EEJOURNALS OPEN ACCESS
EURASIAN EXPERIMENT JOURNAL OF ENGINEERING (EEJE) ISSN: 2992-409X
©EEJE Publications Volume 4 Issue 1 2023

Design and Implementation of a Four-Dimensional Automatic Accident Avoidance System

Rwotolara Daniel

Faculty of Engineering and Applied Sciences Kampala International University Western Campus Uganda.

ABSTRACT

When you think of work-related safety hazards, you probably think about what goes on inside the workplace. But one of the greatest threats to your safety was not in the workplace, but rather on the road. In this study, we have designed an effective way of automatically avoiding accidents. The process includes; mechanical construction of the robotic vehicle model followed by circuit connection and programming of the microcontroller. Mechanical construction represents the process of assembling the chassis to form a vehicle, circuit connection includes the circuit design of the circuit system and programming can simply mean setting and determining the logical operation of the system. The system was fabricated with a robotic vehicle. The robotic vehicle model was fitted with appropriate wheels to enable its movement; the DC motors were also adjusted and mounted close to the wheels to transmit mechanical power to the wheels using a transmission shaft connecting the motors to the wheels. The sensors were mounted on the right, left and the fore-end Centre of the robot vehicle. The 18 volts DC battery powers the system and was firmly fixed in a battery holder which was then mounted on the robotic vehicle to avoid quaking which may cause some anomalies during operation. The system consists of a power supply of 12v DC that has to power the DC motors, we regulated the 12v DC power to 5v which is the voltage level needed for powering the microcontroller, sensors and buzzer, on powering the system, and the operation starts with a forward movement if there was no obstacle in front. The system turns left or right depending on the free path. Ultrasonic sensors emit the sound energy (waves) in a parallel manner, So, actually, the system senses any obstacles that are on the four sides of the car and not on the vertices. Upon detection of an obstacle which happens at a distance of 50 centimetres, the system takes a negligible amount of time to react, that was to say, braking and turning. And 25 centimetres majorly depends on the microcontroller processing speed and the motors' precision.

Keywords: Accident, Robotic vehicle, Road, 12v DC power, Circuit system and programming.

INTRODUCTION

Human lives can be saved from an accident by detecting an accident before it occurs. But this needs advanced accurate human detection and also accident detection capability. At present, there are several works regarding pre-crash detection & avoidance system from obstacles. But are lacking to prioritize crashes with humans or animals compared to obstacles. What would be the situation when a system has to choose between humans and obstacles? If the system is unable to detect humans, then there is a probability to hit humans instead of obstacles. To solve this problem in this work we have to prioritize humans or animals first. The car will avoid humans or animals first then if possible it will try to avoid obstacles also. For many years robotic systems have been widely used for industrial production and in warehouses, where a controlled environment can be guaranteed. In agriculture and forestry, research into driverless vehicles has been a vision initiated in the early 1960s with basic Research on projects on automatic steered systems and autonomous tractors. Recently, the development of robotic systems has experienced an increased interest, which has led many experts to explore the possibilities to develop more rational and adaptable

vehicles based on a behavioural approach. A combined application of new sensor systems, communication technologies, positioning systems (GPS) and geographical information systems (GIS) have enabled researchers to develop new autonomous vehicles.

Statement of Problem

According to the [1-3], road traffic deaths would become the fifth leading cause of death. The report showed that there had been no overall reduction in the number of people killed on the world's roads: about 1.24 million deaths occur annually. Among them cyclists, motorcyclists, car occupants & unspecified road users are high. The number of animals that die in road accidents is also very bad. Therefore, we came up with a system that would automatically avoid collision-related accidents by detecting obstacles from all sides of the car and then it reduces its speed or stops upon detection.

Aim

The main aim of this project is to design and implement a four-dimensional automatic accident avoidance system.

Specific Objectives

- To design an ultrasonic and passive infrared ray (PIR) sensing module.
- To be able to gradually reduce the speed of the wheels upon detection of an obstacle and consequently the robotic vehicle's speed.
- To program a microcontroller such that it processes signals from the sensing module and controls the turning, and stopping of the robotic vehicle accordingly.
- To test and validate the prototype.

Research Questions

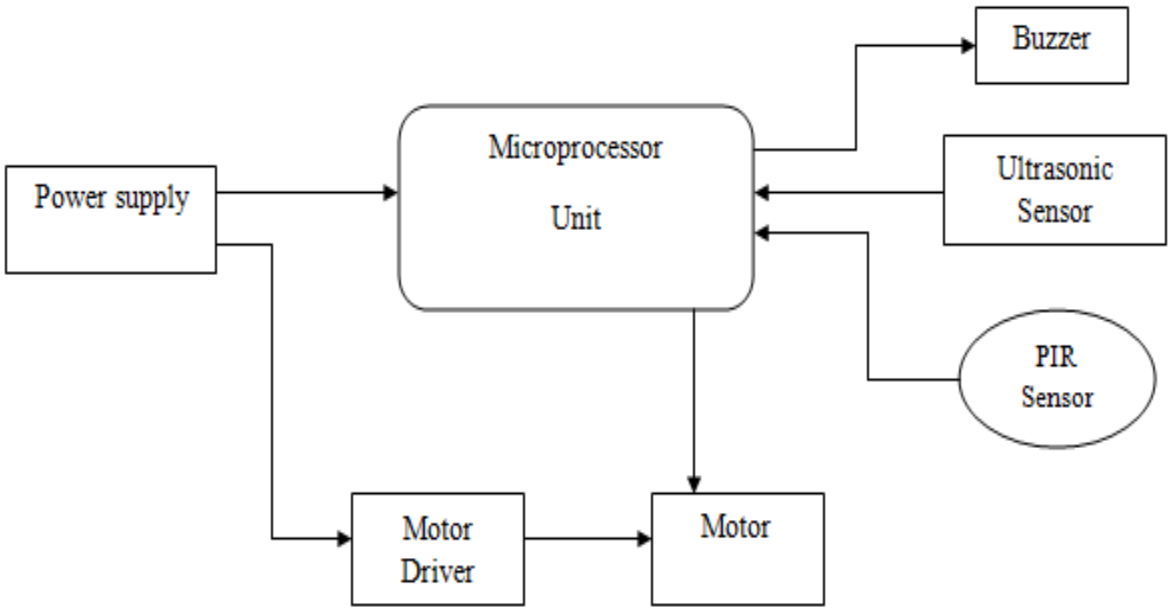
I. How can the speed be gradually reduced on the wheels upon detection of an obstacle and consequently the robotic vehicle's speed?
II. Can program a microcontroller such that it processes signals from the sensing module and controls the turning, and stopping of the robotic vehicle accordingly to reduce the speed?
III. Does designing an ultrasonic and passive infrared ray (PIR) sensing module reduce the speed?

Significance of the Project

This "Four-dimensional Automatic Accident Avoidance System" it is an easily maintainable system that can solve the problem of road accidents caused by automobiles. It eases driving and the system can be improved to make self-driving cars (driverless) even more reliable.

METHODOLOGY

Block diagram of the four-dimensional automatic accident avoidance systems
Figure 1



The power supply section

As shown in the block diagram above, the entire system is powered by a DC power source of 18 volts which can be regulated according to the required power supply voltage of the microcontroller, sensor modules, motors and buzzer. Power regulators, this is a component that is used to step down the voltage to a desired level for example in this project we are stepping down from 12V to 5V.

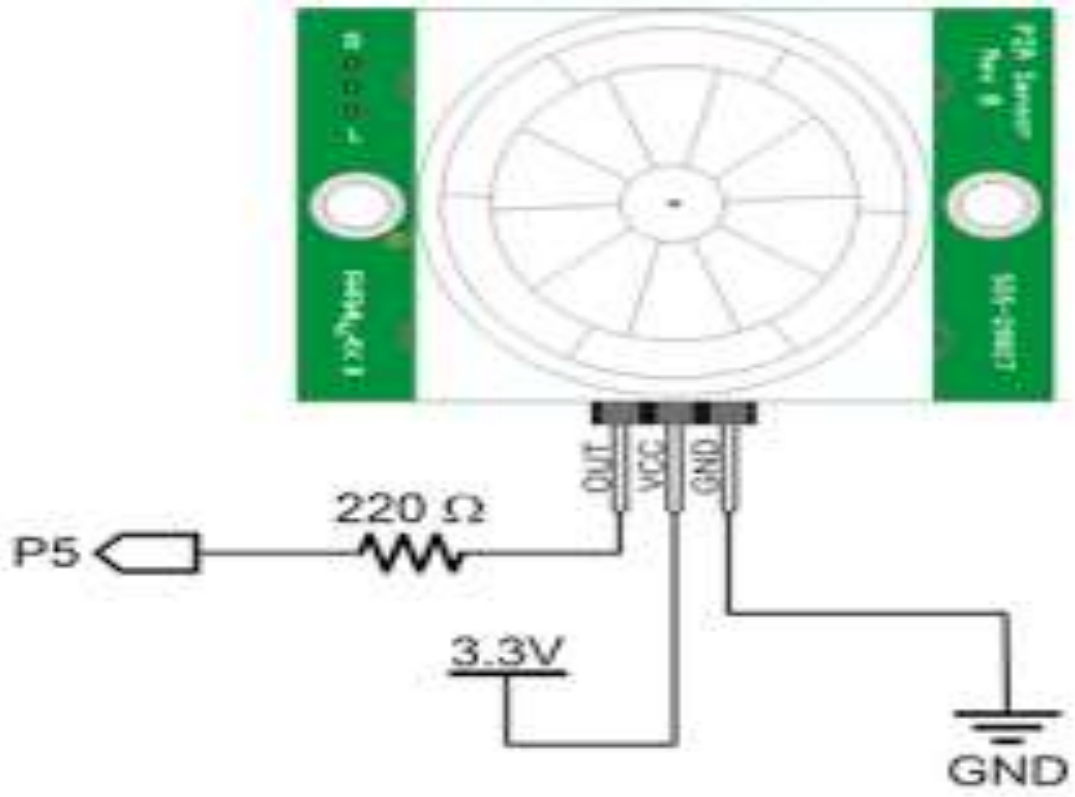
Sensing section

The sensing section comprises of an ultrasonic and PIR (passive infrared ray). The ultrasonic sensor outputs appropriate signals to the microcontroller on detecting humans or other animals and then the speed of the vehicle is reduced gradually until it stops in case it's a human obstacle or it will turn left or right depending on the free path available.

Figure 2

From the diagram above, pin 1 (Vcc) is connected to 5V of the positive voltage for power.
Pin 2 (Trigger) is where a pulse is sent for the sensor to go into ranging mode for object detection
Pin 3 (Echo) This sends a signal back if an object has been detected or not. If a signal is returned, an object has been detected. If not, no object has been detected.
Pin 4 (GND) completes the electrical pathway of the power.

Figure 3: Pin diagram for a PIR sensor



From the diagram above, pin 1 which is the output was connected to the microcontroller input pin through a 220Ω resistor, therefore in case a human obstacle is detected this pin outputs that signal to the microcontroller. Pin 2 (Vcc) is connected to 3.3V of the positive voltage for power.

Pin 3 (GND) This completes the electrical pathway of the power

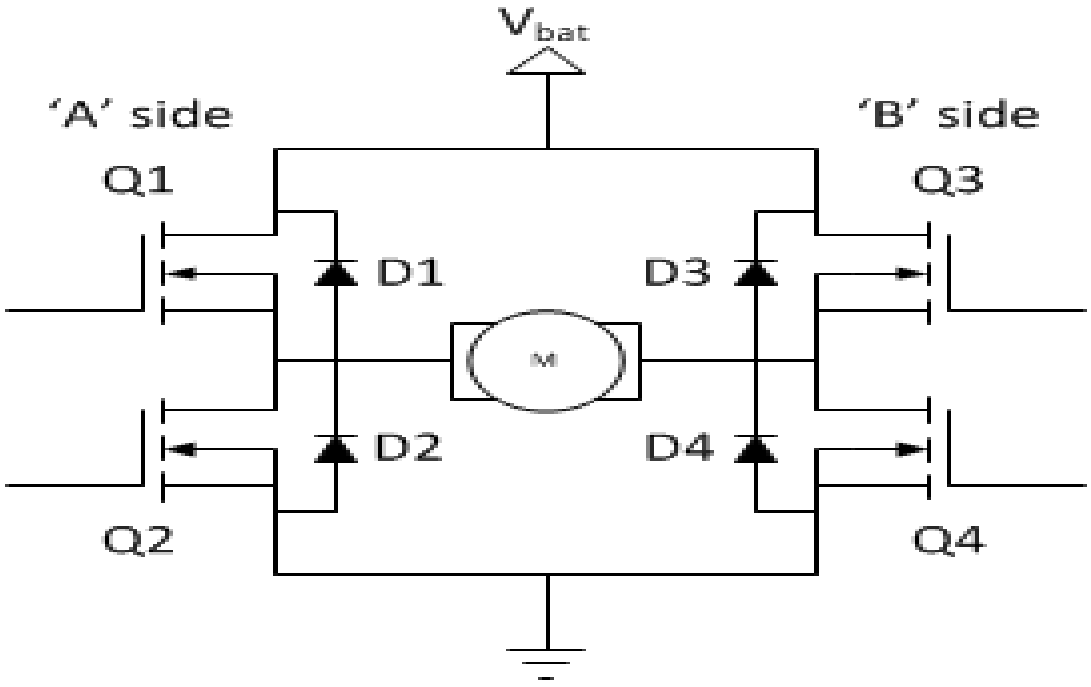
Alerting section

This consists of a buzzer that outputs a sound after receiving signals from the microcontroller about the presence of a human being in front of the vehicle.

Driving system section

The driving system section majorly comprises the motors and the motor driver, the microcontroller outputs an appropriate signal to the motor driver which then drives the motors which causes the wheels to rotate hence movement.

Figure 4: Diagram showing the motor driver circuit



Processing section

The ATmega328P microcontroller is "the brain of this system", in C programming language we wrote an appropriate program and by using tools like a Launchpad we launched the program on the microcontroller chip. The microcontroller and the motor driver circuit were properly soldered on a printed circuit board which was then fixed in the robotic vehicle model to control its movement [4].

Working principle

As seen from the block diagram, the system uses ultrasonic sensors that work by sending sound waves to detect obstacles and determine the distance as the sound bounces back. The system also uses PIR (Passive Infrared Ray) which converts infrared energy into signal voltage in order to detect humans or other animals by the fact that all bodies above the temperature of absolute zero radiate infrared energy information of heat [5]. The system has a switch to start and stop its operation. To start, the switch is put to its on-position and it starts moving forward in a straight manner, until it detects an obstacle from a predetermined distance to the obstacle and the speed of the car starts to reduce drastically and then brakes are applied [6-8]. The fore-end Centre sensor generates a signal which is input to the microcontroller, the output from the microcontroller is taken to the motor driver circuit which prompts it to turn left or right depending on the free space available in front of it. On detecting any obstacles by using the sensors, it moves towards left or right depending on the sensor detecting (right or left) respectively. The DC motors rotate in one direction when the power is supplied to its terminal. However [9], if the power is supplied into the reverse polarity, the robot vehicle will move in the opposite direction. The driving system in the project is a differential driving system. In this system, the wheels are rotated at different speeds resulting in the robot turning right or left. That is why it is called Differential Drive. For example, the robot will turn right if the left wheel rotates faster than the right way [10].

RESULTS

Design

The system has a switch to start and stop its operation. To start, the switch is put to its on-position and it starts moving forward in a straight manner, until it detects an obstacle from a predetermined distance to the obstacle and the speed of the car starts to reduce drastically and then brakes are applied [8]. The fore-end Centre sensor generates a signal which is input to the microcontroller, the output from the microcontroller is taken to the motor driver circuit which prompts it to turn left or right depending on the free space available in front of it. On detecting

any obstacles by using the sensors, it moves towards left or right depending on the sensor detecting (right or left) respectively [11-14]. The DC motors rotate in one direction when the power is supplied to its terminal. However, if the power is supplied into the reverse polarity, the robot vehicle will move in the opposite direction. The driving system in the project is a differential driving system. In this system, the wheels are rotated at different speeds resulting in the robot turning right or left. That is why it is called Differential Drive. For example, the robot will turn right if the left wheel rotates faster than the right wheel.

DISCUSSION

CONCLUSION

Through programming the microcontroller, and circuit designing for the control circuit, different tests carried out such continuity tests helped us to come up with a working prototype of a four-dimensional automatic accident avoidance system. The device was successfully functional and this project is deemed a success because all proposed goals were met. The device was successfully functional with multiple tests carried and it really proved to be reliable, we learnt many skills to develop a device that can be beneficial to us and the rest of the people for their safety while on the road. We, therefore, extend our sincere thanks to everyone who took part in the success of this project.

RECOMMENDATIONS

We recommend the university to rely on technology especially in the safety of our society using automatic devices done by its students for example the four dimensional automatic accident avoidance systems. The University should increase the power electronics and programming course units. This will help to equip students with enough skills to perform their projects and fieldwork. The university should equip the laboratory so that students get access to engineering equipment to enable students to do more of the practical work enough time for practical work. The school should organize more study tours in the industrial fields so that students can get the opportunity to carry out more research on recent technologies.

REFERENCES

1. Global Status Report on Road Safety 2013 by World Health Organization (WHO).
2. S.P. Bhumkar, V.V. Deotare, R.V. Babar, "ACCIDENT AVOIDANCE AND DETECTION ON HIGHWAYS "in International Journal of Engineering Trends and Technology- Volume3 Issue2- 2012.
3. Megalingam, Rajesh Kannan; Amrita Vishwa Vidyapeetham, Kollam, India; Nair, Ramesh Nammily, Prakhya, Sai Manoj, "Wireless vehicular Accident Detection and Reporting System "in Mechanical and Electrical Technology (ICMET), 2010 2nd International Conference on 10-12 Sept. 2010.
4. C. Vidya Lakshmi, J.R. Balakrishnan, "Automatic Accident Detection via Embedded GSM message interface with Sensor Technology "in Mechanical and Electrical Technology (ICMET), 2010 2nd International Conference on 10-12 Sept. 2010.
5. Zutao Zhang, Jiashu Zhang, "A Novel Vehicle Safety Model: Vehicle speed Controller under Driver Fatigue", "IJCSNS International Journal of Computer Science and Network Security", VOL.9 No.1, January 2009
6. M. Bertozzi, A. Broggi, M. Cellario, A. Fascioli, P. Lombardi, andM. Porta, "Artificial vision in road vehicles," Proceedings of the IEEE, vol.90, no. 7, pp. 1258–1271, 2002.
7. S. Tsugawa and Sadayuki, "Vision-based vehicle on japan: Machine
8. vision systems and driving control systems," IEEE Trans. on Ind. El.???, vol.
9. 41, no. 4, pp. 398–405, 1994.
10. Vehicle-highway automation activities in the United States. U.S. Dept. of
11. Transportation, 1997.
12. William Mufana Masisani, Ibrahim Adabara. (2022). Implementation of Smart Grid Decision Support Systems. IDOSR Journal of Scientific Research. 7(1); 50-57.
13. William Mufana Masisani, Ibrahim Adabara. (2022). Monitoring with Communication Technologies of the Smart Grid. IDOSR Journal of Applied Sciences. 7(1); 102-112.
14. Edozie Enerst, Val Hyginus Udoka Eze, Janat Wantimba. (2023). Design and Implementation of an Improved Automatic DC Motor Speed Control Systems Using Microcontroller. IDOSR Journal of Science and Technology. 9(1); 107-119.

Rwotolara Daniel (2023). Design and Implementation of a Four-Dimensional Automatic Accident Avoidance System. *Eurasian Experiment Journal of Engineering, 4(1):77-83*