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Development of an Obstacle Avoidance System for Mobile Robot to Avoid Accident by Using Microcontroller

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Abstract

This paper describes a control car to avoid accident by microcontroller interfacing with a motor control circuit. For the development of the obstacle avoidance system, the control circuit of a toy car was modified. An algorithm was also developed to command the control circuit. The control circuit consists of infrared sensor, motor driver circuit with power supply, transmitter circuit, receiver circuit and infrared LED (IR-LED). DC motor was used as an actuator to control the designed car. Infrared sensors were used to generate high and low frequency in the transmission circuit. High frequency was generated when the response of the capacitor was low and low frequency was generated when the response of the capacitor was high. According to the signal from receiver circuit, the microcontroller sends signal to the program that controls the DC motor to drive the car. The results show that the designed car can satisfactorily avoid most of the common obstacles.

Keywords: obstacle avoidance; mobile robot; microcontroller; infrared sensor.

1. Introduction

An obstacle avoidance system is a mobile robot that follows markers or wires in the floor, or uses vision or lasers or sensors. They are most often used in industrial applications to move materials around a manufacturing facility or a warehouse. Application of the automatic guided vehicle has broadened during the late 20th century and they are no longer restricted to industrial environments Automatic guided vehicle is a field of application automation, which is a modern technology in automobile sector. Automated guided vehicles (AGVs) increase efficiency and reduce costs by helping to automate a manufacturing facility or warehouse. The first AGV was invented by Berrett Electronics in 1953. The AGV can tow objects behind them in trailers to which they can autonomously attach. The trailers can be used to move raw materials or finished product. The AGV can also store objects on a bed. The objects can be placed on a set of motorized rollers (conveyor) and then pushed off by reversing them. Some AGVs use forklifts to lift objects for storage. AGVs are employed in nearly every industry, including, pulp, paper, metals, newspaper, and general manufacturing. Transporting materials such as food, linen or medicine in hospitals is also done. An AGV can also be called self-guided vehicle (SGV). In Germany the technology is also called Fahrerlose Transport system (FTS) and in Sweden forecloses trucker. Lower cost versions of AGVs are often called Automated Guided Carts (AGCs) and are usually guided by magnetic tape. AGCs are available in a variety of models and can be used to move products on an assembly line, transport goods throughout a plant or warehouse, and deliver loads to and from stretch wrappers and roller conveyors [1].

There are many systems available for the development of this type obstacle avoidance system following: - Laser Target Navigation, Steering control, Vision-Guidance, Forward sensing control system, Path select mode.

In this paper we work with forward sensing control system. Forward sensing control uses collision avoidance sensors to avoid collisions with other AGV in the area. Most AGVs are equipped with a bumper sensor of some sort as a failsafe. The optical uses an infrared transmitter/receiver and sends an infrared signal which then gets reflected back is familiar concept. The problems with these are they can only protect the AGV from so many sides. They are relatively hard to install and work with as well.

2.1 System Overview

This project is about automatic guided vehicle to avoid accident. For this infrared LED is used to radiate continuously infrared ray and detect any reflection of these beams on any obstacle in front of the vehicle. At first vehicle drives at constant speed, if any obstacle in front of the vehicle comes, the vehicle would automatically stops and search for alternative way to pass out. The main components of the circuit are DC motor, transistor, resistor, diodes and 8V DC supply.

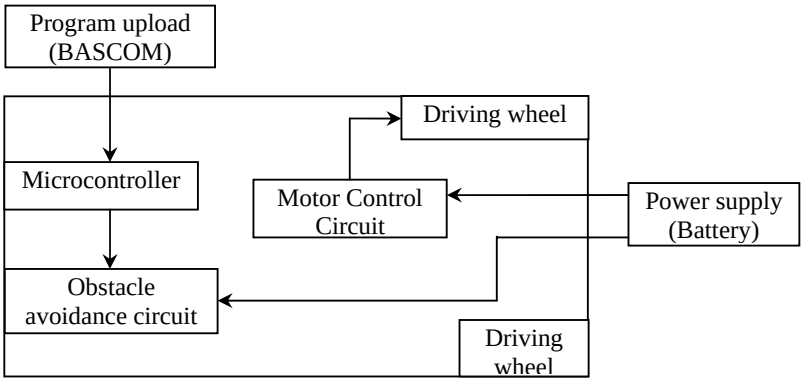


Fig: 1: System overview

Here infrared sensor is used to generate high and low frequency in the transmission circuit. High frequency is generated when capacitor's capacity is low and low frequency is generated when capacitor's capacity is high. Another circuit which is called receiver circuit, which receives the high and low frequency and analyze whether it is high or low frequency and sends signal to the program that controls the DC motor according to the analysis result. Variable resistor and capacitor is used for adjusting high and low frequency.

2.2 Methods And Tools Used

Table 1: Specification of a System

Item	Specification
Language Used	C++(BASCOM)
For circuit animation	Protious_7.6
Microcontroller	AT mega32

3. DC Motor Controller Driver Circuit

DC motor driver circuits connected with microcontroller at pin 20 and 21 namely T1 and T2 through resistor. When T1 is closed, DC motor rotates clockwise and vehicle moves forward. When T2 is closed, DC motor rotates anticlockwise and vehicle moves backward.

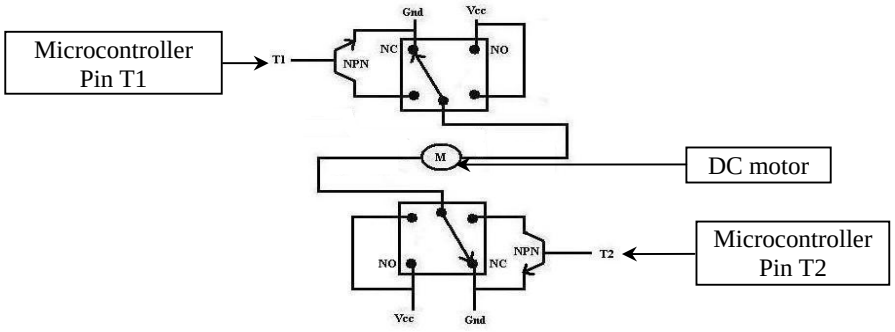


Fig: 2: DC motor driver circuit

4. Experimental Setup

In this paper infrared sensor and infrared LED is used as sensor. Infrared (IR) sensors contain an emitting diode as well as a detector. Both the emitter and detector face in the same direction. If the sensor is pointed at nothing it returns a high value. If there is something nearby, that will reflect the IR light then the value decreases. These sensors have an active range of approximately 2 cm. The actual range depends on the reflectance and size of the object being detected. [5]

Controlling system of the vehicle is completed by controlling the speed of DC motor. The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage the speed of the motor will reduce gradually. The speed controller works by varying the average voltage sent to the motor. It could do this by simply adjusting the voltage sent to the motor, but this is quite inefficient to do. A better way is to switch the motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect. [5]

The experimental setup of obstacle avoidance system for mobile robot to avoid accident is following-

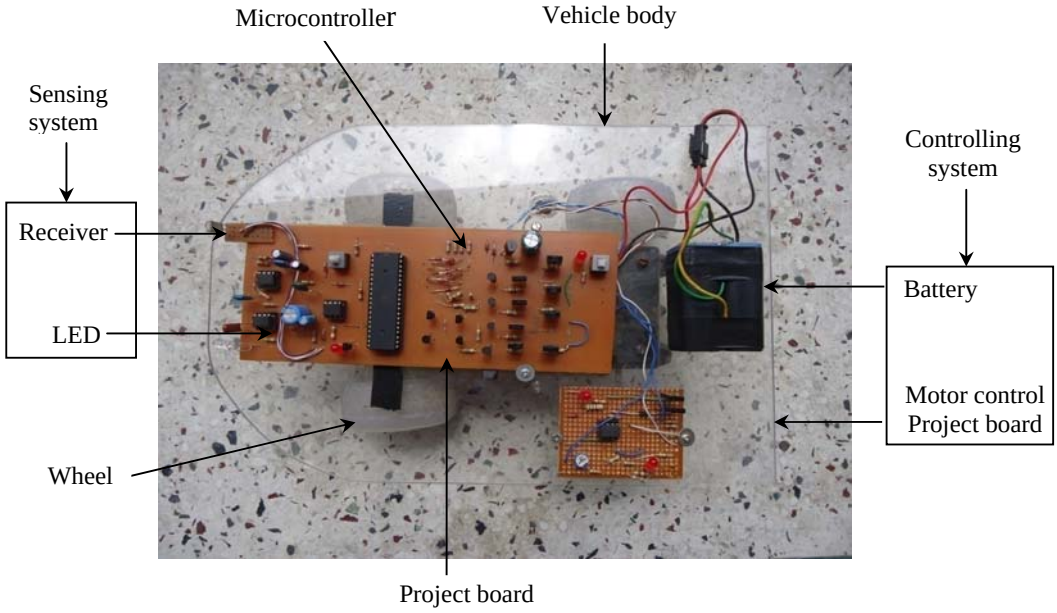


Fig: 3: Experimental setup of the obstacle avoidance system

4. Sensor Selection

A sensor is a device which receives and responds to a signal or stimulus. Here, the term "stimulus" means a property or a quantity that needs to be converted into electrical form. Hence, sensor can be defined as a device which receives a signal and converts it into electrical form which can be further used for electronic devices. A sensor differs from a transducer in the way that a transducer converts one form of energy into other form whereas a sensor converts the received signal into electrical form only.

In selecting a sensor for a particular application three number of factors that need to be considered:

1. The nature of the measurement required e.g. the variable to be measured, its nominal values, the range of values, the accuracy required. The required speed of measurement, the reliability required the environmental conditions under which the measurement is to be made.
2. The nature of the output required from the sensor, thus determining the signal conditioning requirements in order to give suitable output signals from the measurement.
3. Then possible sensors can be identified, taking into account such factors as their range, accuracy, linearity, speed of response, reliability, maintainability, life power supply requirements, ruggedness, availability and cost.

5. Block Diagram of the System

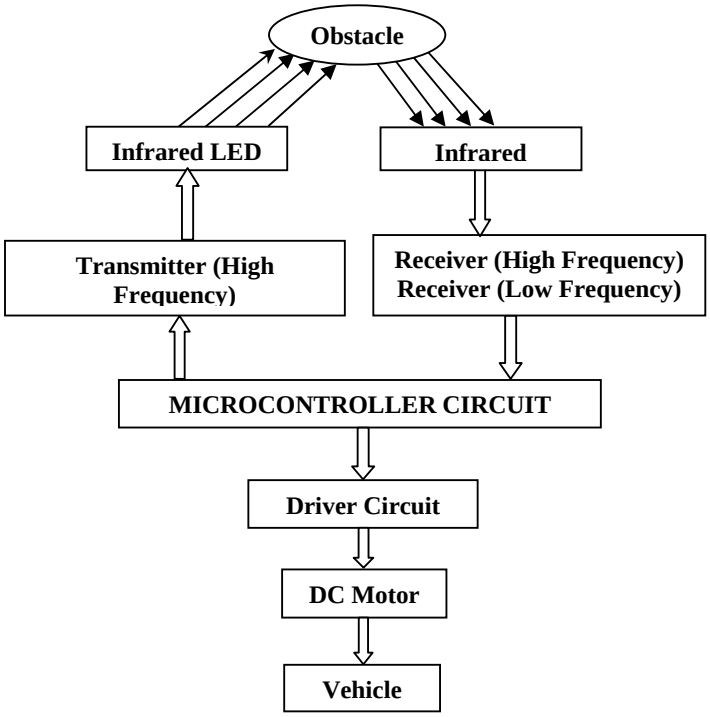


Fig: 4: Block diagram of the system.

6. Algorithms of the System

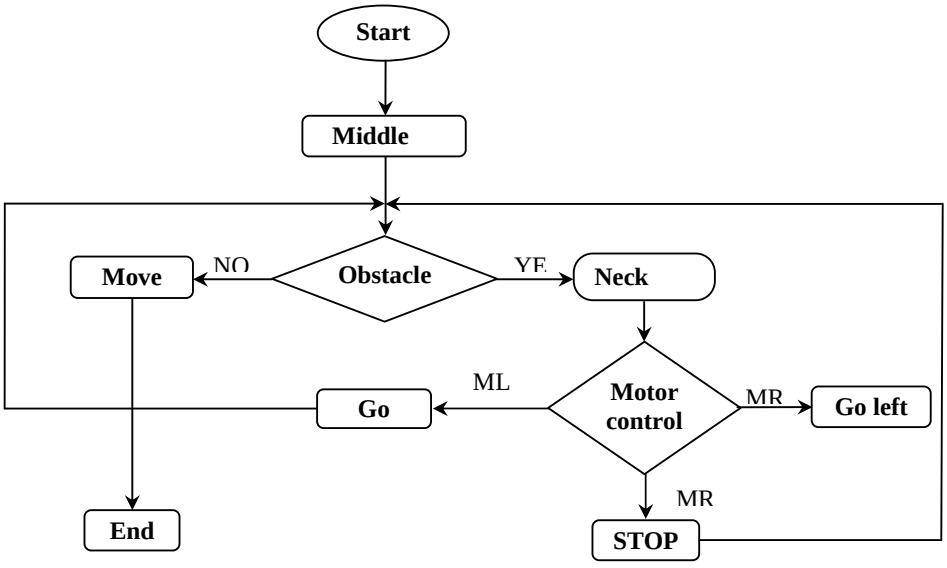


Fig: 5: Flowchart of the system

Legend
M= Middle
L=Left R=Right

7. Working Principle of Controlling System

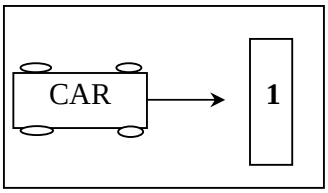
There are many types of motors that are in used these days. The common ones are DC types, AC types, stepper motors and brushless DC motors. The speed of a DC motor is directly proportional to the supply voltage, so if we reduce the supply voltage from 12 Volts to 6 Volts, the motor will run at half the speed. How can this be achieved when the battery is fixed at 12 Volts? The speed controller works by varying the average voltage sent to the motor. It could do this by simply adjusting the voltage sent to the motor, but this is quite inefficient to do. A better way is to switch the motor's supply on and off very quickly. If the switching is fast enough, the motor doesn't notice it, it only notices the average effect.

When you watch a film in the cinema, or the television, what you are actually seeing is a series of fixed pictures, which change rapidly enough that your eyes just see the average effect - movement. Your brain fills in the gaps to give an average effect. Now imagine a light bulb with a switch. When you close the switch, the bulb goes on and is at full brightness, say 100 Watts. When you open the switch it goes off (0 Watts). Now if you close the switch for a fraction of a second, and then open it for the same amount of time, the filament won't have time to cool down and heat up, and you will just get an average glow of 50 Watts. This is how lamp dimmers work, and the same principle is used by speed controllers to drive a motor. When the switch is closed, the motor sees 12 Volts, and when it is open it sees 0 Volts. If the switch is open for the same amount of time as it is closed, the motor will see an average of 6 Volts, and will run more slowly. As the amount of time that the voltage is increases compared with the amount of time that it is off, the average speed of the motor increases. We can see that the average speed is around 150, although it varies quite a bit. If the supply voltage is switched fast enough, it won't have time to change speed much, and the speed will be quite steady. This is the principle of switch mode speed control. Thus the speed is set by PWM – Pulse Width Modulation [10].

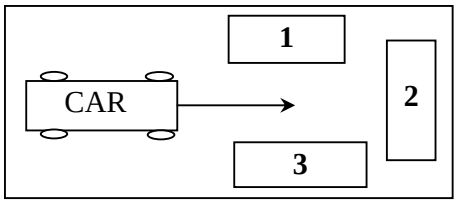
8. Experimental Scenario

The constructed obstacle avoidance vehicle is able to avoid different types of shape of objects. In this system the LED transmitted ray which is reflected by the objects presents in front of the vehicle and receive by the receiver circuit. Then microcontroller circuit controls the DC motor by regulating the voltage. Then the vehicle search for alternative ways to move. Here some configuration in which the constructed vehicle is performed.

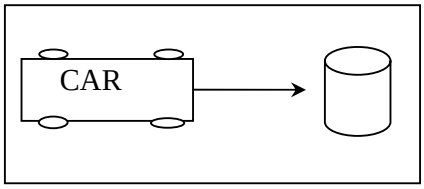
Configuration 1:



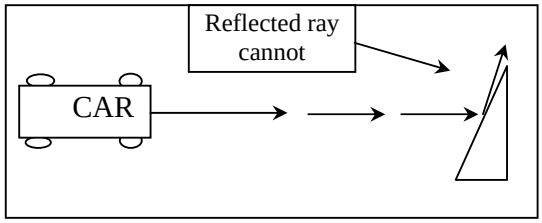
Configuration 2:



Configuration 3:



Configuration 4:



9. Experimental data

Table 2: Experimental data

Configuration	Obstacle No	Observation	Obstacle Avoidance
1	1	1	Yes
		2	Yes
		3	Yes
2	3	1	No
		2	Yes
		3	Yes
3	1 (circular)	1	No
		2	No
4	1(Inclined)	1	No
		2	No

10. Performance

Table 3: Performance accuracy

Configuration	Accuracy
1	100%
2	66.67%
3(circular)	0%
4(Inclined)	0%

The performance of obstacle avoidance system is good. The vehicle can avoid obstacle very carefully and the successful operation percentage is 100% for the configuration 1.For the configuration 2 there is failure for 1 observation. Hence the performance of the vehicle for configuration 2 is 66.67%.The vehicle is unable to sense circular obstacle in the configuration 3.For configuration 4, as the reflected ray cannot receive by the sensor so the car cannot avoid accident for inclined surface. The car can sense an obstacle more than 3 inch high. It cannot sense an obstacle less than 3 inch high; this is disadvantages of the constructed car.

11. Discussion

It is the time for automation. In automatic guided vehicle, the vehicle automatically senses the presence of obstacle in front of the vehicle and stops. Then the vehicle search for alternative way to pass out. Some improvements in the performance can be achieved by changing the components used (e.g. high range sensor for receiver circuit). Automatic guided vehicle will not be able to obey oral instructions from policeman, so a digital system will have to be developed. Toy car is used for the design and construction of the vehicle is made as required to fulfill the objectives. In automobile sector computer controlled software is used to control the vehicle. But we select this topic to use microcontroller because of- Low cost, Simplicity in design, Greater flexibility, Low weight, Required less space.

If high range (ultrasonic sensor) sensor is used, it can easy to detect the long distance object. For control the vehicle efficiently, program also be updated requirement. If receiver and transmitter circuit can develop, high accuracy may be achieved. Image processing software may be used for identifying the obstacle. However the automatic guided vehicle developed is performed satisfactorily as required. The car cannot sense inclined and round surface.

12. Conclusion

For the development of system, a vehicle has been designed by designing various elements. Then system circuit diagram and project have been designed. The performance of the vehicle tested and the vehicle can carry load of about 2 kg. In this project infrared sensor is used to detect obstacle nearer the vehicle about 6 inches. But when this concept developed in large vehicle then high range sensor or high-resolution camera can be used. Image processing software may be used to identify the obstacle. For detecting low and high distance obstacle receiver module will be developed and send data quickly in the control unit to control the vehicle. So it will be most beneficial technology now a day. If high range sensor is used, it can easy to detect the long distance object. For control the vehicle efficiently, program also be updated requirement. If receiver and transmitter circuit can develop, high accuracy may be achieved. Image processing software may be used for identify the obstacle.

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