Automatic Braking System

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***Abstract*—This system reduces the response time to apply brakes in a vehicle by relying on digital sensors and microcontrollers instead of human senses. An ultrasonic sensor mounted at the front of a vehicle measures the distance and velocity of any approaching object ahead of the vehicle. The microcontroller then decides whether or not to apply the brakes depending upon the object's distance and velocity. The distance and velocity threshold is set by the user.**

I. Motivation

Unless a major breakthrough is made in genetic engineering, the human brain will never be able to compute and process data as fast and as accurate as a computer. So, in situations where this inability can cause not only financial losses but also loss of precious lives, it is best to use feasible digital systems and computers' processing abilities.

One such situation is high speed traffic. Failing to judge a situation and/or failing to react fast enough can cause a catastrophic failure. Keeping this in mind, we chose automatic braking system as our semester project.

Furthermore, this project covers most of the topics we've studied in ME-312 (Measurement & Instrumentation) including gathering and manipulating data from a digital sensor, removing errors using averaging and other techniques, integrating sensors with an Arduino and creating a graphic user interface on LabVIEW.

II. Work Done

My contributions to this project are as following:

A. Finding an appropriate sensor

Numerous proximity sensors come available in the market including laser proximity sensor, ultrasonic proximity sensor and, infrared proximity sensor. Some are highly sensitive and have a high range but are expensive while others come at a low cost but fail to provide usable and reliable results given their low range and sensitivity. I chose to use HC-SR04 ultrasonic sensor. I considered the price, minimum and maximum range, accuracy, and availability while choosing the sensor. HC-SR04 comes at a low cost of PKR 200, has a range of 0.02 m to 4 m with an accuracy up to 3 mm and is readily available in the market.

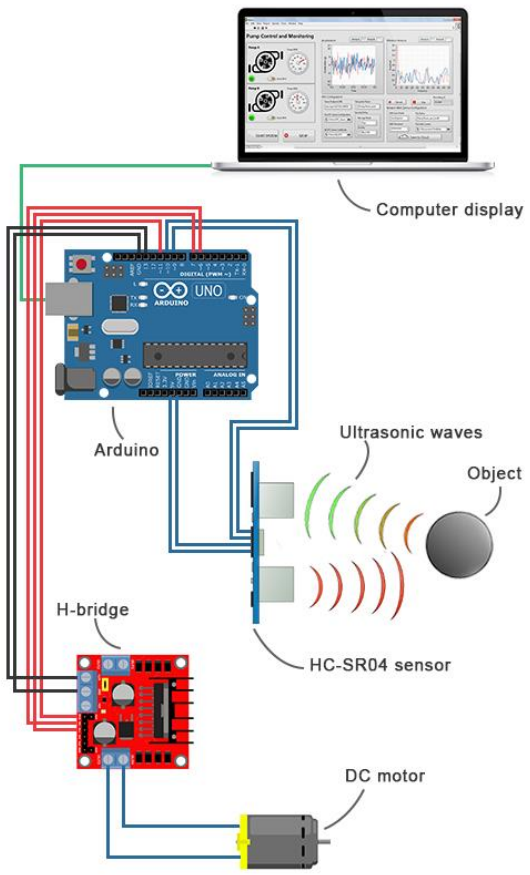
B. Programming to find distance and velocity

I integrated the ultrasonic sensor with the Arduino using a preliminary program. A code was taken from a tutorial website [1] and was later modified to calculate required variables. This program calculated the distance and the velocity of any object in front of the sensor. The programming was done such that the HC-SR04 sensor sends a wave (a 1 ms pulse) and measures the time it takes for the pulse to bounce back from the any object directly in front of the sensor and hit the receiver end of the sensor. This time is then used to measure the distance using velocity of ultrasonic wave in vacuum. Another ultrasonic wave is sent after 100 ms and the corresponding distance is measured again. These two distances are used to determine the velocity of the object. Thresholds for distance and velocity are set and an LED is operated using these conditions. This LED is set to turn on when the distance and/or speed exceed the thresholds. The LED was just used to help generate the program using hit-and-trial method and was replaced for a motor through an H-bridge.

C. Challenges Faced

1) Arduino programming
2) A sensor with a better accuracy can be used.
3) A sensor with better a wider and longer range can be used.

III. Layout Diagram



IV. Expected Results

When working perfectly, the system is supposed to apply brakes i.e., reverse the direction of rotation of the dc motor every time the object speed and/or the object distance exceeds the threshold value set by the user. The results are supposed to be shown clearly on the computer display using a graphical user interface created on LabVIEW.

V. Future Work Possibilities

This system can be worked on and made better in the future. Several limitations being faced currently can be overcome.

A. Overcoming current limitations

Although somewhat reliable for our project, HC-SR04 sensor has its limitations as well. Some of them include the following.

4) Currently the sensor used will not work properly during snowing, raining, dust storms etc. Working around this problem might be a fun challenge.
5) A sensor with a better accuracy can be used.
6) A sensor with better a wider and longer range can be used.

B. Measuring absolute velocity

This system works by measuring the relative velocity i.e., the velocity of an object with respect to the vehicle. Absolute velocity can be integrated to provide more complicated and better conditions to the system.

C. A more intelligent system

There might be situations in which applying sudden breaks might not be the best option. Instead the driver of the vehicle might want to steer away from the object. This creates a problem as the system will always try to apply brakes and will not allow the driver to steer the car away in any other direction. A more intelligent system can be integrated to care for such possibilities.

D. Integration with self-driving cars

Self-driving cars are highly dependent on their sensor systems and this system can be integrated with self-driving cars with further enhancements including intelligent programming and the use of better sensors.

VI. Conclusion

After vigorous testing the automatic braking system performed perfectly within its limitations. The system applied brakes just as the object in front of the ultrasonic sensor crossed the velocity and/or distance threshold. The computer display showed the results without any problem.

References

[1] http://howtomechatronics.com/tutorials/arduino/ultrasonic-sensor-hc-sr04/