Robotic Modes of Transportation

By: Kelly Lindell

Submitted to:
Frank LaBanca
Program Director
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Abstract

BEAM stands for biology, electronics, aesthetics and mechanics. BEAM technology is revolutionary for its biological and simple approach to robotics. BEAM robots function on a series of simple transistors and the nervous net, which is an analog system that solves real time control problems. The typical complicated expensive digital robots seen today function on a computer program labeled the neural net. BEAM robots are much easier and less expensive to create than robots that function on the neural net because they can be created out of recycled materials and require no computer programs. Ultrasonic distance sensors use sound to measure the distance it is away from something, similar to the way bats use sonar. Using the speed of sound it can calculate the distance it is from an object by waiting to see how long it takes for the echo to return after being reflected off a perpendicular surface. The two technologies, Ultrasonic Distance Sensors and BEAM robotics, where combined to create a robotic automobile that is able to prevent itself from crashing or coming in contact with another object, specifically by preventing tail gating.

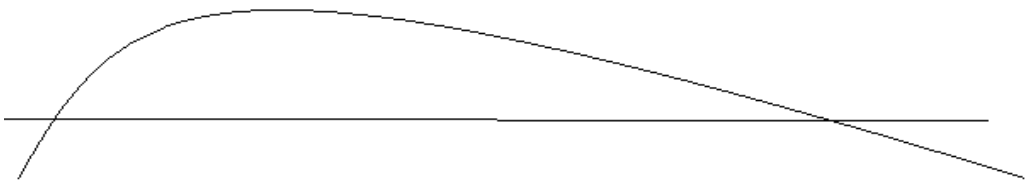
Materials	**Equipment**
Ultrasonic Distance sensor	Soldering Iron
Capacitors	Solder
Transistors	
Resistors	
Two recycled toy car bodies	
DC Motor	
Circuit boards	

Introduction

Over 40 million car accidents occur internationally every year, most of them due to speeding and tailgating. Tailgating occurs often due to carelessness on the road, some people don't realize what a safe distance is between cars or that their getting to close to the car in front of them. When the car before them stops short there is so little distance between the two cars the driver of the second car doesn't have time to react, or break. The result is a tragic accident, or a several car pile-up. It's evident in most accidents that the cause was human error while operating the vehicle, and not an accident related to the malfunction of the car; thus, the only way to prevent accidents is to automate the automobiles. Since accidents linked to tailgating is so prevalent, this project focuses on preventing tailgating from occurring by creating a robotic car that will not allow it's self to drive to closely to the rear end of the vehicle in front of it.

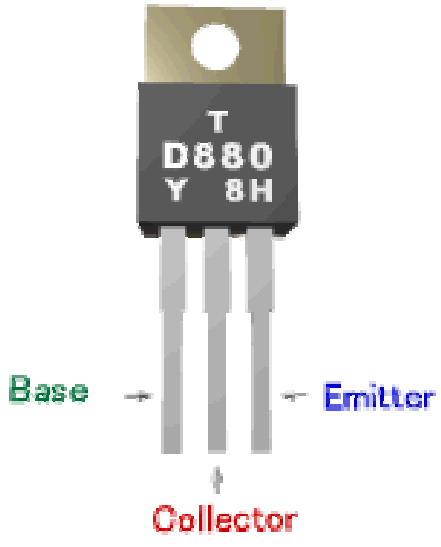
For simplicity, the robotic car designed in this experiment was designed in a new form of robotics called BEAM. BEAM stands for biology, electronics, aesthetics and mechanics. BEAM involves creating robots that's movements emulate that of an animal, or the more popular bug. Most BEAM robots are solar powered duplicates of insects, but while modeling robots after living counterparts is common in BEAM robotics, it is not what separates BEAM robots from other robots. BEAM robots are easier to build and work with than the typical modern computerized robots. One of the reasons for this is the different type of systems robots function on. Typical computerized robots

function on the neural net. The neural net is a complicated digital artificial intelligence program inserted into a robot inside a microprocessor. BEAM robots function on the Nervous net. The Nervous Net is a non-linear analog system that solves real time control problems. Control problems are closely related to control theory, the mathematical study of how to manipulate the parameters affecting the behavior of a system to produce the desired outcome. An example of this would be a thermostat. The thermostat is programmed to stop heating the house when it reaches a temperature of, for example, 70 degrees. The thermostat will take samples of the temperature of the house, analyze it and then compare it the desired out come (70 degrees). If the sample data taken and the desired outcome are a match the thermostat will perform the action of ceasing to heat the house. A BEAM robot works the same way. Lets say that a robot functioning on the Nervous Net is going to attempt to cross a room. The robot is going across the room, and it bumps into a shoe. The sensors will indicate that it has bumped into something. That is the desired outcome that produces the action. Every time the robots sensors indicate it bumped into something it will take a left, until eventually it has bumped it self across the room. This is a basic example of how the nervous net works in BEAM robotics. It was mentioned earlier that the nervous net was an analog system. The Neural Net is digital. Analog is continuous while digital is discreet.



The top sin wave is an example of how it would be read by an analog system, while the second is how it would be read by a digital system. The analog system is constantly taking data from its environment. Listening to a song with a digital ear would be like hearing only every 8th note. Wouldn't it be a lot nicer to hear the whole song, and get all the data?

In Beam robotics the feedback travels through a series of transistors and other circuitry. Transistors are switches in the electrical circuit, or amplifiers of a signal. There are two types of transistors, NPN or PNP, which stand for negatively doped silicon and positively doped silicon. Both work the same way but use opposite signals to do so. The NPN turns on when the base has a positive signal applied to it and the PNP when a negative signal is applied to it. The three leads coming out of the transistor are power input, power control and power output.



The transistor can take the tiny control signal on its base lead and other higher amounts of power run through its other two leads.

Resistors are one of the most common electrical parts in a robot. Resistors resist the flow of energy on a circuit board. If electricity were water the resistor would be the narrow nozzle on a hose. These can be used to lower the amount of electricity coming at a part that can only handle a certain amount.

Resistance is measured in ohms, which come from ohm's law: The number of things that move past a point is proportional to how hard they are pushed divided by how much they resist.

Capacitors are very important in building a robot, especially robots run by solar power. Capacitors store energy. If electricity is related to water, then a capacitor is a water balloon. It has the ability to take in the energy till it is full, and then release to run the robot when it's needed later. While a solar powered robot is taking in sunlight, the capacitors are storing some of the energy they are receiving from the solar panel. If the capacitors fill up with energy by the time there is no more light, then the capacitors will release the energy and the robot can still run in the dark, just like animals bodies store fat and then use it for nutrients during times of famine.

The most important piece of equipment in the Experiment is the Ultrasonic distance sensor. The Ultrasonic distance sensor works similarly to the way bats use sonar. The sensor sends a ping from its transducer and waits to receive an

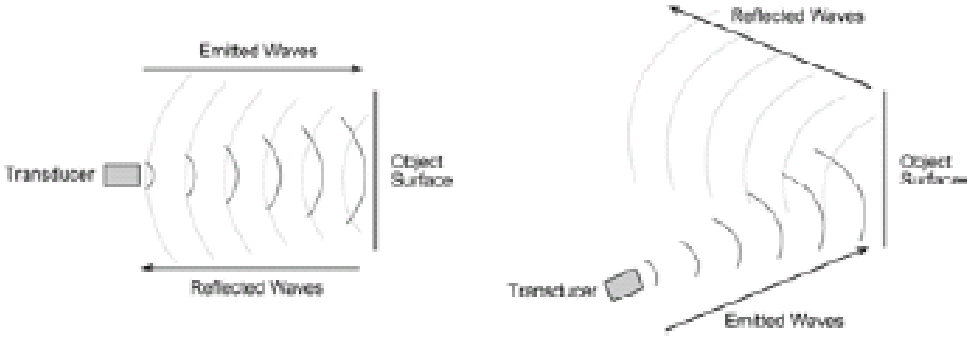
echo. Then, if the speed of sound it known, the sensor can calculate the distance it is from the object judging by how long it took to receive the echo. The speed of sound, however, changes with temperature, so a thermometer must be included in the sensor. The ultrasonic distance sensor can work up to a distance of 10 meters, but for the purpose of this experiment the distance is only about 5 centimeters. The sensor will miss the object it is supposed to sense the distance from if it is at an angle greater than 12 degrees, so in this experiment the cars will be going in a straight line.

The first robotic car in this experiment is designed to run for about 45 seconds and goes at a slower pace than the other car. The second car runs continuously when turned on. It has an ultrasonic distance sensor programmed on the front. When it reaches a distance of less than 5 centimeters to the car in front of it the sensor will send a signal through the inverter, to a transistor that will amplify the signal, which will cause a relay to switch the motors turning the cars wheels off, thus the car will stop until it is again a safe distance away. Then the relay will switch back, causing the motor to start.

Conclusion

The car was tested in various trials and proved to work just fine. After further analysis, however, it was concluded that the ultrasonic distance sensor would not be practical in a real car. One limitation of the design is

the fact that the Ultrasonic distance sensor can only measure the distance from something at less than a twelve-degree angle, because otherwise the transducer would not receive the echo. Therefore it will only work on a straight path. Roads are often curvy and do not guarantee such a straight path. Even moving the car over a couple inches to the side could interrupt the transducers echo.



Also, the Ultrasonic Distance Sensor cannot measure a distance over 10 meters, and while that is fine for a slow country road, much more distance is needed on the highway to ensure safety. When applying this idea to a functional automobile, it is clear that radar would be a much more sufficient tool. Radar has a wider beam, so it can take data in from almost any angle. It also can measure from significantly further distances, over 1000 feet in only a microsecond.

Another issue with the car designed is if it stops short because it is tailgating, other cars behind it that do not have collision avoidance installed could crash into the halted vehicle, causing a several car pile-up. If the automobile is one

among many that has collision avoidance installed, a pile-up is not a concern. However, The severe Whiplash or injury that could result from the car immediately stopping after cruising at such fast speeds is a problem that should be addressed. A practical alternative to this sudden halting would be to slow the car down instead. The speed the car slows down to would have to be dependent on the speed it was going at first. This could be accomplished by using a variable resistor.

Even though there are many improvements to be made on the design, it is still a positive step towards the future of fully automated vehicles.

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