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Design and Implementation of Smart Car with Self-Navigation and Self-Parking Systems using Sensors and RFID Technology

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Abstract: In this paper the research is done on making a smart car prototype which is having the functions like self-navigation, space detection for parking, self-parking, obstacle detection, and alcohol detection. AVR microcontroller is used for achieving these functions. For self-navigation function, Radio Frequency Identification technology is used, with the help of Radio Frequency Identification cards. On-board RFID receiver module is used to locate RFID cards which are embedded in the path of navigation. IR sensors are placed into the car in different directions for sensing the obstacles and space for parking the car. This smart car is having two modes of operation, one is manual mode and other is automatic mode. Alcohol detection module detects that the driver has consumed alcohol or not, if this module detects alcohol, then the car will not get turn on for driving in manual mode. Automatic mode consists of features like self-navigation, self-parking and obstacle detection and manual mode consists of alcohol detection. The goal of this research is that to make smart self-driving car. The features of smart car are achieved here by doing self-navigation and obstacle detection with the help of Radio Frequency Identification module and Infra-Red sensor module respectively, in very low cost and for small purpose.

Keywords: AVR, RFID, GPS, IR, ADC.

I. INTRODUCTION

In this project it is proposed to do a smart car prototype which includes the functions which are involved in the driverless cars. These functions help to make the human efforts less. It includes the features like self-navigation, space detection for parking, self-parking, obstacle detection, and alcohol detection. AVR microcontroller is used for achieving these tasks. Various sensors are interfaced with the ports of AVR. IR sensors are interfaced with the ADC port, this internal ADC will convert the reflected analog signals into digital signals. Reflected signals are in the form of voltages. So according to the distance, voltage gets changed. Output signals of ADC are processed by the AVR microcontroller. IR sensors helps in achieving the objectives, such as space detection for parking, obstacle detection, self-parking. Self-navigation is achieved with the help of Radio Frequency Identification technology by using Radio Frequency Identification cards. Alcohol detection module detects that the driver has consumed alcohol or not. If this module detects the alcohol consumed by the driver, then the car will not get turn ON for driving in manual mode.

We used here RFID receiver module for navigation from source point to destination point automatically. Instead of using RFID technology [1], we can use GPS module also for navigation from source point to destination point. But the costing for this method is very high and one more disadvantage is that the latitude, longitude information received from satellites can have errors up to 3 meters. But the small prototype cannot withstand with these much errors occurring in between the actual points and the point information received from the satellite. RFID cards are inserted into the path of the car. So that it can be sensed by the RFID receiver module. Each card is having its unique identity code and that code contains information of moving the car in particular direction such as left, right, front. While moving in any direction the car detects the obstacles coming in front of it with the help of IR sensors [4]. At that time car executes the routine for obstacle detection, which performs the braking task.

When the destination point is reached then if user wants to park the car, then user has to select the self-parking mode. In this mode smart car moves in forward direction for detecting the space required for parking. When the required space is detected then it will start moving the car for parking. In alcohol detection module, alcohol consumption of driver is detected. If this module detects the alcohol, then car will get turned ON for driving in manual mode of operation.

II. METHODOLOGY

Figure 1 shows the block diagram of smart car. The sensor module consists of a pair of IR-LED and photo-transistor i.e. TIL 38 and TIL 78 respectively. There are three sensors which are placed in front side, back side and left side of the car. Front and back area of the car is covered by front and back sensors and left sensor covers left area of the car. While moving the car forward and reverse

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sensors prevents the car from scratching. Only left sensor is used because according to the Indian driving system we have left part of the road from the divider for driving and driver seat is at right. So that in parallel parking only left side parking is allowed. These IR sensors firstly emit the IR rays and then reflected back on the photo-detectors. And according to the availability of space it will detects the parking space for our vehicle. IR rays are emitted on the surface which behind the vehicle in all directions. Available distance is measured by the intensity which will get to the photo-detector. The main concept behind this is that if the received IR light intensity is converted into proportional voltage by the photo-detector. Photo-detector output terminals are given to the AVR microcontrollers ADC port pins. ADC is having one reference voltage. This reference voltage is calculated by considering the point distance require to park the car. We are getting the intensity in terms of voltage which is compared internally by the AVR. If this sensed value is greater than the threshold value then it shows that there is sufficient width space for parking the vehicle or vice versa. Whenever the car put into the Auto–Park mode, it will start sensing the width wise space for parking and if sufficient width wise space is achieving continuously then it starts counting at that moment only. This counter counts in increasing order continuously until the AVR gets sufficient width wise space for parking. When this counter exceeds the threshold value set internally for counter, then it stops counting and now controller has information as the sufficient length wise space is detected for parking the car in parallel parking mode.If any obstacle is detected on the way of the car, then IR sensor detects that obstacle, and the reflected rays are having more intensity. This is compared internally by the AVR microcontroller with the threshold voltage set in the software. If this sensed value is less than the threshold value then car will stop immediately. Two stepper motors are attached to the back wheels of the car.

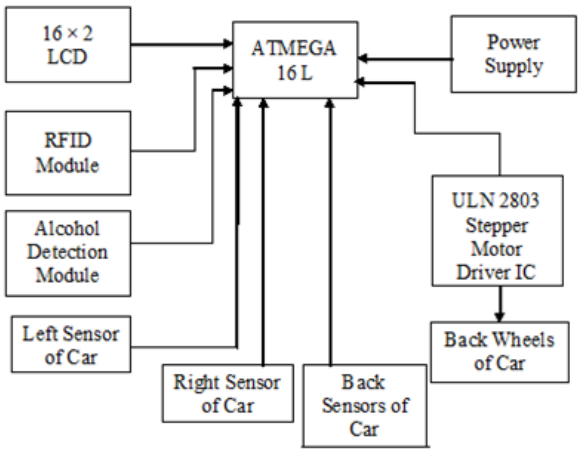

Fig. 1 Block Diagram of Smart Car

These stepper motors are drive with help of stepper motor driver ULN 2803. These two stepper motors are operated in half stepping mode. For moving the car in forward direction, excitation given to the two stepper motors are like “1 1”. For moving the car in left direction it is “-1 1”. For moving the car in right direction it is “1 -1”. Lastly for moving the car in backward direction it is “-1 -1”. RFID cards are inserted into the path of the car. So that it can be sensed by the RFID receiver module. Each card is having its unique code and that code contains information of moving in particular direction such as left, right, forward and backward. This information is filled in the software. Whenever these cards are detected by the receiver module, it sends the information of that card to the controller and the controller will perform the movement of the car accordingly. While moving in any direction it detects the obstacles coming in front of it. At that time car executes the routine for obstacle detection, which performs the braking task. Alcohol detection module performs the task of detecting alcohol from driver. This smart car is mainly having two modes of operation. One is Manual mode and other is Self-Driving mode. In manual mode the driver will have to drive the car. So if the driver has consumed the alcohol, then this smart will not allow the driver to drive the car. So the car will not get turned ON in this case. LCD display shows the different results in different modes of the smart car. In self-parking mode it shows the decimal values of the reflected signal from front, back and left sensor. And also shows the counter value for counting the space detected. In self-navigation mode it shows the information about direction of movement of the smart car.

III. RESULTS

As this smart car is having two different modes of operation, one is manual mode and other is auto-mode. Manual mode result is shown on display in fig. 2. The LCD display is showing 00 digits, which shows the information that the car is in manual mode of driving. In this mode the alcohol sensing module senses the alcohol consumption of driver.

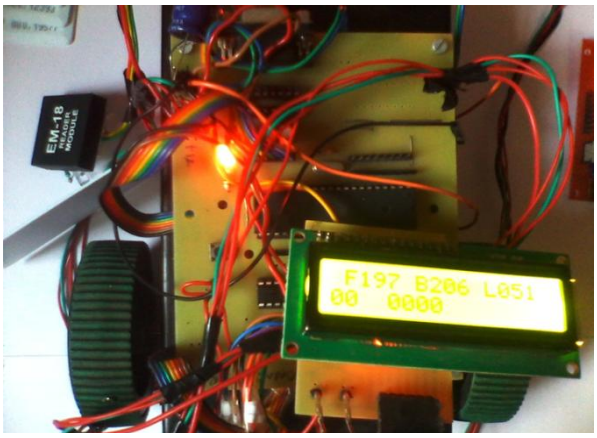

Fig. 2 Manual Driving Mode of Operation

Second mode of this smart car is auto-mode, in which automatic navigation of the car is done and the display shows “10” digits as the car is put in auto-mode. Automatic navigation is achieved with the help of RFID technology. So that different cards are put on each turn of

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the pathway. When car moves on the pathway, RFID reader module detects the cards. The LCD display in fig. 3 is showing 4713800504D digits, which shows the RFID card number which is detected by the receiver module and perform the action written behind the unique code of that card by AVR microcontroller.

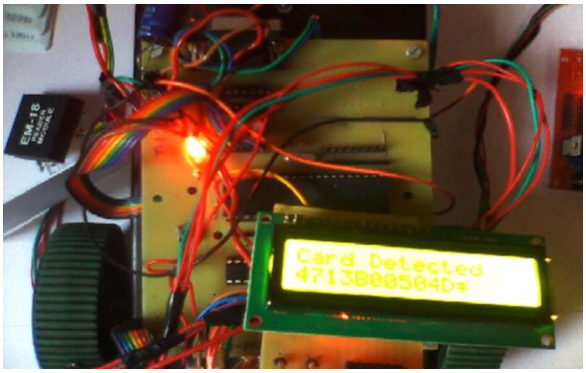

Fig. 3 Automatic Navigation Mode of Driving

The LCD display in fig. 4 is showing "11" digits which shows that, car is in self-car parking mode. These digits will be incremented upto "16" until the end of this mode.

In this mode all the values of sensors are monitored and the movement in that particular direction is done according to the space detected by the sensors. If any obstacle is coming into the way, braking action will be done.

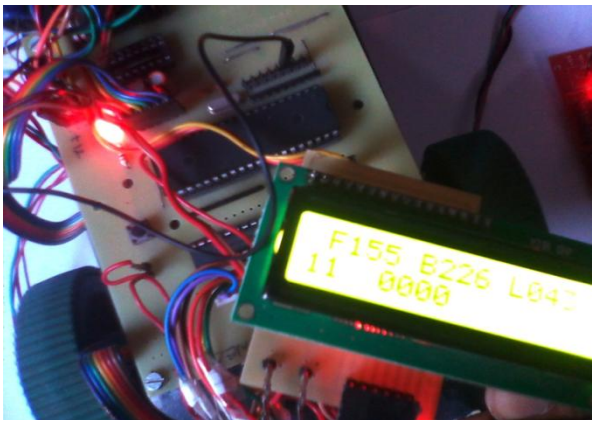

Fig. 4 Self Car Parking Mode

In this mode firstly the width wise space is detected by the sensors and if it is sufficient, then counter starts counting up to threshold count. The counter counts continuously if and only if the width wise space is sufficient otherwise counter stops counting and count is reset.

This process is executed until the next space is detected. The threshold count value is set according to the length wise space required for parking the car in parallel parking mode. After detecting the sufficient space for parking the car, the parking is done by moving in back and left direction.

IV. CONCLUSION

In this project, we have done the smart car prototype. It is having various features such as self-navigation from one point to the other point, space detection for parking, self-parking, obstacle detection, alcohol detection. If we use GPS module for self-navigation it will receive latitude, longitude points from various satellites which may have error up to 3 meters and it is not that much accurate for small models. So to overcome this type of error RFID technology is very much useful in this case for self-navigation purpose. IR sensors are used for detecting the obstacle coming into the path of the car and also for detecting the space for parking. Stepper motor is used for precise movement of car in the specified direction. IR sensor values are received by the AVR microcontroller continuously and according to those values self-parking subroutine is executed. All these above features are executed in auto mode of driving. In manual mode of driving only one feature is executed which is alcohol detection feature. In this feature, alcohol consumption of driver is detected. If this alcohol module detects the alcohol consumption, then the car will not get turned ON for driving in this mode.

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