Software Requirement Specifications Document

Autonomous Obstacle Avoiding Robot using Arduino

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Abstract

The industry for autonomous vehicles is growing. According to studies nine out of ten traffic accidents are due to the human factor, if the safety can get good enough in autonomous cars they have the potential to save thousands of lives every year. But obstacle detecting autonomous robots can be used in other situations as well, for example where the terrain is inaccessible for humans because of different reasons. In this project, a self navigating obstacle detecting robot was made. The robot uses ultrasonic sensors to detect obstacles and avoid them. An algorithm of the navigation of the robot was created and implemented to the Arduino. For driving the wheels, two servo motors were used. The robot consisted of three wheels, two in the back to which the servo motors were attached and one caster wheel in the front. This made it possible to implement differential drive which enabled quick and tight turns. Tests were performed which showed that the robot could successfully navigate in a room with various obstacles placed out. The placement of the sensors worked good considering the amount of sensors that was used. Improvements in detection of obstacles could have been made if more sensors had been used. The tests also confirmed that ultrasonic sensors works good for this kind of task.
Keywords: Mechatronics, Autonomous Robot, Ultrasonic Sensors, Servo Motors, Arduino

Introduction

Autonomous vehicles can be used for a lot of different purposes and the industry is growing. With autonomous vehicles follows new challenges and safety is one that is very important. If the safety is good enough autonomous vehicles have the potential to save thousands of lives every year. Studies show that nine out of ten traffic accidents are due to the human factor. Other benefits of autonomous vehicles could be improved energy efficiency and reduced driving costs. This report presents how an obstacle detecting autonomous robot was developed.

1.1 Purpose

The purpose of this Bachelor's thesis project was to build a robot that could detect
obstacles in its path and avoid them by turning in another direction. Following
research questions will be investigated in this thesis:
How should the robot navigate?
• How could the robot detect obstacles in its lane and what should it do when it encounters them?
– What kind of sensors are needed?
– Where should the sensors be placed?

1.2 Scope

This project developed an obstacle avoiding robot to detect and avoid obstacles in its path. The robot is built on the Arduino platform for data processing and its software counterpart helped to communicate with the robot to send parameters for guiding movement. For obstacle detection, three ultrasonic distance sensors were used that provided a wider field of detection. The robot is fully autonomous and after the initial loading of the code, it requires no user intervention during its operation. When placed in unknown environment with obstacles, it moved while avoiding all obstacles with considerable accuracy. In order to optimize the movement of the robot, we have many considerations for improvement. However, most of these ideas will cost more money and time as well. In future cameras can be used to detect the obstacle however, it is better to get CCD or industrial use ones to get clear and fast pictures. Even the ones we mentioned in the camera holder part will be better because of the special software.

1.3 Background

Autonomous robots are freely moving and can operate without direct human supervision. They are capable of making their own decisions based on what it perceives and has been programmed to recognize. An obstacle detecting autonomous robot has many applications. The technique can be implemented in cars for example. If the control system is fast enough it can decrease the speed quick and avoid accidents with obstacles that occurs rapidly. With the traffic becoming more complex with new situations the requirements on the control system and algorithms increases. Autonomous robots can also be used in situations where it is dangerous or in any other way inappropriate for humans to be.

General description:

Arduino

The microcontroller used in this project is an Arduino Uno. Arduino is an opensource platform. The Arduino boards are easily programmed on the Arduino Software (IDE) [14]. Arduino Uno is based on the microcontroller ATmega328P which has a flash memory of 32 kB. It has 14 digital input/output pins and six of these can be used as PWM outputs. The board can be connected to a computer with a Universal Serial Bus (USB) cable to power it or to an external power supply, the recommended voltage input is 7-12 V. If it is powered with less than 7 V it may become unstable and more than 12 V may cause the voltage regulator to overheat and damage the board.

Ultrasonic sensors

When wanting to measure distance between a moving object and obstacles that may appear around it, ultrasonic sensors are a good alternative. They are cheap but not the most precise. Ultrasonic sensors measures distance by transmitting pulses of ultrasonic sound-waves which propagates through the air and is reflected and received by the sensor when there is an object in front of them. If there is an object in front of the sensor, the sound-waves reflects and returns to the receiver. One problem with them is that if the object in front of the sensor is tilted relative to the sensors transceiver, only such a small amount of the sound-wave will be reflected back to the sensor that the object won't be detected. This can also cause problems with the measured distance, if the area where the sound-waves hits the object is a little bit tilted the distance may be detected as longer or shorter than it actually is.To calculate the distance between the object on which the sensor is placed and the obstacle, equation can be used.

$$l = tc/2$$

Where l is the distance, t is the time and c is the speed of sound. It is divided by two because the time is measured from when the signal is transmitted from the sensor to when it is received and in that time the sound-waves have traveled the distance twice, back and forth. What makes the calculations less accurate is the value of the speed of sound. Since the speed of sound depends on temperature it is not ideal to use the same value all the time. What could be made to improve this is using a temperature sensor and constantly update the value.

Servo Motors

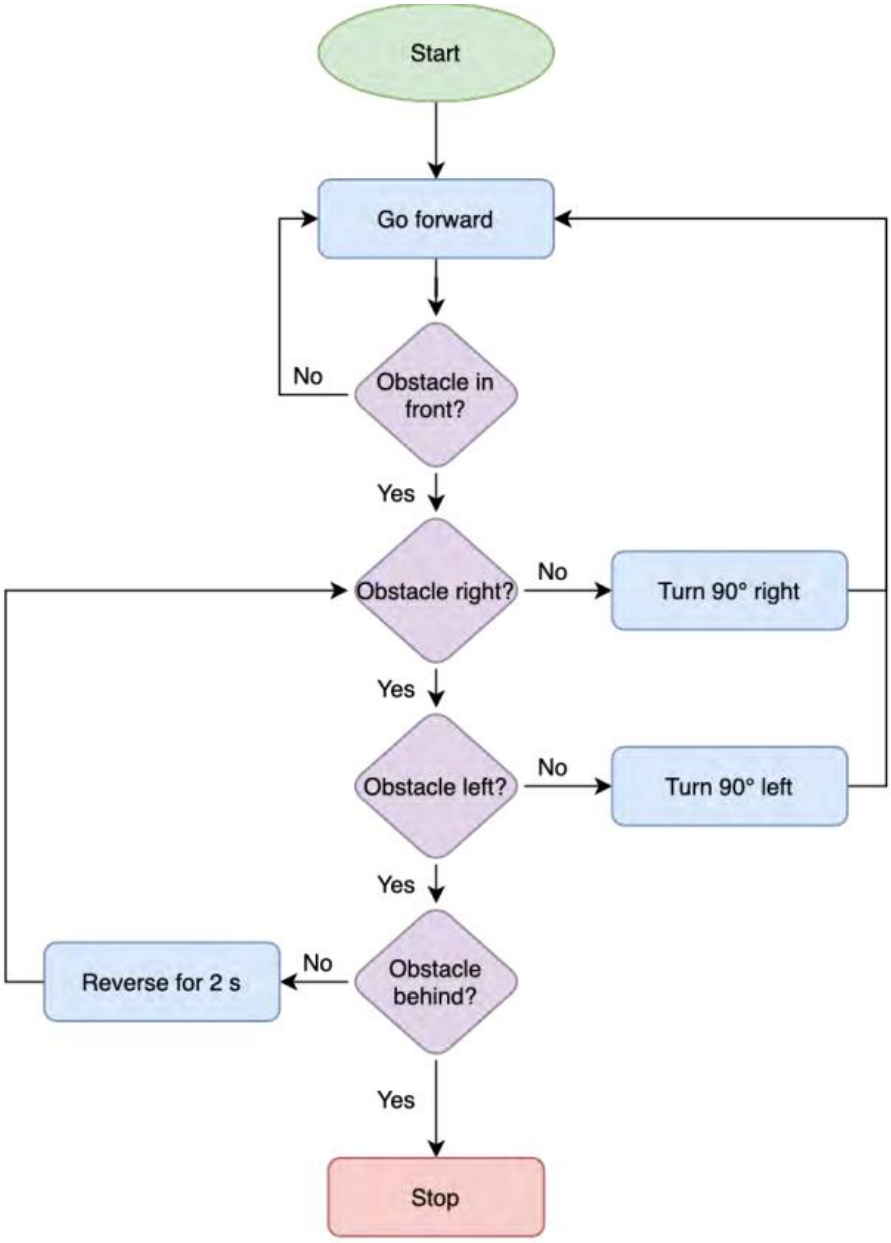
Servo motors are simple electric motors that offers closed-loop position control. They are controlled by a signal, also known as Pulse Width Modulation (PWM). PWM is a technique where digital control is used to create a square wave, which is a signal that switches between full on and full off. From PWM you get analog results with digital means. It simulates different voltages between full on and full off depending on the portion of time that the signal spends on versus off. If the on-off pattern is repeated fast enough, it will appear as if the signal is a steady voltage. The servo motor provides control of linear or angular position, velocity and acceleration. They differ from each other in how many degrees they can rotate and how much they can torque. Servo motors have many different applications, such as robotics, printers and automatic door openers.

Software

The code for the microcontroller was created in Arduino IDE and can be found in Appendix A.

Algorithm

A flowchart was created to describe the algorithm that the robot uses. The flowchart can be seen in figure 3.1. The robot started with driving forward. If it encountered an obstacle in front of its path it checked if there was an obstacle to the right, if not it turned 90° to the right and then continued to drive forward. In the occasion it was an obstacle to the right as well the robot checked to its left and if there was no obstacle there it would turn 90° left and continue forward. In the case where there were obstacles both in front and to both sides the robot would check behind and if the way was free there it would reverse and then again check its right and left sides. If a situation occurred where there were obstacles all around the robot the motors would stop and the robot would have to be moved manually.

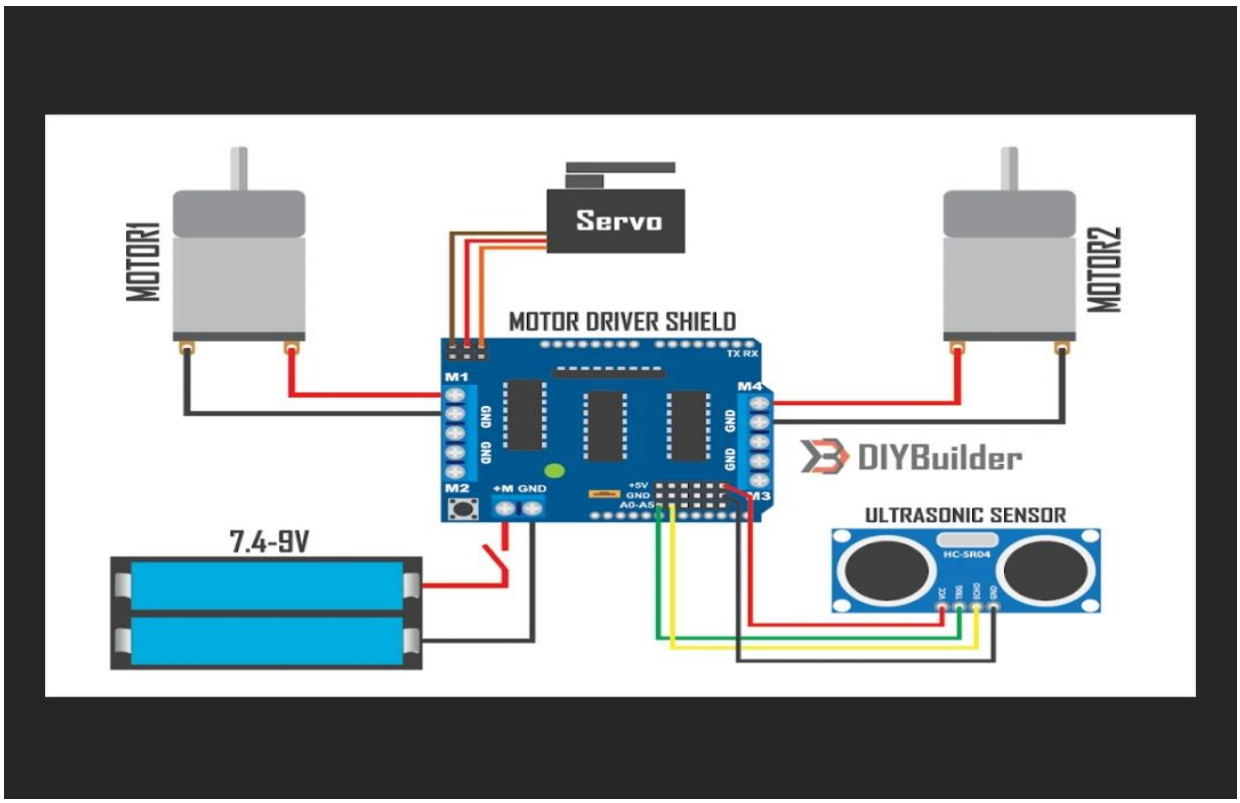

Start
Go forward
Obstacle in front?
No
Yes
Obstacle right?
No
Turn 90° right
Yes
Obstacle left?
No
Turn 90° left
Yes
Obstacle behind?
No
Reverse for 2 s
Yes
Stop

Hardware Requirement

1. Arduno UNO
2. Arduno motor driver L293D
3. Ultrasonic sensors
4. Gear Motors
5. Servo motor

Software Requirement

1. Arduno Software IDE1.8.19
2. C++



Conclusion

- The goal of our project is to create an autonomous robot which intelligently detects obstacle path and navigate conveniently according to the actions we set for it.