Obstacle Identification and Accident Prevention in Vehices

U.Suneetha
Dept.of Electronics,S.K University, Anantapur, A.p, India

Abstract: In the present days the research undertaken in the field of intelligence robotics and applications. We wanted to explore this field by building a robot car that can potentially avoid the obstacles. This is a user controlled robot car that has been integrated with ultrasonic sensors to get the information from the surrounding area and thereby avoid any kind of obstacle collisions. This is a robot car that can be remotely controlled using a Bluetooth terminal mobile/PC application and has the capability to avoid the collision with the obstacles. Essentially when the user gives a command that can potentially lead to an obstacle collision overrides this command and stops avoiding any major damage.

Key words: Robotic, microcontroller, Bluetooth and ultrasonic sensors.

1. Introduction

The robot car design structure primarily consists of microcontroller, one dc motor, one servomotor and four ultrasonic sensors, a dual motor driver and a Bluetooth module. The car is capable of moving in six directions (forward, Backward, forward right, forward left, backward right, backward left). Additionally the car also incorporates an obstacle avoidance feature using the proximity sensors (ultrasonic). The car is controlled wirelessly using the Bluetooth module which is mounted on the car. A mobile/Pc Bluetooth terminal application is used to send the control commands to the car. The detailed explanation is as follows.

2. Hardware

The main hardware components is used in the design of obstricle identification and accident prevention car have been listed below.

1. Atmega 328P Microcontroller
2. Bluetooth Module
3. Dc Motor
4. Servo motor
5. Motor Driver- L293dne
6. Ultrasonic Sensors

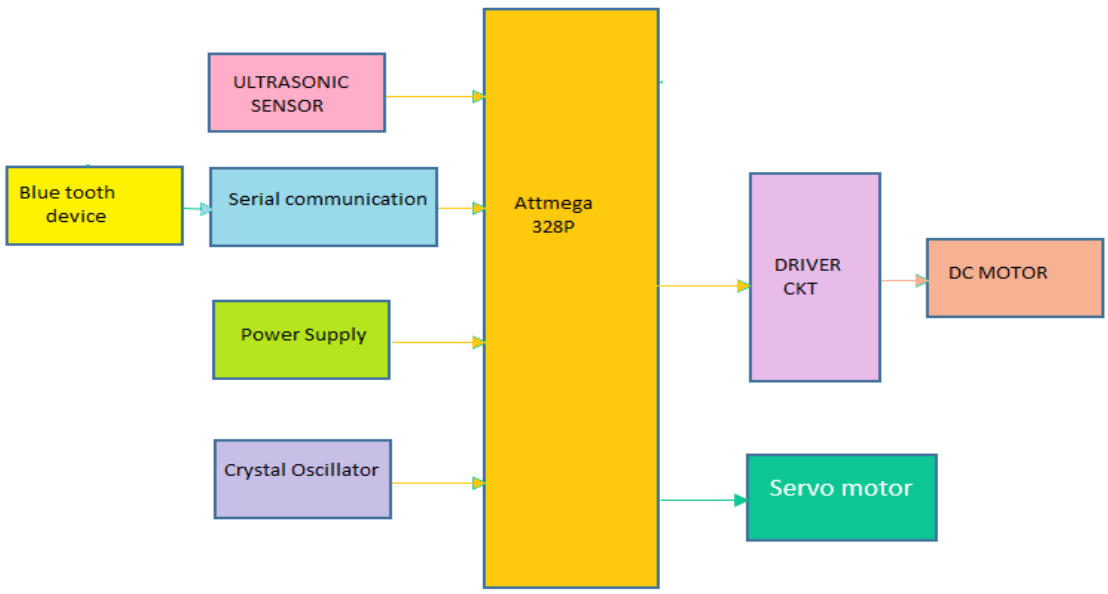

Figure 1: Block diagram

2.1 ATMEGA 328P

The high-performance Microchip 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1KB EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts,serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

2.2 BLUETOOTH MODULE

The Bluetooth module HC-05 is a MASTER/SLAVE module that is very easy to operate and can be used in a master or slave configuration making it a great solution for wireless communication. The Bluetooth module is interfaced to the microcontroller using serial communication (UART). The receive terminal of the Bluetooth module is connected to the transmit channel of the microcontroller and transmit channel of the microcontroller is connected to the receive end of the microcontroller. When set in the master mode the module can initiate a connection with other devices and in this way when mounted on the car the module can pair with another client for instance a smart phone. Through the use of a Bluetooth terminal on the mobile phone or the computer the user can send the data over to the target system. For this project one character of data is transmitted through the Bluetooth connection for enabling the direction control of the robot car. The primary standards that we have followed is determined by the Bluetooth Special Interest Group (SIG). This standard essentially sets the PC addresses available for our use as well as limits our applications to the 2.4-2.485 GHz ISM band[1].

The Bluetooth module is interfaced with microcontroller to wirelessly transmit the commands from the user to the robot car. In this project one character commands are sent from the Bluetooth terminal application on the PC/Mobile to the HC-05 Bluetooth module mounted on the car using the serial communication interface. The command PT_SETUP() has been used to setup the serial communication and the required baud rate for the functioning of the Bluetooth[2].

2.3 DC MOTOR

The DC motor which essentially is an extension of DC motor that has a gear assembly attached to it. The DC motor works over a fair range of voltage (6V-12V) and as the input voltage increases the speed (RPM) of the motor also increases. One significant disadvantage of these class of motors is that they generate significant voltage spikes that can potentially damage the microcontroller. Two optoisolaters have been used in the circuit to provide an electrical isolation between the Dc motor and the microcontroller. The main functionality of DC motor in this project is enable the bidirectional control of the robot car.

2.4 MOTOR DRIVER- L293DNE

A motor driver is an integrated circuit chip that acts an interface between the microcontroller and the motors. They act as current amplifiers since they take a low-current control signal and provide a higher-current signal which is utilized to drive the motors. The most commonly used motor driver IC's are from the L293 series such as the L293D. This IC with 16 pins consist of two H-bridges and are designed to control 2 DC motors simultaneously. The motor controller (H bridge) is typically used as a simple driver for the DC motor to turn ON and OFF in one direction and can also be used to drive the motor in both directions. Appropriate input high and input low voltage levels to enable each channel of the device. This project utilizes bidirectional control mechanism of the motor driver[3].

2.5 SERVO MOTOR

Fundamentally, servomotors are electrical devices that can rotate objects at specific angles with great precision. The main components of the servomotor consists of a motor, potentiometer and a controlling circuit. The motor runs on a closed loop feedback system where by the difference in the values given to the error amplifier (one from the potentiometer which is the measured angle and the other is the true value of the angle to be reached which is given by the microcontroller) is minimized. The control signal to the servomotor is given in the form of Pulse Width Modulation by the microcontroller. The servomotors can 90 degrees in either directions from the neutral positon. Pulses of 1.5msec and 2msec will turn the motor 90 degrees and 180 degrees respectively. These pulses are given with an interval of 20msec[4].

A basic servo motor normally has three terminals: Ground, Vcc and PWM input signal. As described in the hardware section of the project the based on the duty cycle change given by the user the direction of the servomotor changes. In this project we have once again used an OpenCapture to generate the pulse width modulation pulse with a frequency of 50HZ.

2.6 ULTRASONIC SENSORS

This project utilizes four ultrasonic sensors and these are integrated into the system to enable obstacle avoidance feature in the car. Two sensors were placed on the either side of the car and one was placed on the front side and the other is placed on the backside of the car. The HC-SR04 ultrasonic module provides 2cm - 400cm non-contact measurement function with a ranging accuracy of about 3mm. The Module includes ultrasonic transmitter, receiver and a control circuit. The sensor is activated by sending a 10 µs pulse from the microcontroller. The ultrasonic sensor gives back an echo response when it detects an obstacle within the specified distance by the user[5].

The first part of ultrasonic sensor involves generation of a trigger signal from the microcontroller to initialize it. We have given the trigger signal through PWM wave that has very low frequency (10HZ) and a pulse width of 10 µs. An Open Capture has been used for each of the four sensors to output a PWM trigger signal from the I/O ports of the microcontroller.

A robot chassis kit has been purchased online which is linked in the Appendix section. The chassis has been modified according to our requirement to robustly house all the hardware components. The sensors have been hot glued to the sides of the car and the hardware circuitry was soldered on the protoboards and then was mounted on to the chassis using metal clamps and screws. The microcontroller which is mounted on a large board was drilled on to the base of the car chassis. The car is three wheeled with two in the back and one in the front that essentially controls the direction in which the car moves.

3 SOFTWARE

The major software component of the robot car is the signalling algorithm. It has been implemented using a protothread that was ran 100 times a second to obtain good control and stability over the vehicle.

STOP: This state is the default state of the car, that is all states go to the STOP state before entering some other state. The STOP state is in-charge of checking of all the ultrasonic readings and to stop the car when one of the defined criteria is met.

FORWARD: This is the state that the car enters when user gives the command 'f' through the Bluetooth serial terminal. The car turns the wheels in the forward motion and the duty cycle of the servo is maintained at 4200 to provide front direction.

BACKWARD: This state relies on the south sensor and the car enters this state when the user gives the command 'b' through the Bluetooth serial terminal.

FORWARD LEFT: This is the state that the car enters when user gives the command 'i' through the Bluetooth serial terminal.

FORWARD RIGHT: The car enters this state when user gives the command 'o' through the Bluetooth serial terminal.

BACKWARD LEFT: The car enters this state when user gives the command 'k' through the Bluetooth serial terminal.

BACKWARD RIGHT: The car enters this state when the user gives the command 'l' through the Bluetooth serial terminal.

CIRCULAR LEFT: The car enters this state when the user gives the command 'q' through the Bluetooth serial terminal.

CIRCULAR RIGHT: The car enters this state when the user gives the command 'w' through the Bluetooth serial terminal.

For this project we had to include a Serial Peripheral Interface Setup for setting the I/O pins of the microcontroller to opencapture pins and input capture pins[6]. This is necessary for the interfacing of the sensors and the servomotor to the microcontroller.

RESULTS

The final configuration of the car is capable of accurately moving in any one of the six directions (forward, backward, forward-right, forward-left, backward-right, backward-left) with 100% accuracy by extensive training of the car through optimization of the duty cycle. Essentially we have given a time offset of 1.5 seconds to align the servo motor in the neutral direction after turning into a particular direction. The performance of the car to obstacle avoidance is good with an accuracy of 80%. The car stops when the sensor (that is if the car is going in the backward direction the forward sensor doesn't work) detects an obstacle with a range of 3.448cm despite the user giving the driving commands. However the system fails to perform in a few corner cases. When the car is supposed to make a turn alongside a boundary it detects the boundary as an obstacle and the stops. There were also instances when the hardware circuitry of the car caused a hindrance to the sensor causing false detection. This was rectified by rewiring and remounting of the hardware compactly on the chassis of the car.

CONCLUSION

In the present work we are able to explore the domain of wireless communication modules like the Bluetooth, sensors etc. and their integration with the microcontroller. There exists an incredible amount of scope to expand upon this project. Some of future improvements we would like to make include designing of an autonomous parking mode and an intelligent path planning algorithm for the robot. Our design with the sensors can be improved through the utilization of their values to intelligently train the robot to perform specified tasks. Initially we also proposed to have an alternate energy source for the car. We planned to have a saline water based power source where the car runs on the voltage obtained through the electrolysis of salt water. Due to time constraints and infeasibility of the technique at this stage we had to stick to the 9v battery to power the car.

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