Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2015
(ICMERE2015) 26 – 29 November, 2015, Chittagong, Bangladesh

ICMERE2015-PI-162

DESIGN AND IMPLEMENTATION OF A MICROCONTROLLER BASED VEHICLE CONTROLLER FOR WHEELCHAIR AUTOMATION

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Abstract- *Wheelchair is a mobility device designed for carrying physically challenged people from one place to another with the help of attendee or by own self. Manual wheelchairs are very difficult to control by a physically challenged person. Commercial intelligent automatic wheelchairs are very expensive. We have designed a low cost automatic vehicle controlling system that can be used for automation of wheelchairs. Here a wheelchair will move from a place to another with the help of motors. Whenever an obstacle is found in front of the wheelchair then the wheelchair will stop and move to another direction. The obstacle is detected by the IR sensor of our developed Wheelchair Controller. The sensor output is then inputted to a microcontroller. The microcontroller controls the directions of the wheelchair according to the embedded program. It handles the wheelchair motor using control relay. The prototype of the system is implemented on small vehicle and shows desirable performance for intelligent collision detection and avoidance.*

Keywords: Automatic Vehicle Controlling, IR Sensor, Microcontroller, Wheelchair Automation

1. INTRODUCTION

Every human being wants to move freely. Nobody likes to live as a parasite of others. But physically challenged peoples and handicapped parsons cannot live and move without assistance of other peoples. In past disabled people were kept socially isolated. Instead of assessing their physical, emotional or mental condition, all of them received same behavior. They were kept away from social gatherings because they needed special attention or extra people to take care. In recent years there have been a wide range of assistive and guidance systems available to improve the life style of the physically challenged people to a great extent and to make their life less complicated.

In the medical sector, a wheelchair is an important appliance. The demand of the physically handicapped and the aged parsons are rising highly. Manual wheelchairs are not comfortable for physically challenged peoples at all. On the other hand, automatic electrical wheelchairs are too costly for the average peoples of developing countries like Bangladesh. Many automatic wheelchairs do not have collision detection and avoidance system which are required for persons with extreme disability.

These despondent conditions made us to think of developing a microcontroller based low cost vehicle control system that can be used for wheelchair automation. Our motivation is the betterment of the handicapped people of economically developing countries such as Bangladesh. We have developed a vehicle controlling system that can be used for automation of manual wheelchairs with low cost. Here the wheelchairs can stop automatically due to obstacles and can move forward, backward, left and right. Our designed automatic control system can control braking system of vehicles for safety to avoid collisions. The control system can be used for the automation and collision avoidance of wheelchairs for physically disabled peoples. The overall framework of this project is to restore autonomy to severely disabled people by helping them use independently a low cost power wheelchair.

The objectives of this work are to:

- detect existence of any obstacle in front of the vehicle by infrared sensors.
- design a vehicle control circuit that can make primary decision of avoidance before collision occurs.
- control the wheelchair with the front two wheels by two individual dc motors according to the position of obstacle or any vehicle.

The rest of this paper is organized as follows. In section 2 we have reviewed some related works. Section 3 describes the model of our developed system.

Implementation of the prototype of vehicle control for wheelchair automation system is presented in Section 4. Finally Section 5 concludes the paper with further research directions.

2. RELATED WORKS

Many researchers around the globe are working on efficient and intelligent vehicle controlling system and automated wheelchairs. Y. Quan et. al. adopted fuzzy control technology in their paper to allow direction change of steering engine and implement smart car's direction control flexibly and intelligently. Typical PID adjustment is used in speed control by optimizing the parameters. The control strategy of their paper is programmed on basis of MC9S12DG128B, which is a 16-bit MCU [1].

Based on the research about the motion mechanism of the Automatic Guided Vehicle (AGV) and the manipulator mechanism, an AGV and Dunking Robot system was developed in [2]. It was provided with a new structure that makes one steering engine able to control two kinds of movements. The AGV characterizes with flexible operation, lightweight structure, and quick response. The control system completes the major operations and processing through MCU and its control core is AT89S51. S. SARAVANAN and T. KAVITHA works on Vehicle Navigation and Obstacle Detection System Using RFI and GSM [3]. Their project allows vehicle to reach the desired destination using tracking and obstacle detection schemes. PIC microcontroller 16F877A is used in the project.

Reference [4] is a work on Ultrasonic Car Braking System. The project allows braking car producing and emitting ultrasonic waves frontward in a predetermined distance in front of the car. PIC is used to control servo motor based on detection pulse information to push pedal brake. Real time embedded operation system µC/OS-II is applied in an automatic system for smart car's steering which is based on freescale microcontroller MC9S12DG128[5]. Hardware design, the translation process of µC/OS-II and the design of user's tasks in the control system for intelligent vehicle's auto control are presented in detail in the paper. For actual practice, it is claimed in the paper that the system has a good performance in real time response and reliability.

The paper of [6] presents an inexpensive and intelligent framework that can identify and report an accident for two-wheelers. Authors said that they targets two-wheelers because the mortality ratio is highest in two-wheeler accidents. This framework includes a microcontroller-based low-cost Accident Detection Unit (ADU) that contains a GPS positioning system and a GSM modem to detect and inform accidental events to a centralized server. The ADU calculates acceleration along with ground clearance of the vehicle to identify the accidental situation. On detecting an accident, ADU sends accident detection parameters, GPS coordinates, and the current time to the Accident Detection Server (ADS). ADS maintain information on the movement of the vehicle according to the historical data, current data, and the rules that is configured in the system. If an accident occurs, ADS notifies the emergency services and the preconfigured mobile numbers for the vehicle that contains this unit.

An approach to the design of a Driver assistance system is described in [7] which is based on a methodology for the design of an Intelligent Driver Information Unit (DIU) for Autonomous Intelligent Cruise control. Such system is claimed to be able to provide the driver with accurate, reliable, necessary and sufficient and timely support on the basis of unreliable and limited input information. Their system runs on the basic of CAN communication protocol that supports CSMA/AMP so that the system is effective and only transfers the relevant data to the DIU and meets the real time needs. S. Singh presented the design of Microcontroller Based Automatic Vehicle in [8]. 89c52 microcontroller is used to generate PWM signals. A sample surveillance application is discussed here.

In [9] the authors proposed a system which is controlling a wheelchair is carried out by the human voice commands. The voice commands produced by the user are captured and processed by the intelligent system. The system is integrated with Ultrasonic sensor and IR sensor for obstacle detection and path finding.

3. DESIGN OF THE PROPOSED SYSTEM

The block diagram of the automatic vehicle control system is illustrated in Fig. 1. Here 555 timer in IR transmitter Unit works as a clock generator. The 555 timer generates a frequency which is 668Hz. Then the amplified frequency comes in IR Receiver Unit. The amplified frequency is supplied to microcontroller. In microcontroller the program was set. If any obstacles come in front of vehicle then it will sense by IR transmitter & IR Receiver and the vehicle will take turn in left or right according to the program of microcontroller by controlling DC motor by Relay[10]-[11].

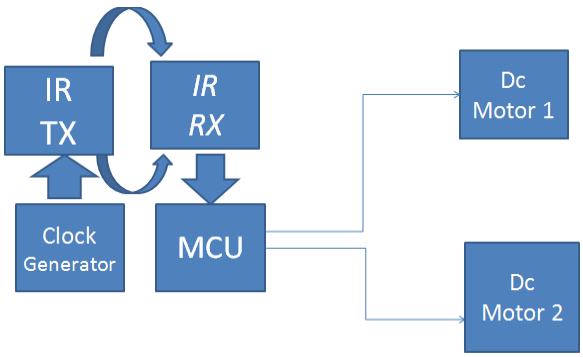

Fig.1: Block diagram of the system

The circuit diagram is divided into two units namely Transmitter unit and Receiver unit for simplicity. The circuit diagram of IR transmitter is shown in Fig 2. Here 555timer operates in *astable* mode so that it can trigger itself. We got 38 KHz frequency in the output. This frequency saturated the *npn* transistor C8050. So the LED will get ground and it starts glowing.

The circuit diagram of IR Receiver is shown in Fig 3. We have connected all the components of our IR receiver circuit accordingly. The IR Receiver is based on silicon

photodiode. When LED light is reflected by an object and fall on the photo diode the receiver module triggered out. With the controlling of DC motor by relay, the vehicle will take turn right, left, back automatically.

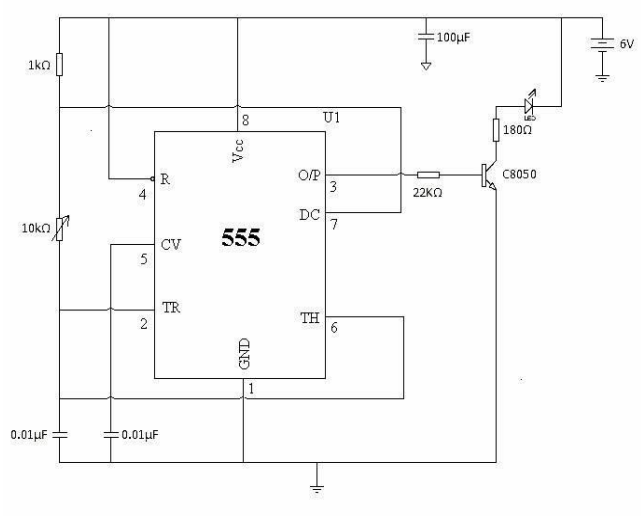

Fig.2: IR transmitter

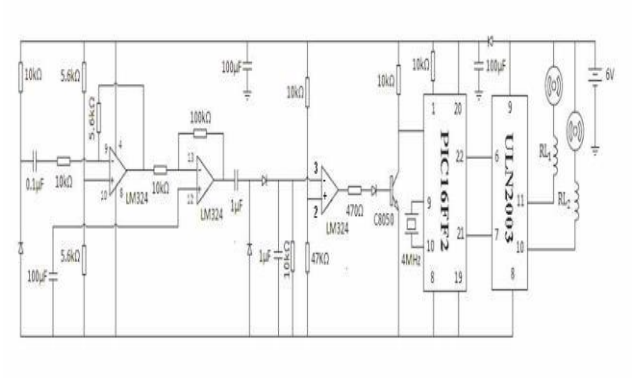

Fig.3: IR receiver

4. IMPLEMENTATION OF THE SYSTEM

We have used Photon Basic programming tool in Windows XP operating system to develop the vehicle control program for the wheelchair automation system. The system was implemented in the Electronics lab, Dept. of EEE, IIUC. At first we have implemented our IR Transmitter circuit in bread board. After being sure that the IR transmitter is working well and LED light is glowing then we have implemented the IR Receiver circuit. The implemented view of the whole circuit is presented in Fig. 4.

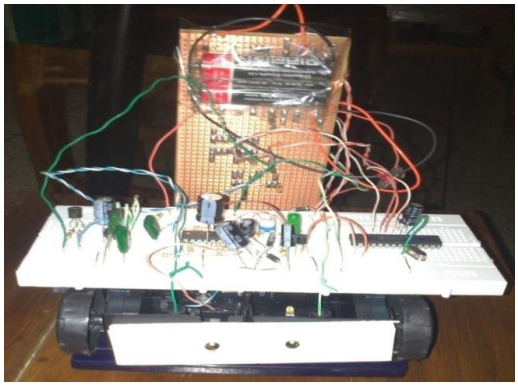

Fig 4: Implemented view of the system prototype

The microcontroller we have used for this development is PIC16F72 which belongs to the Mid-Range family of PIC Micro devices [12]. The program memory contains 2K words, which was translated to 2048 instructions, since each 14-bit program memory word is the same width as each device instruction. The data memory (RAM) contains 128 bytes. There are 22 input pins that are user configurable on a pin-to-pin basis. Selected Pin descriptions are presented in table 1.

Table 1: Description of the PIC16F72 pins used

Pin name	Pin no	Description
OSC1/CLK1	9	Oscillator crystal input/external clock source input
OSC2/CLK0	10	Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode. In RC mode, the OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
MCLR/Vpp	1	Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device
RAO	2	PORTA is a bi-directional I/O port
RB0-RB1	21-22	PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs
V_{ss}	8,19	Ground reference for logic and I/O pins
V_{dd}	20	Positive supply for logic and I/O pins

We have written the interfacing program using Proton Basis. In the program we have denoted Port A as input and Port B as output. R and L are denoted as two variables which contain 0-255 byte. We loaded the PIC 16F72 according to the program by loader. According to the program command relay is controlled by ULN2003. The DC motors were controlled by relays and the vehicle can turn right, left, and can turn back. The control logic is illustrated in flow chart of Fig. 5. The vehicle move forward if there are no obstacles. If the vehicle finds any kind of obstacles in its front, it turned right and run forward, if again it detect any obstacle that time it turn left and move forward. If again it will detect any obstacle that time it will turn 180 degree and run back.

We have tested all the appliances using our interfacing program from our laboratory PC and found desired results. We measured the output frequency of 555astable we got 38 kHz and the LED light was glowing on that frequency. We used silicon photodiode as receiver module. After connecting full circuit diagram we implemented the system using a vehicle toy. It worked

perfectly. In practice, our prototype system was able to detect obstacles up to 35 cm. The vehicle was avoiding collision and changing direction according to the interfacing program. We found that our microcontroller based automatic vehicle controlling system for wheelchair automation could detect obstacle automatically and avoid collisions.

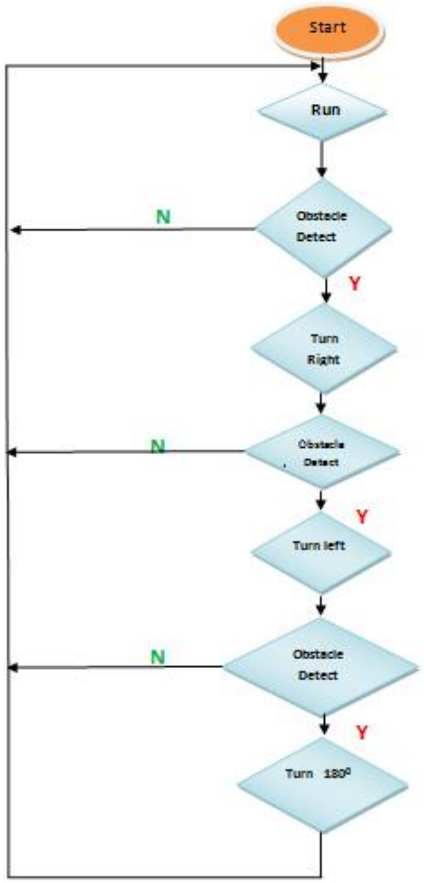

Fig.5: Flow chat of the control logic

5. CONCLUSIONS

Automated wheelchairs can be used to help handicapped people, especially those persons who are not able to move. In this paper, we have presented a system for detecting obstacle in front of the wheelchair or other vehicle and avoid them automatically to evade collision. The work is based on avoiding collision of vehicles by extending the application of PIC microcontroller and Infrared ray. PIC microcontroller is used because it is a low cost component and can be used to control peripheral devices. The prototype of the system is implemented and desired result was found. Vehicles are detecting obstacle up to 35cm and automatically changing directions to avoid collision. There is no doubt that the idea can be implemented in several ways. In future we are interesting to design the system to increase the obstacle detection range up to some meters. We will also try to add speech recognition in our system. There are several barriers that have to be overcome before smart wheelchairs can become widely used such as cost versus accuracy.

6. REFERENCES

[1] Y. Quan, Z. Yunzhou, W. Hao, and W. He, "Application of fuzzy algorithm in the direction of intelligent car", in *Proc. of the 2nd International Conference on Future Computer and Communication (ICFCC)*, 2010, pp. V2-669 – 673.

[2] X. Cheng, and R. Tao, "Design of automatic guided vehicles and dunking robot system", in *Proc. of the International Conference on Intelligent Human-Machine Systems and Cybernetics (IHMSC)*, 2011, Page(s):3 – 6.

[3] S. Saravanan, and T. Kavitha, "Vehicle navigation and obstacle detection system using RFID and GSM", *Journal of Theoretical and Applied Information Technology*, vol. 38, no. 2, pp. 206-209, 2012.

[4] M. Shahrizan, and B. Sahri, "Ultrasonic car braking system", B.Sc. Thesis, Universiti Malaysia Pahang.

[5] X. Wang, H. Li, and Y. Zhu, "Design on automatic control system for smart car based on μC/OS-II," in *Proc. of the IEEE 2nd International Conference on Cloud Computing and Intelligent Systems (CCIS)*, 2012, vol.3, pp.1188 – 1191.

[6] A. Meena, S. Iyer, M. Nimje, S. Joglekar, S. Jagtap, and M. Rahman, "Automatic accident detection and reporting framework for two wheelers", in *Proc. of the International Conference on Advanced Communication Control and Computing Technologies (ICACCCT)*,2014, pp. 962 – 967.

[7] N. Ilangovan, R. Jagatheesan, P. G. S. Parthipan, A. Jeyasaravanan, and G. Prabhakar, "Microcontroller based autonomous vehicle control system using can bus," in *Proc. of the International Conference on Advanced Communication Control and Computing Technologies (ICACCCT)*, 2014, pp. 1027 – 1031.

[8] S. Singh, "Microcontroller based automatic vehicle", accessed from http://www.csharpcorner.com/

[9] J. Kathirvelan, R. Anilkumar, Zachariah C.Alex, and A.Fazul, "Development of low cost automatic wheelchair controlled by oral commands using standalone controlling system", in *Proc. of the IEEE International Conference on Computational Intelligence & Computing Research (ICCIC)*, 2012.

[10] M. H. Rashid, *Power Electronics: Circuits, Devices, and Applications*, Elsevier, 2011.

[11] B.L. Theraja, *Basic Electronics*, S. Chand, 1st Edition.

[12] PIC 16F72 "Data Sheet" ww1.microchip.com/downloads/ en/devicedoc/39597b.pdf