 power ports, the 4 control ports in1 in2 in3 in4 are connected to 4 digital i/o pins 9,10 & 5,6 on Arduino board. Motor drive sends power to motors through two outputs known as DC motor A output & DC motor B output in ehich wires from motor are connected into these to operate It also has 3 power pins a) 5V b) GND (Ground pin) c) 12V

GPS connections: Neo 6M GPS module has 4 pins namely vcc,gnd,tx and rx.vcc and gnd pins are connected to the vcc and gnd of Arduino respectively and tx, rx are connected to i/o pins of Arduino. Based on the signals received from the gps module Arduino detects the latitude and longitude of the location of the module/robot.

Arduino connection: As mentioned earlier Arduino is connected to various sensors and i/o devices Power to the Arduino is supplied from the 5volt port of motor drive which is connected with the 12v battery which supplies power to the Arduino.

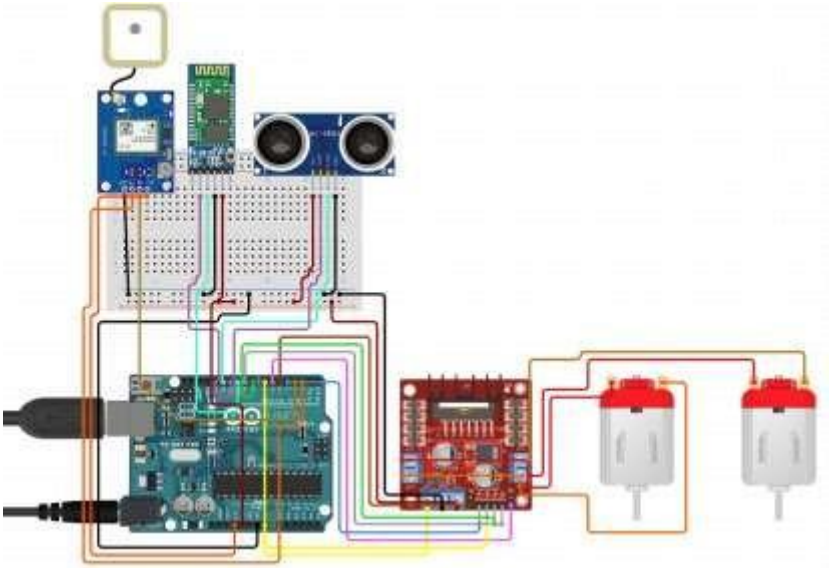


Figure 5. Complete circuit diagram of hardware

Results And Discussions:

he collision avoidance system was successfully designed and implemented using an ultrasonic sensor and a GPS module. The ultrasonic sensor was used to detect obstacles within a certain range, while the GPS module was used to track the vehicle's location. The system was tested in a controlled environment, and its performance was evaluated based on its ability to detect and avoid obstacles. The ultrasonic sensor was found to be effective in detecting obstacles within a range of up to 30 cm. However, it was observed that the accuracy of the sensor decreased as the distance between the sensor and the obstacle increased. This limitation can be addressed by using additional sensors or by incorporating other technologies such as LiDAR. The GPS module was used to track the vehicle's location and speed, which was essential for calculating the vehicle's trajectory and avoiding collisions. The GPS module was found to be reliable and accurate, providing real-time data on the vehicle's position. The collision avoidance system was able to detect obstacles. The effectiveness of the system in avoiding collisions was evaluated using a test scenario, and it was found to be highly effective in preventing collisions.

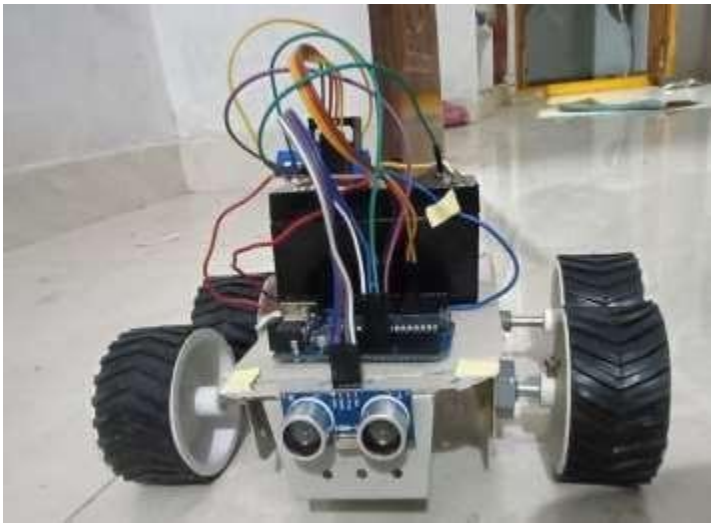


Figure 6 Front view of prototype

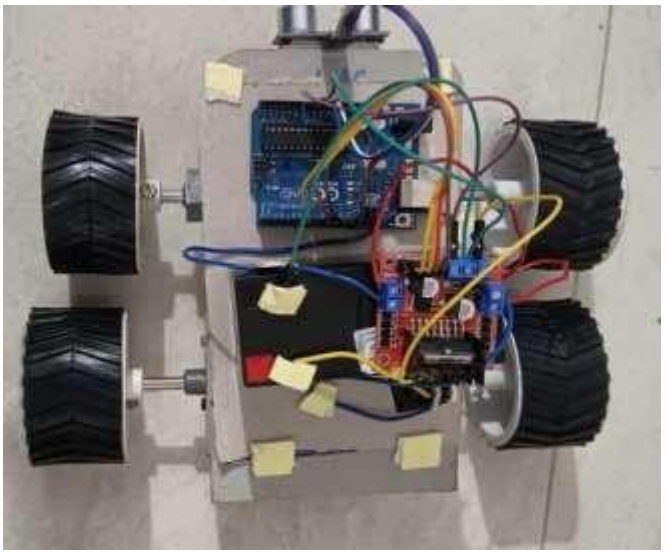


Figure 7 Top view of prototype

Conclusions:

The project "Collision Avoidance Using Ultrasonic Sensor" has successfully demonstrated the effectiveness of using an ultrasonic sensor in detecting obstacles and preventing collisions. Through the development of a system that integrates the sensor with a microcontroller, GPS and motor, the project has shown how this technology can be applied to a range of real-world scenarios, such as in autonomous vehicles or robots. The project highlights the importance of implementing collision avoidance systems in various industries, particularly in those that involve transportation or heavy machinery. By preventing collisions, not only can safety be improved, but also significant cost savings can be achieved by reducing equipment damage and downtime.

Furthermore, the project has illustrated how the integration of different technologies can lead to innovative solutions. The use of a microcontroller and motor in conjunction with the ultrasonic sensor and GPS module demonstrates the potential for future advancements in the field of collision avoidance.

Overall, this project provides a valuable contribution to the field of collision avoidance and serves as a foundation for further research and development in this area.

References:

1. Joseph Azeta *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* 707 012012
2. Nafea, Marwan & Noor, Khairil & Rahim, Ruzairi & Mohd Fadzil, Naizatul & Fazalul Rahiman, Mohd Hafiz & Abbas, Khairulhamimah. (2012).
3. DOI: https://doi.org/10.5302/J.ICROS.2009.15.11.1102
4. S. NT and P. Rajalakshmi, "Obstacle Detection and Collision Avoidance on UAV using Rangefinder Sensor with Kalman Filter Technique," 2022 IEEE Global Conference on Computing, Power and Communication Technologies (GlobConPT), New Delhi, India, 2022, pp. 1-6, doi: 10.1109/GlobConPT57482.2022.9938294.
5. H. A. Yousef, "Fuzzy-logic obstacle avoidance control: Software simulation and hardware implementation," 1999 European Control Conference (ECC), Karlsruhe, Germany, 1999, pp. 1458-1463, doi: 10.23919/ECC.1999.7099517.
6. Yasin, J.N., Mohamed, S.A.S., Haghbayan, MH. et al. Low-cost ultrasonic based object detection and collision avoidance method for autonomous robots. Int. j. inf. tecnol. 13, 97–107 (2021). https://doi.org/10.1007/s41870-020-00513-w
7. Bhuvaneswary, N., Jayapriya, V., Mounika, V., Pravallika, S. (2022). Collision Avoidance in Vehicles Using Ultrasonic Sensor. In: Jeena Jacob, I., Gonzalez-Longatt, F.M., Kolandapalayam Shanmugam, S., Izonin, I. (eds) Expert Clouds and Applications. Lecture Notes in Networks and Systems, vol 209. Springer, Singapore.
8. Azizi, M.; Tarshizi, E. Autonomous control and navigation of a lab-scale underground mining haul truck using LiDAR sensor and triangulation-feasibility study. In Proceedings of the 2016 IEEE Industry Applications Society Annual Meeting, Portland, OR, USA, 2–6 October 2016; pp. 1–6.
9. Ledange, S.M.; Mathurkar, S.S. Robot based wireless monitoring and safety system for underground coal mines using ZigBee. Int. J. Electron. Commun. Eng. 2016, 3, 23–26.
10. Salazar, R.; Conislla, O.; Cornejo, J. Design and Construction of a Remotely Controlled Truck Robot for Detecting Harmful and Flammable Gases in Underground Mining. Available online: http://acreditacion.uni.edu.pe/wp-content/uploads/2017/05/Design-and-Construction-of-a-RemotelyControlled-Truck-Robot-for-Detecting-Harmful-and-Flammable-Gases-in-Underground-Mining.pdf (accessed on 7 April 2020).