AUTOMATIC SHUTTLING OF METRO TRAIN BETWEEN STATIONS

S.Jayachitra[1], Santhosh H[2], Shivani G[3]
[1]Assistant Professor, Electrical and Electronics department, MVJ College of Engineering, Bangalore, India
[2,3]Electrical and Electronics department, MVJ College of Engineering, Bangalore, India

Abstract
The main aim of this paper is to demonstrate the technology used in driverless metro trains which are functioning in many developed countries. A driverless prototype train is designed using ARM7 microcontroller that enables the automatic operation of the train from one stop to another. The proposed system aims in reducing the human intervention is metro trains to as minimum as possible which in turn reduces the possibility of human error. In this project LPC2148 microcontroller has been used as CPU. The automatic stopping of the train is carried out by RFID reader, which enables the train to stop when the RFID reader senses the RFID tags placed in the stations. The door of the trains is also enabled to operate automatically and IR sensors are placed near the doors to count the number of passengers leaving and entering the train. The train is also equipped with an obstacle detecting unit which stops the train when it senses an obstacle and the necessary information are displayed on an LCD.

Keywords: LPC2148, RFID, IR sensors, DC motor, LCD.

I. INTRODUCTION

There has been much advancement in the urban railway transit, starting from the engine to the metro trains and to recent automatic metro trains. Driverless metro train is an intelligent and innovative mass transit solution. Driverless technology meets a certain number of objectives involved, including high capacity, speed and regularity, reduced operational cost, adaptability, and flexibility in terms of human resources; it fulfils the idea of new approach to mobility.

Introduction Automatic train control- As definition, the ATC refers to the whole system which includes all the other automatic functions. The overall ATC system must incorporate the functions of Automatic Train Operation (ATO), Automatic Train Protection (ATP), and Automatic Train Supervision (ATS). These are the three functional areas of the ATC, they can be briefly described as;

- Automated train operation (ATO) - This subsystem is responsible for the automatic operation of throttle and brake commands to move trains between stations and stopping locations.
- Automatic Train Protection (ATP) – This subsystem is responsible for the safety-critical functions including train protection.
- Automatic Train Supervision (ATS) – This subsystem is responsible for the centralised supervision and control of train movements including office management server functions associated with train protection.

Automatic Train Control (ATC) makes use of machines to perform all or most of the functions of the train control in the normal mode of operation. ATC procurement specifications vary greatly in terms of approach and level of detail; but the trend in the newer systems is toward a more quantitative form of specifications, particularly for reliability, maintainability, and availability requirements. Automatic train control reduces the involvement of human in the operation of trains. There exists a need for effective and efficient transport system with all the increase in population. The driverless trains provide effective solutions to many issues such as time delay or irregularities, high capacity and cost etc. In this project a prototype train is

enabled with a CPU to perform the regular operations automatically. Arm7 microcontroller is used as CPU, it is used to perform the automatic operation as well as the automatic opening and closing of door, the train is equipped with a RFID reader which enables the train to stop automatically when it reads the data from the RFID reader, IR sensors are placed near the door to count the number of passengers entering or leaving the train, the train is also enabled with obstacle detecting unit which detects any obstacles in front of the train and stops it.

A. Literature review

Thabit sultan Mohammed, Wisam Fahmi Al-Azzo, Mohammed Ahmed Akaak and Mohammed Laheeb Suroor proposed a concept on "Full Automation in Driverless trains" [1]. The system concept proposes a solution to some of the major challenges related in existing metro trains systems. They used PIC microcontroller as CPU and to stop the train automatically they used IR sensors.

The unmanned train operation (UTO) which doesn't require a driver's supervision is not a recent development. Several other countries such as France, japan, had been testing out new technologies in this aspect, however there are fully functional driverless systems in countries like Dubai [2], which has the world's longest fully automated system .The first driverless metro in Torino, Italy [3] is also one of the successful metro systems in the world. They used the Siemens VAL technology as a key element to implement a fully automated metro system to provide a very high level of performance. Their main aim was to address the traffic congestions and also to address the structural circulation problems. V Sridhar wrote a paper on "Automated System Design for metro train" [5], it provides certain new applications such as automated announcement system using voice IC and radio frequency for tracking station data. It also mentions the usage of encoded RFID tags which are placed in every station, while the train is equipped with a reader, when the train comes in contact with the RFID tags the reader receives the data and is programmed to stop when receiving the data while announcing the station details with the help of a voice chip. Judith M. Cohen, Alexander S. Barron, Richard J. Anderson, and Daniel J. Graham wrote the paper called "Impacts of unattended train operations on productivity and efficiency in metropolitan railways" [6]. This paper gives the idea about the terminologies such as Grades of Operations (GoA), and the several types of it. GoA1 is a manually operated train, GoA2 is an automated train with a driver in it to perform crucial operations, GoA3 also has an automated train but it has a train attendant in the passenger car, GoA4 is a fully automatic train which doesn't require any supervision [4] Yap Kwee Seng, Ng Hon Wai, Dr Samuel Chan, Leong Kwok Weng wrote a paper which give the necessary steps to be taken to ensure the safety availability and, reliability of the metro trains.

The "Mythologies, Metro Rail systems and Future Urban Transport" [7] by Dinesh Mohan gives reasons as to why the improvement of metro systems is necessary to increase the access and mobility in India. It also gives the information about the History, technology and urban transportation from the pr-1850 till the recent developments. It also addresses the problems such as "sustainable urban mobility" which were faced during construction of the Indian metro system and how they dealt with it.

B. Problem in the present system

Rail based 'Mass Rapid Transit System' has been widely accepted as a solution for most of the traffic and environmental pollution related problems which major cities are facing throughout the world. With the increasing in traffic demand, coupled with increasing in number of vehicles on road, the traffic congestion has significantly increased over the past years. In order to improve the public transportation system, the Mass rapid Transit Systems have been provided or being planned in various parts of the world. Metro rail is a form of mass transit public transport system employing trains.

The main problems existing in the system are

- Constant need of human interference to ensure the safe operation.
- The implementation requires high cost and the installation consumes more time.
- Since the current system depends on man power for operation there exits risk of safety and many discrepancies.
- Over occupancy is also one of the major problems in the existing system as it may cause train delays and disrupt the schedule.

PROPOSED SYSTEM

C. Description of System

Our proposed system reduces human intervention by making the train operation automatic therefore reduces the risk of safety and availability.

The automatic passenger counting enables to point the heavy load point and adjust the schedule therefore reducing the over occupancy and also preventing train delaying. The obstacle detecting unit prevents from any accidents by sensing any interference to the train movement.

The system will also display the necessary details about the stations on the LCD display. When the train arrives at the stations it reads the 8 bit data stored in the RFID tags and the train stops automatically. Two motor drivers are used in this project, one for the train movement and the other one is for door operation. Power supply of 12V is used for operation.

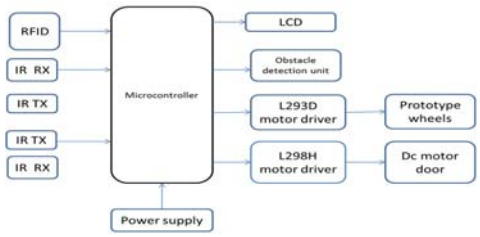

Fig. 1

D. Working

The circuit consists of ARM 7 LPC2148 microcontroller, RFID reader, IR sensors, DC motors, motor drivers, buzzer, battery and LCD.

The heart of this project is ARM 7 controller. It acts as CPU and the LCD, RFID, IR sensors and the motor drivers are interfaced to it. The fig 1 shows the block diagram if the circuit where the microcontroller acts as the CPU and it takes input from RFID through universal synchronous and asynchronous protocol (UART). The input from IR sensors are taken to count the passengers and also the controller is programmed to stop the train upon sensing the RFID tags and after stopping it is programmed to open and close the door automatically with the help of motor drivers L293D and L298H, after a prescribed time. Microcontroller takes the supply of 12V from the lead acid battery.

The motion of the prototype is controlled by the L298H motor driver interfaced with the ARM7 microcontroller by controlling the rotation of two motor. Name of the each station is displayed in the LCD as the prototype stops after reading the RFID tags and the door opens, this operation is done by L293D motor driver which operates the door by controlling the rotation of a single motor. The door closes when the prescribed time is reached or when the maximum occupancy is reached; the LCD also displays the opening and closing of door. The passenger counting operation is done with the help of two IR sensors placed at the door, one sensor counts the passengers entering and the other sensor counts the passenger leaving the train. The front of the train is mounted with an IR sensor which is interfaced to the microcontroller. It acts as an obstacle detection unit along with the buzzer, when the sensor senses any object in front of the train, the train stops while the buzzer gives a warning sound.

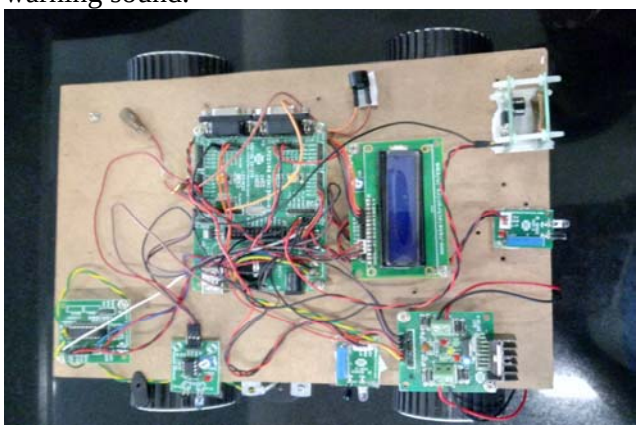

Fig.2

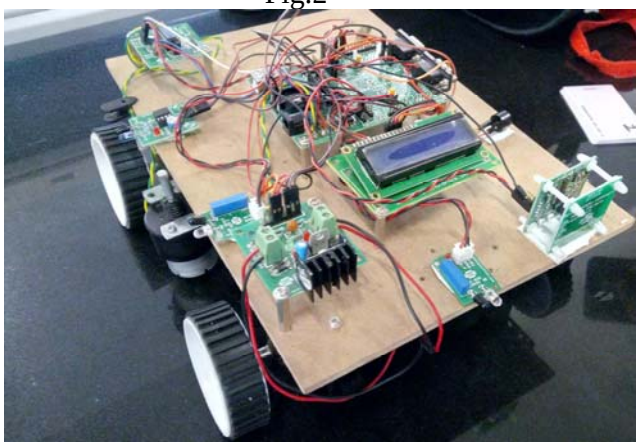

Fig.3

Components

- LPC2148 microcontroller
- 16x2 LCD display
- L298H driver
- L293D driver

- DC motors
- IR sensors
- RFID readers and tags
- buzzer

- LPC2148- It is a microcontroller based on a 32 bit ARMTDMI-S CPU with 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory. It also has In-System Programming or In-Application Programming (ISP/IAP) via on-chip boot. It consists of Multiple serial interfaces including two UARTs (16C550), two fast I^2C-bus (400 kbit/s), it has 64 pins out of which 48 are general purpose and the rest are reserved pins. It has up to 45 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP64 package. It also has On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz. It consists of two Analog to digital convertors.. CPU operating voltage range of 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O pads. IT also has Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog timer and a Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input
- LCD- A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD
- L298H driver- It is a dual H bridge motor, it can drive two motors simultaneously in forward or reverse direction. It can work in 5- 35 volts and up to 2 amps per channel.
- L293D motor driver- It is a quadruple Half H Bridge motor driver integrated circuit. The motor operations of two motors can be controlled with the pins 2 and 7. Its supply voltage ranges between 4.5 to 36 volts. It has separate input- logic supply.
- IR sensors- An infra-red sensor is an electronic instrument senses certain characteristics of its surroundings by either emitting or receiving infrared radiation. The IR sensor consists of IR LED and a IR photo diode. Its output voltage ranges from 3 to 5 volts and has a detection range of 2 to 30 cm.
- RFID- RFID stands for radiofrequency identification. It comprises of a small chip with a small antenna and a small integrated circuit. The RFID tags will have 8 bit data encoded in them. RFID reader will have coils and when the RFID tags come in range of the reader, it detects the data in the tags.
- Buzzer- piezoelectric buzzer is used to alarm when the IR sensors detects any obstructions to the train.

E. Conclusion & Future Scope

This system can be further improved in future by making use of high-speed sensors which enables fast and more efficient operation. In the future this system can be improved by creating a highly reliable metro trains with the help of new automatic train control and protection by the use of communication based train control, by implementing this the human intervention can be further reduced as a results it reduces the threats which are caused by human error.

References

[1] Thabit sultan Mohammed, Wasam fahmi Al-Azzo,Mohammed Ahmed Akaak, Mohammed Laheeb Europe "Full Automation in Driverless Trains:A Microcontroller-based prototype". , Vol 3, Issue 7,July 2014 pp. 10417- 10422

[2] "The Dubai Metro, the World's Longest Fully Automated Metro Network".

Mitsubishi Heavy Industries Technical Review Vol. 49 No. 2 June 2012.

[3]]Sauvard and Philippe, "Siemens VAL Solution in Torino- The First Driverless Metro in Italy", International Conference on Automated People Movers 2005, Orlando FL, pp.1-12, May 2005.

[4] Automated Metro – Ensuring Safety and Reliability with Minimum Human Intervention: Yap KweeSeng, Ng Hon Wai, Dr Samuel Chan, Leong Kwok Weng Systems Assurance & Integration Division Engineering Group Land Transport Authority, Singapore.

[5] V.Sridhar "Automated System Design for Metro Train", International Journal of Computer Science Engineering.Vol 1 Sept 2012 pp. 30 -41

Miryam Hernandez, "Metro automation: A proven and scalable solution," Euro Transport, Vol.12, pp.30-32, December 2014.

[6] Cohen and M.Judith, "Impact of unattended Train Operations on Productivity and Efficiency in Metropolitan Railways," Transportation Research Board 94th Annual Meeting 2015.

[7] Mohan, Dinesh, "Mythologies, Metro Rail System and Future Urban Transport," in Proc. Economic & Political Weekly, Jan. 2007, pp. 41-53.

[8] Dapeng Zhang and Dianwei Qain, "Study on leader-Follower Control in the Metro Unattended Train Operation," in proc. International Conference on Advanced Mechatronic Systems(ICAMechS), Melbourne, Australia Nov. 30-Dec.3, 2016.

[9] Hairong Dong,Bin Ning, Baigen Cai, and Zhongsheng Hou, "Automatic Train Control System Development and Simulation for High-Speed Railways," IEEE Circuits and System Magazine vol.10 Issue 2,pp.6-18, Secondquarter 2010.