Microcontroller Based Driverless Metro Train

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Abstract

The duty of any train transportation system is to provide secure, consistent, efficient and high-quality service to the passengers. As many rail lines run at or near their capacity limits, automation is often the only way to maximize the operational performance of a train service system. Implemented on existing lines, automation is in many cases more cost-effective than constructing new lines or extending platforms. The move to train automation can be justified by their numerous benefits like schedules of train operations become more exact and timely, the frequency of the trains can be improved, especially in low traffic hours, as more and shorter trains can be inserted in traffic without the need for more operational staff, and the enhanced safety, where the element of human error is taken out completely. Besides, automation can reduce the wear-and-tear of train by optimizing energy consumption and potentially reduce operating costs through more effective and regular train operation. The train stops and starts automatically and the doors are closed and opened automatically. Driverless trains are equipped with a control system, which is programmed to make them following a specific path. Stations on such a path, timings of the train, opening and closing of train doors and distances between stations are all predefined. The whole operation and maintenance of the train is done automatically without any human intervention by using microcontroller as brain for the whole train operation.

Keywords: *Microcontroller, Driverless trains, Automation*

1. Introduction

Modern technologies are being integrated in almost all aspects of our life including transportation, where a lot of advancement has been made. Railroad transport, for instance, has undergone a huge transformation, starting with the early steam operated engines to the most recent bullet train.

Many developments in railroad transport has utilized the existing infrastructure, where the existing metro system is being modernized and equipped with automatic train control and safety system in order to make them more efficient. Driverless automated concepts have been adopted, and the first recorded implementation was the London underground Victoria line, opened in 1967.Many other rail lines are then automated with the aim of reducing operational costs and improving the frequency of service.

In automated train control (ATC) systems, different grades of automation (GoA) have been incorporated. The grades of automation (GoA2, GoA3, GoA4) are corresponding to Semi-automated Train Operation (STO), Driverless Train Operation (DTO), and Unmanned Train Operation (UTO) respectively. Grades of automation (GoA) are defined according to which basic functions of train operations are responsibilities of staff, and which the responsibilities of the system itself. For example, a Grade of Automation 0 (GoA 0) would correspond to on-sight operation, like a bus running on street traffic. GoA 4 would refer to a system in which trains are run fully automatically without any operating staff onboard. Systems work within the GoA4 is normally having an overall signaling system with the necessary connections, automatic train supervision, track vacancy detection and communication functions. In fact any new metro system constructed and implemented today integrates at least some level of automation reaching out to new fully driverless technologies.

This system has designed with the help of step down ac transformer, bridge rectifier, L293D, LCD display, IR sensors and Microcontroller for driving the DC motors. It is less costly, more compact, easy way of transport from and to remote area, controls the locomotion more precisely and effectively as compared to other systems.

In this project, part of this automation tasks are considered, and a microcontroller-based prototype is developed. Actions such as traveling through a given path with predefined stations, sensing the arrival at the station and hence, proper stopping are implemented in the prototype. Messages that are synchronized with the train's progression through its path are announced to passengers via a display. Moreover, there are alarm signals produced as appropriate. Controlling of the doors in terms of open and close and timings of such actions are considered.

2. Proposed system

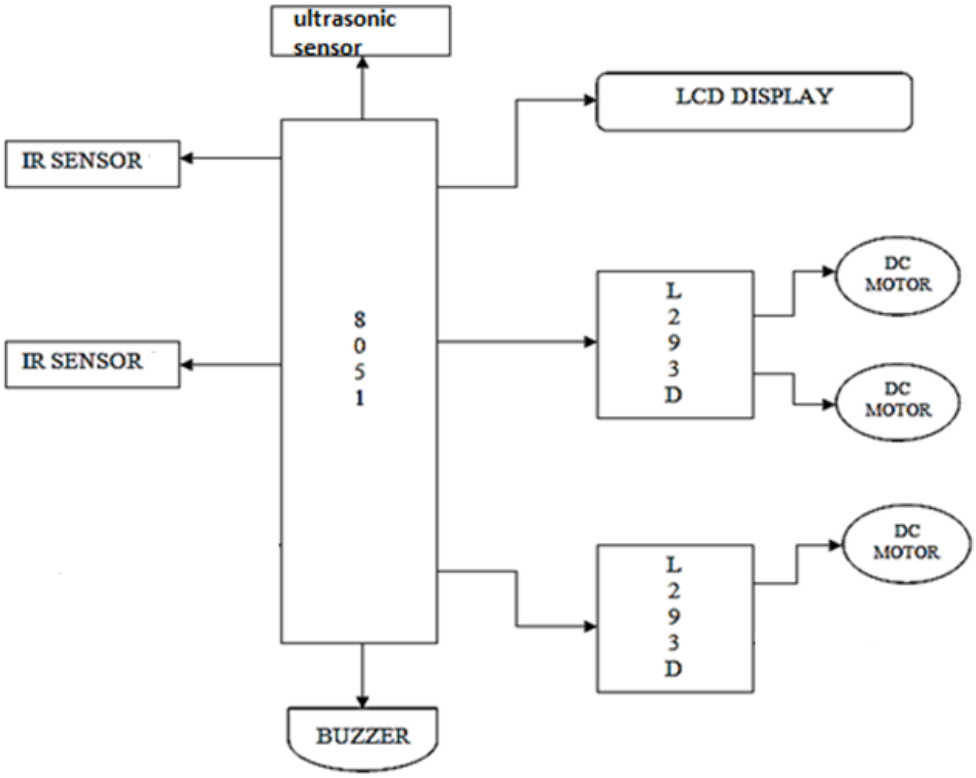

Fig.1 : Block Diagram of Microcontroller based Driverless Metro train

In the proposed system the supply voltage of 12V DC is given to the equipment in the project work with 5V DC supply, so a voltage regulator 7805 is used in between. For Dc motors, 12V supply is given via 7812 voltage regulator. The 12V DC supply is given to 7805 voltage regulator and then given to IR sensors, Ultrasonic sensor and the LCD module.

3. Harware implementation

3.1 Arduino Uno:

Micro controller is an integrated circuit or a chip with a processor and other support devices like program memory, data memory, I/O ports, serial communication interface etc integrated together. Unlike a microprocessor (ex**:**Intel8085), a microcontroller does not require any external interfacing of support devices. Intel 8051 is the most popular microcontroller ever produced in the world market.
Most microcontrollers will also combine other devices such as:

- A Timer module to allow the microcontroller to perform tasks for certain time periods.
- A serial I/O port to allow data to flow between the microcontroller and other devices such as a PC or another microcontroller.
- An ADC to allow the microcontroller to accept analogue input data for processing.

3.1.1 Features of AT89C51 :

- 8K Bytes of Re-programmable Flash Memory.
- RAM is 256 bytes. 4.0V to 5.5V Operating Range.
- Fully Static Operation: 0 Hz to 33 MHz’s
- Three-level Program Memory Lock.
- 8-bit Internal RAM.
- 32programmable I/O Lines.
- Three 16-bit Timer/Counters.
- Eight Interrupt Sources.
- Full Duplex UART Serial Channel.
- Interrupt recovery from power down mode.

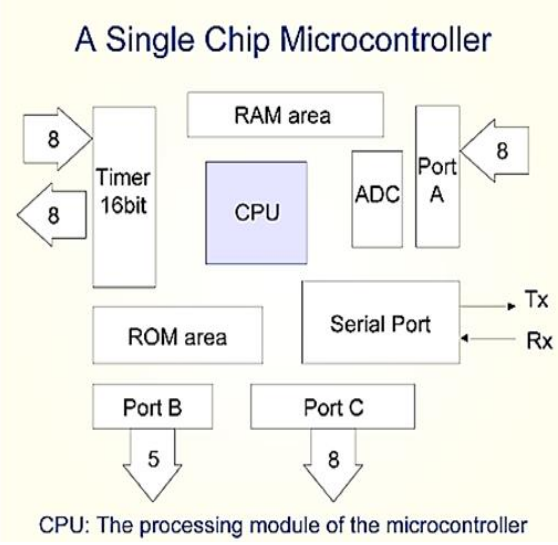

Fig.2: Block diagram of Microcontroller

3.2 Ultra Sonic Sensors:

Ultrasonic Ranging Module HC - SR04

Product features: Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The Basic principle of work:

- Using IO trigger for at least 10us high level signal.
- The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
- If the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning. Test distance = (high level time×velocity of sound (340M/S) / 2.

Fig.3: Ultrasonic Sensor

3.3 IR Sensor:

An infrared sensor is an electronic device, which emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of the sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IRLED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

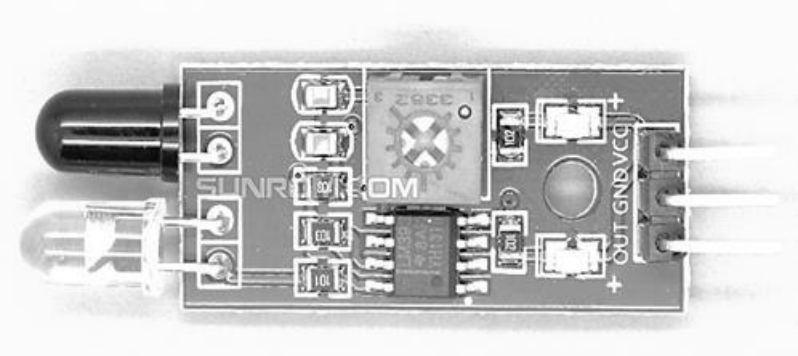

Fig.4: IR Sensor

4. Working and operation

This proposed system is an autonomous train and it eliminates the need of any driver. Thus, any human error is ruled out. In this project microcontroller from 8051 family has been used as CPU. Whenever the train arrives at the station it stops

automatically, as sensed by an IR sensor. Then the door is opens automatically so that the passengers can go inside the train. The door then closes after a prescribed time set in the controller by the program. It is also equipped with a passenger counting section, which counts the number of passengers leaving and entering the train. The door closes when it reaches maximum occupancy level irrespective of time allotted for the door to remain open.

The passenger counts are displayed on a LCD display interface to the microcontroller. The movement of the train is controlled by a motor driver IC interfaced to the microcontroller. The train incorporates a buzzer to alert the passengers before closing the door and also warn them before staring. As the train reaches the destination the process repeats thus achieving the desired operation. Further the project can be enhanced by making this system more advanced by displaying the status of the train over an LCD screen for the convenience of the passengers. The status of the train consists of the parameters like, expected arrival and departure time etc.

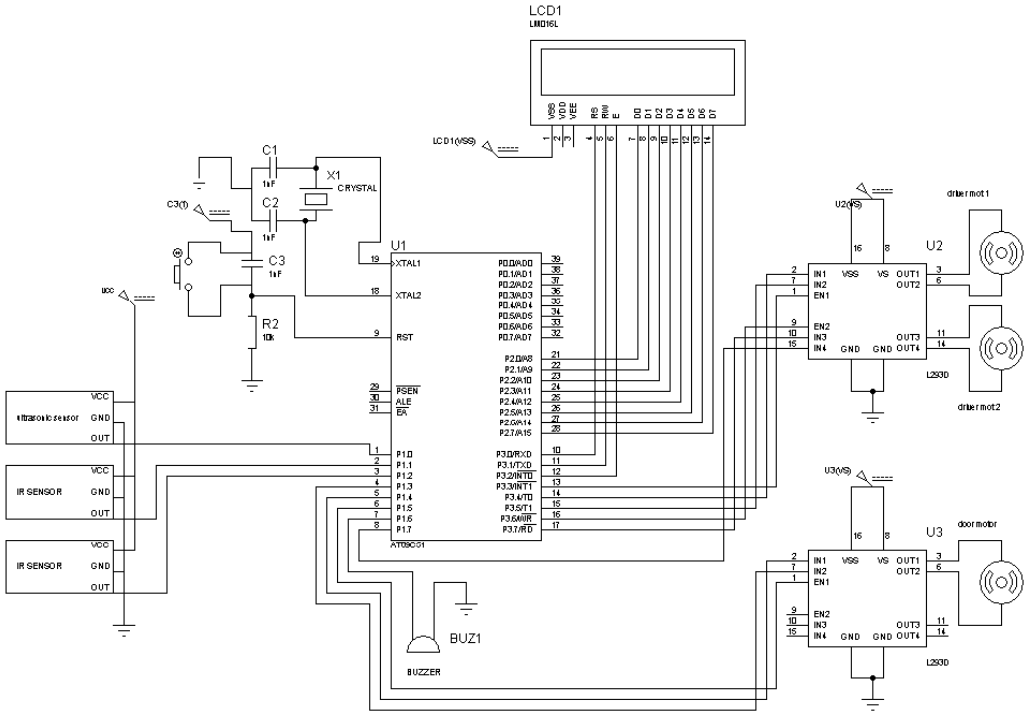

Fig. 5 Schematic Diagram of Microcontroller based Driverless Metro train

5. Results

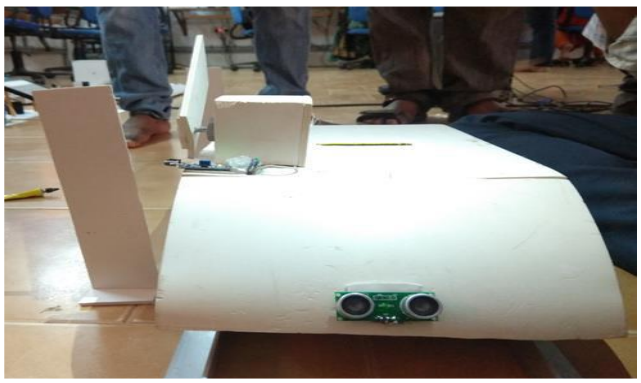

Fig. 6 Prototype Model of Microcontroller based Driverless Metro train

This kit explains about the project "MICROCONTROLLER BASED DRIVERLESS METRO-TRAIN." In this project when the kit is ON it displays a message on the LCD as "DRIVERLESS METRO-TRAIN".

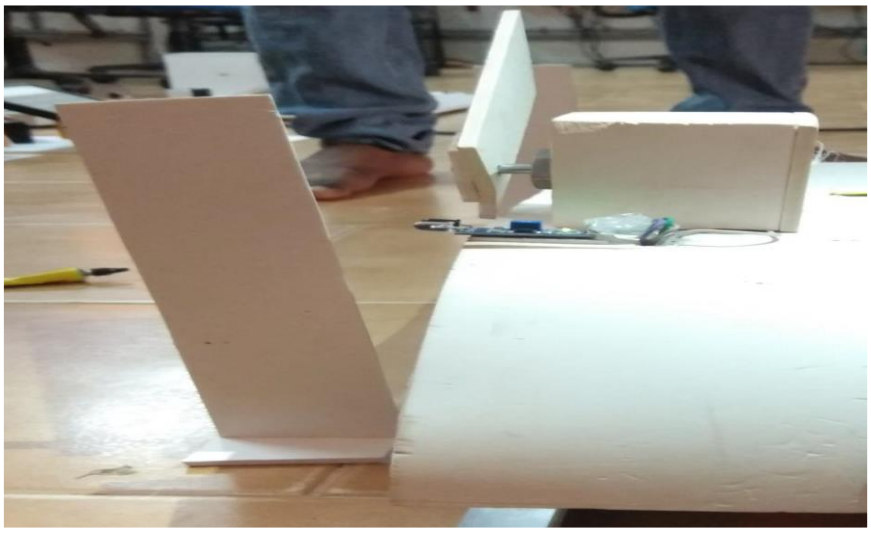

Fig. 7 Prototype Model of Microcontroller based Driverless Metro train with automated door operation

Fig. 7 shows the door control system. This system controls the door of the train opening and closing based on the station arrival and a predetermined delay by a buzzer alert.

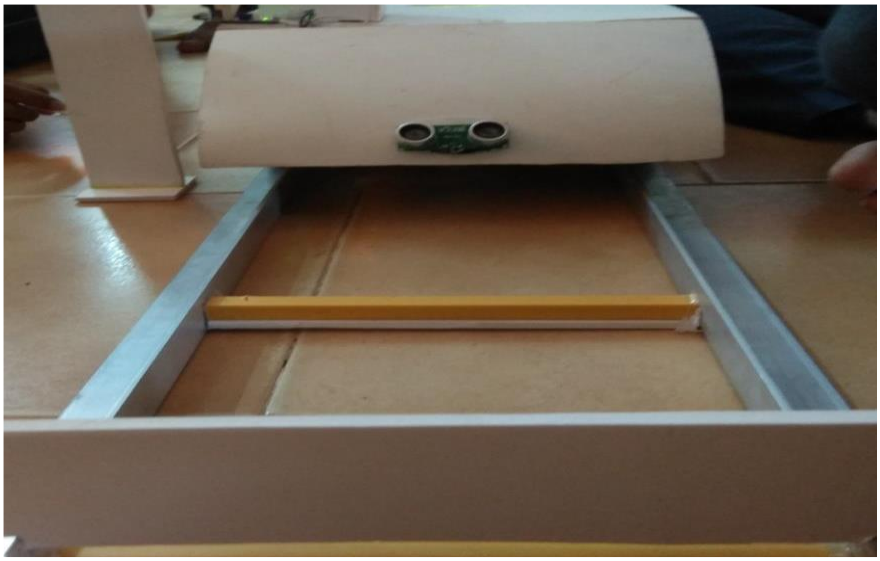

Fig.8 Prototype Model of Microcontroller based Driverless Metro train with anti-obstacle collision system

Fig. 8 shows the anti-obstacle collision system using Ultrasonic sensor. The main Objective is to stop the train movement whenever an obstacle is present in between the stations under train locomotion.

6. CONCLUSION

The Unmanned Metro systems are more reliable, comfortable and safer than road based systems & it reduces congestion on the roads. However systems planned in India shows that cost overrunning and underutilization of capacity. Technology integration may look like for the modernization of difference service sector, transport. Estimation of

passenger demand for transit services should consider complete journey of commuters including access time. The whole operation and maintenance of the train is done automatically without any human intervention. The duty of any train transportation system is to provide secure, consistent, efficient and high-quality service to the passengers. As many rail lines run at or near their capacity limits, automation is often the only way to maximize the operational performance of a train service system. Implemented on existing lines, automation is in many cases more cost-effective than constructing new lines or extending platforms.

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