Faculty of Information Technology

Railway Passenger Information System

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CONTENT

CHAPTER 1

INTRODUCTION

1.1 Introduction

Srilanka is a small country where most of the travelling takes place through public transportation systems due to average economy of citizens. The most common ways out of them are buses and trains. Even though buses are easily accessible to people, many tend to choose trains over buses due to several reasons like train fee being considerably less than bus fee, the amount of time spent for the journey being nearly half of that than the bus, travelling in trains being much more comfortable than the bus etc.

People working at long distance, school children etc. are regular passengers of trains. Although regular travelers are familiar with the train route and stations, people like foreigners, occasional local train travelers like people going on trips at vacations, elderly people etc. maybe not so.

1.2 The Problem

The Railway system in Srilanka is still in a developing state, compared to most of the international Railway systems. In most of the developed countries, trains are facilitating passenger information systems at hand lengths where passengers can know the train's current location, stations in the route, next station, time taken to passenger's destination etc. But in Srilanka there are no such systems that we are aware of.

Our team noticed that train passengers face number of problems in the event of recognizing the passing railway stations when he/she isn't familiar with the train route or at night times, even if they are familiar with the route. This may cause passengers to miss the exact station to get down and we happened to notice that this scenario occurs quite often.

Due to several reasons like missing the relevant railway station due to falling asleep, insufficient light to notice the name board at night time, train speed being too high to notice the board etc., passengers sometimes miss the railway station that he/she is supposed to get down. If the passenger is foreign to the area it will be difficult to recognize the surrounding at the first glance. They might be a foreigner or even a local person who is going to that area for the first time. And elderly people with short sight or hearing often face difficulties while traveling in train.

1.3 Solution in brief

As a solution to this problem, our team decided to fix a display system in train compartments which will show important information about railway stations and notices relevant to trains. This will be accompanied by a series of announcements, a SMS (Short Message System) system and a storage system.

- The LCD display fixed in the compartment will inform the passengers about the current station, what the next station is, approximate time taken to reach the next station and notices relevant to trains like information and advices. (ex:-'No smoking')
- A short time before reaching a railway station, an announcement will be given to the passengers telling that we are reaching this station in a few seconds. This will be given in all Sinhala, English and Tamil languages.
- The passengers in the compartment will receive a SMS alert to their phones by the system when they are about to get off in their relevant railway station. The phone is not required be a smart one, everybody with any model of phone will be benefited by this facility.
- Information regarding the name of the railway station, date & time the train reached the station will be saved in the system so that the railway department can review the data later in case they are needed.

Our system can be used in an efficient way to save the valuable time of passengers and make their journey much more comfortable. Besides, it will be really easy for both regular passengers and occasional travelers if they can know the getting down station beforehand so they don't have to constantly be aware of all the stations.

This is a microcontroller based automated system where GPS is used to find exact locations. This system will help passengers to be aware of their route, without much trouble

CHAPTER 2

LITERATURE SURVEY

Google Maps

Google Maps provide facilities like identifying the location, directions, time to reach a certain location etc. But this doesn't facilitate train routes plus requires internet facility and also constant signals.

Besides, not many people in Srilanka can afford a smart phone, which is necessary to access google maps. And also even though younger generation knows how to operate these smart devices, older generation faces problems in handling them due to the generation gap.

CHAPTER 3

AIM AND OBJECTIVES

3.1 Aim

To develop a railway passenger information system.

3.2 Objectives

- To let the passengers know about the current station, next station of the train.
- To announce the next station, a short time before the train reaches the station which will give passengers time to get ready to get down.
- To let the passenger know about his destination through a SMS.
- To keep the information system as user friendly as possible.

CHAPTER 4

ANALYSIS AND DESIGN

4.1 Top level architecture of the proposed system

The top level architecture of the proposed system comprises of the following modules. Namely; GPS module, LED display, SD card module, GSM module and audio module.

Figure 4.1 shows the interaction among these modules.

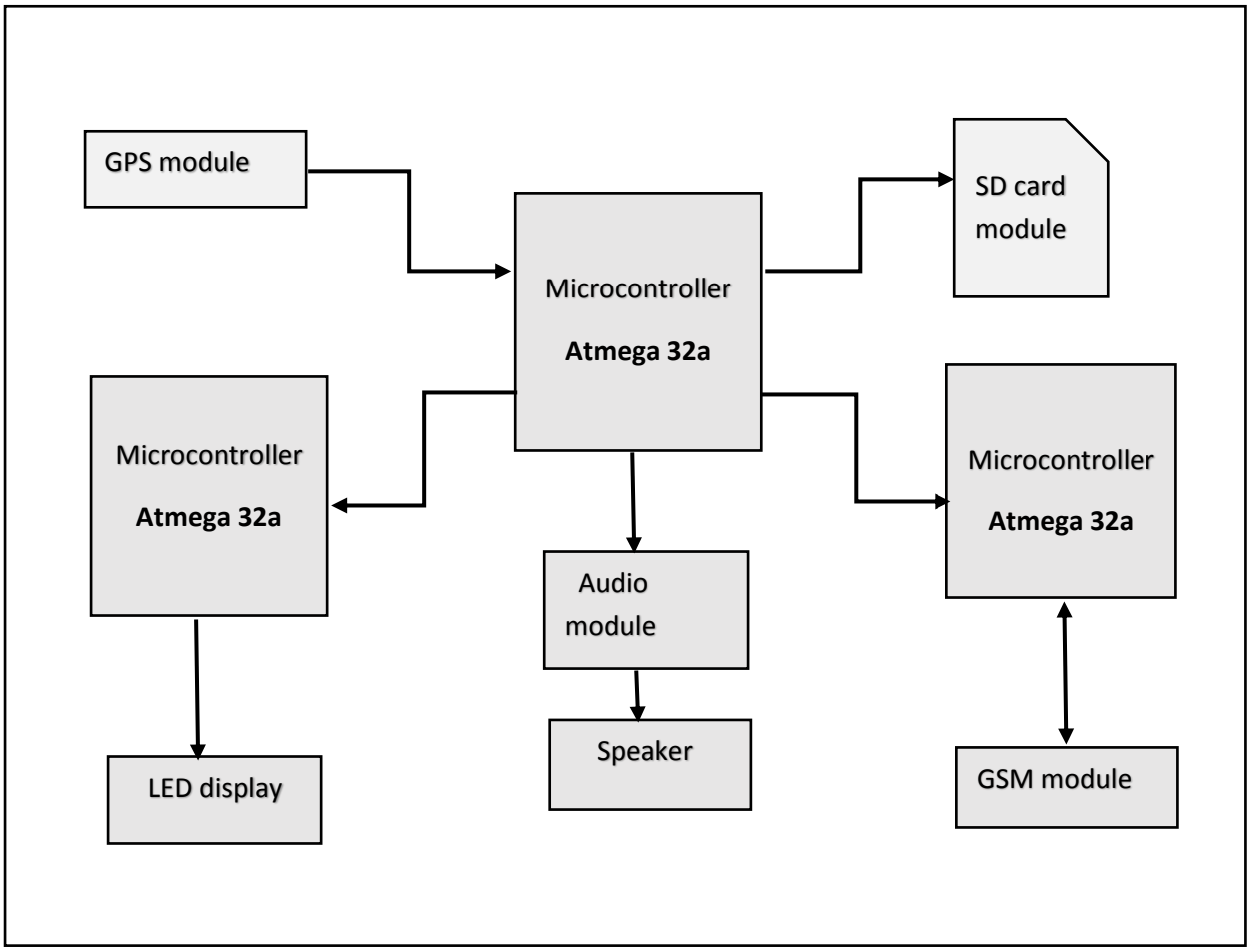


Figure 4.1: Top level architecture of the proposed system

4.2 Architecture of the device (components and modules in use)

GPS Module – Ublox Neo 6m

GPS module is considered the most important module used for our system since the functions of locating the exact position of the train is possible through this. The GPS module selected for this purpose is **U-blox Neo 6m** which uses NMEA protocols. The GPS communicates via the USART module (Universal Synchronous Asynchronous Receiver Transmitter) of the Atmega 32a using Asynchronous Reception mode. Therefore, after initiating a handshaking protocol with the Satellites, the GPS module provides the Microcontroller with the GPS NMEA sentences as a stream of bytes, which are read accordingly.

LED display- 16x32 Red Green Dual-Color LED Dot Matrix Display Module

This is dual color display. This uses two lines of shift registers. One line for the green color and other for the red color. Data lines are separately connected to these two colors. One module has 16 rows and 32 columns. Big display is made of eight 8x8 led matrices.

GSM Module – SIM 900A

GSM is a SIM 900A module, but only used for transmitting and receiving text messages. The GSM module will be used to communicate with passengers' phones. The format of the messages are predefined in the codes.

SD card

SD card is used as the storage media in our system. Data are sent from microcontroller to SD card module then directly written to SD card. We used a capacity of 2GB since memory is large enough to hold records of 4 years history. The SD card module we use here is a micro SD card module. For reading it on PC a microSD adapter has to be used. This feature involves the longest piece of code which involves defining fat32 file system, defining SPI routines and SD card reading and writing routines. The header files which were included in the source are spi_routines.h, i2c_routines.h, sd_routines.h and fat32.h. We have done testing on this feature by writing strings of data to a plain text file created on the SD card.

Audio Module - DFPlayer Mini

Audio module is a DFPlayer Mini module. It can communicate with microcontroller via UART communication method through RX and TX pins. It also supports controlling through ADKEYs. We have used ADKEY method in our project. All the announcements are prerecorded and stored in the 2GB micro SD card used for the module. Module is programmed to announce the relevant announcement when the train reaches a certain coordinate range.

4.3 Schematic diagram of the system

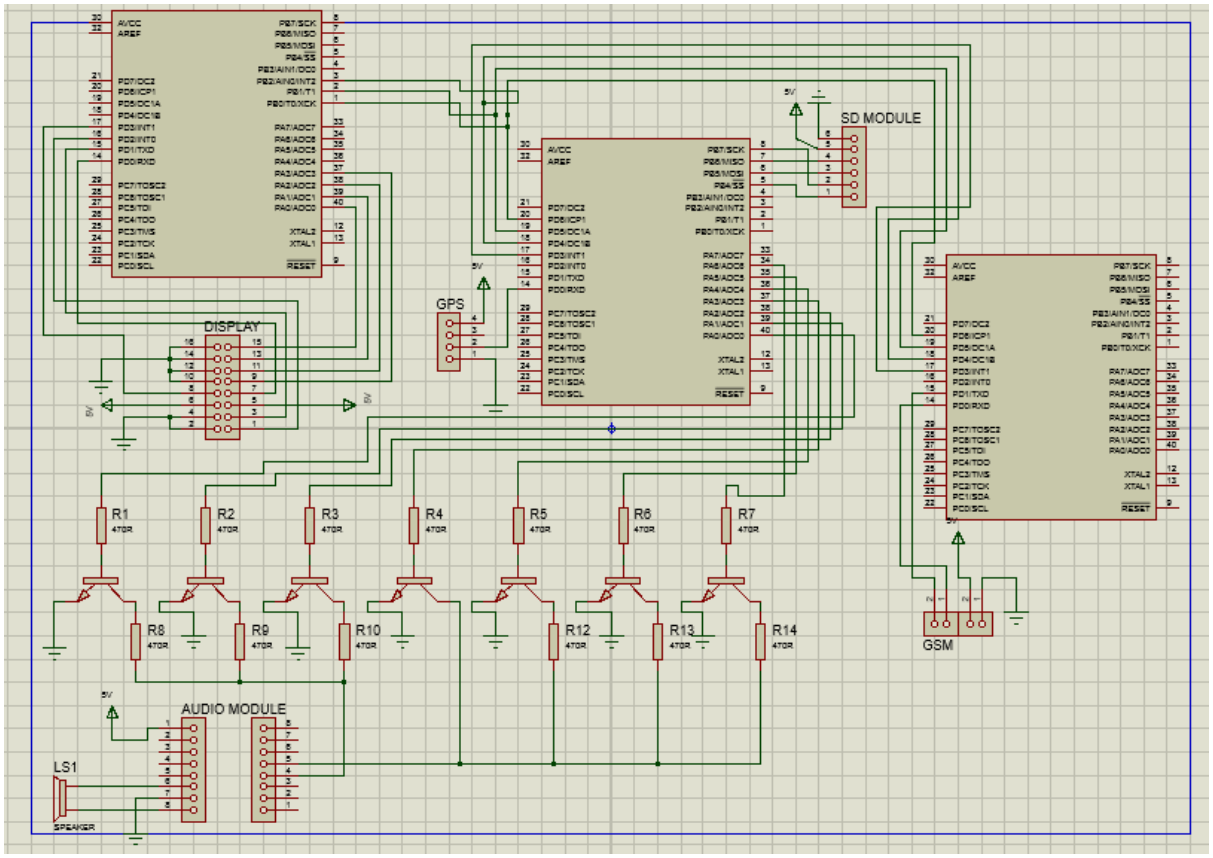


Figure 4.21: schematic diagram of the system

CHAPTER 5

TESTING AND IMPLEMENTATION

5.1 Testing and implementation

Testing and implementation was carried out at separate stages. Firstly, the identification of components and the requirements from each component, according to the device specifications, was discussed within the group and with the supervisor and instructors. Therefore, ATMEGA32A was selected based on the facts that it was commonly used, so knowledge could be obtained easily.

All the coding was done with Atmel Studio 7.0. Initially we began with LED display and GPS module.

First we tried to create our own LED board. But had to give up it because it needed heavy soldering and expanding the board was not successful.

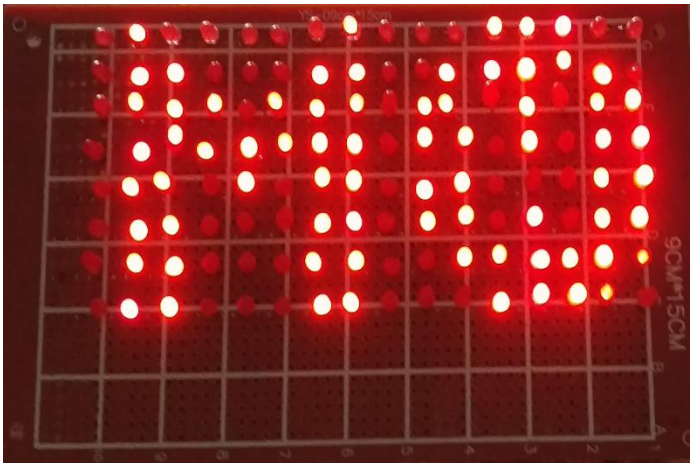


Figure 5.1: Handmade LED marix

So we looked for a readymade LED display. It was hard to find a LED board which is perfectly compatible with ATMEGA32A. But we choose P10 LED board and started coding it. With much effort we could program it to display any word. But processing power and internal storage of ATMEGA32A was not enough to display moving words or to change the word according to our system.

Figure 5.2: P10 LED display

So we looked for another LED board and found a much compatible one. A dual color 16*32 LED matrix. It was came without soldering and we had to surface mount it before using. Then we programmed it. It is built with shift registers. So we went through shift registers to understand its behavior. Program for the LED display was solely developed by one of our group member. Finally we could expand it to 2 displays and increased the size of the display.

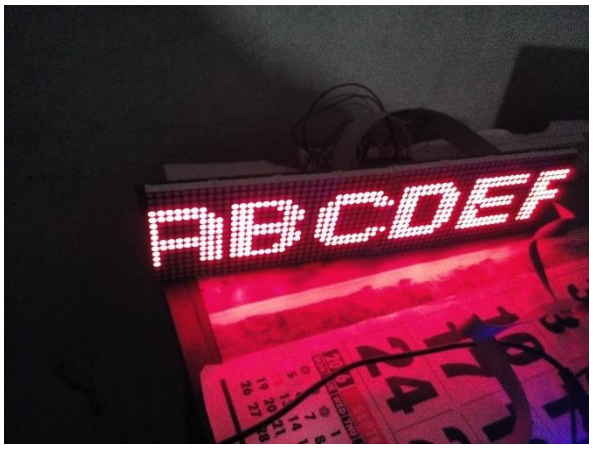


Figure 5.3: New LED display, which is now used

Meanwhile we looked into GPS too. It was the basis for our systems whole algorithm. NEO 6 GPS module provided a GUI application. So firstly we connected the module to the computer via a USB to serial convertor and tested it with the GUI application.

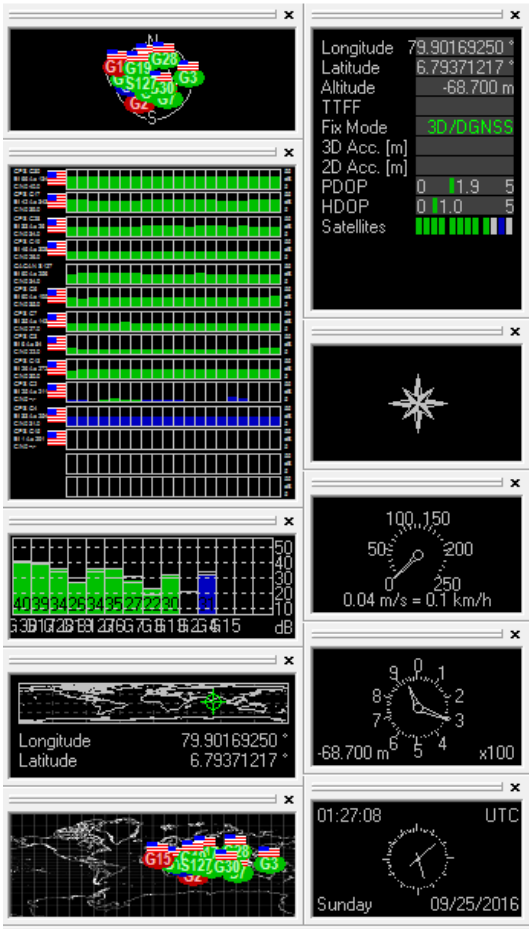


Figure 5.4: GUI application connected with GPS module

Then for the testing purposes we needed a LCD display. So we interfaced a LCD display with ATMEGA32A. Firstly it did not show anything. But then we came to know that it's brightness should be adjusted through a variable resistor. Finally we could interface it with 8 bit mode.

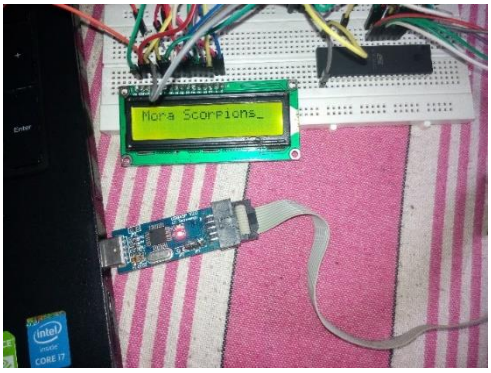


Figure 5.5: Testing of LCD display

After that we started interfacing GPS module with ATMEGA32A. We realized it communicates via UART communication method. So firstly we wrote few functions to carry out UART communication. At the beginning interfacing was not successful. It gave as some random ASCII symbols. Then with great assistance of GPS module data sheet and ATMEGA32A datasheet we got to know that this GPS module needs less than or equal to 0.2% of error rate. So we had to use the double data transmission speed of ATMEGA32A (had to enable U2X pin).

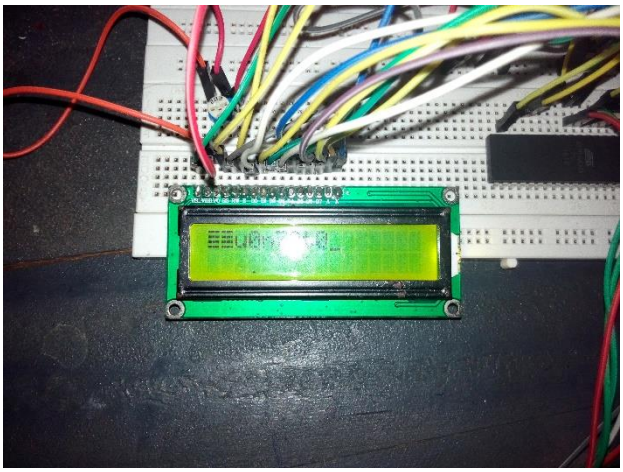


Fig 5.6:Random character

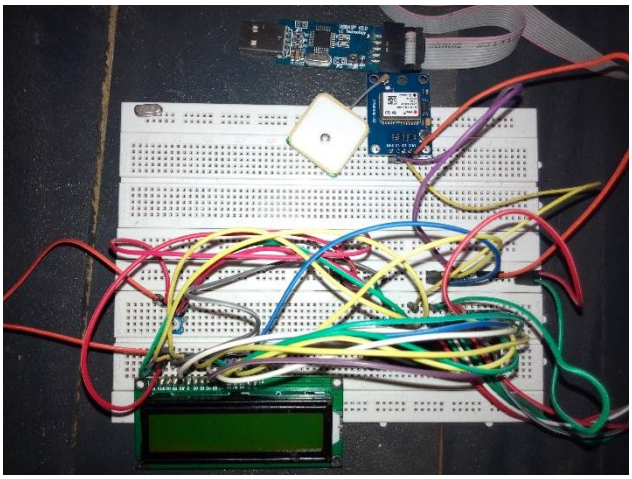


Fig 5.7: Interfacing GPS with help of LCD

Then we looked into SD card module interfacing. We bought a SD card module and started interfacing. But it was not successful at all. So we went through several other projects which uses SD card modules with ATMEGA32A. Then we found out that it needed to be functioning at 8 MHz clock speed in order to communicate with the SD card. So we had to change the clock speed of ATMEGA32A. We had to change the FUSE bits to do that. So finally it was successful.

Then we looked into interfacing of our audio module. We chose DFPlayer Mini as our audio module. Initially we tried to communicate with it using UART. But we realized that we will have to use another microcontroller as there is only one RX and TX pins in ATMEGA32A. So we looked into the ADKEY controlling method of DFPlayer Mini. It was very successful and we had to use transistors to control it with ATMEGA32A. Finally we recorded the announcements and successfully played them whenever we need them to be.

At prototype evolution we were supposed to add a GSM module to the system. So we started digging into it. We bought a SIM 900A module and started testing it. At the beginning it was not successful. It only worked at random times. We thought that there is a problem with the UART connection. We tried altering UART settings with the knowledge gained when interfacing GPS module. But it did not get better. Then we met our project advisor and he advised us to check the power connection, there could be a power unstableness, and told us to put some capacitors and resistors. So it as the perfect answer for our problem and we successfully interfaced our GSM module.

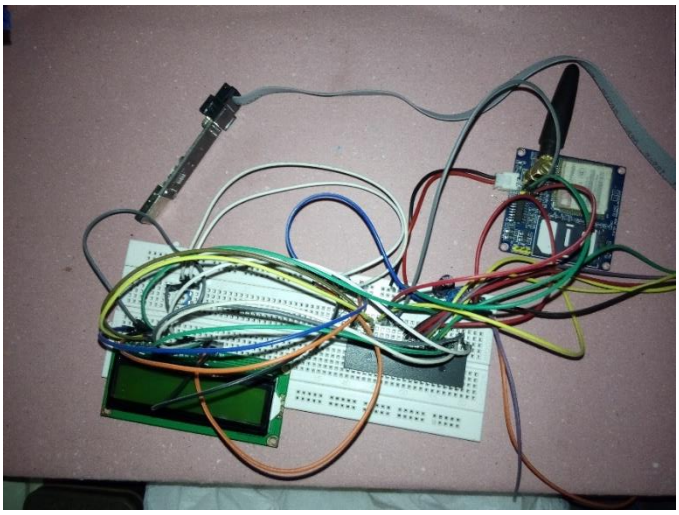


Figure 5.8: Interfacing GSM module

Finally it was time to put together all these components. So algorithms were developed to support our system. We communicated with 3 microcontrollers via a simple way using several pins.

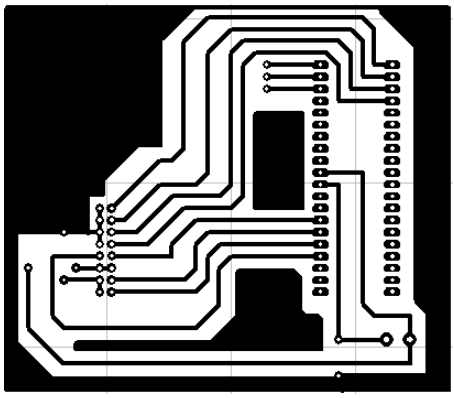
Then we went on few check runs.

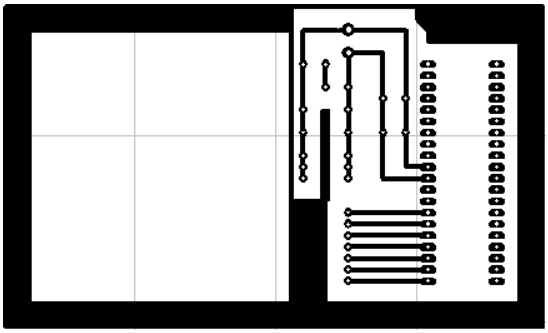
After finishing interfacing all the components it was time to design PCBs and the casing for the system.

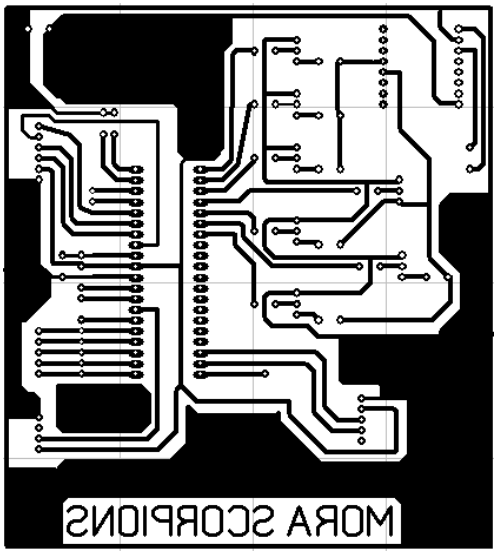
We designed 3 PCBs and the casing for our system.

Figure 5.9: Making PCBs

5.2 Printed Circuit Board Design







CHAPTER 6

FURTHER WORK

- Improving the system to calculate the delay between 2 stations than the average approximate time taken. This can be used when the train is later than the calculated approximate time between 2 specific stations. So the passengers can get to know at what time they can reach their destination.
- Developing the system to send the current location of the train to the railway department. So the department is aware where the trains are and it can be used to minimize accidents.
- Developing the current message system to an app so that passengers will be connected with the system just at a touch of the screen. It will be much easier for the passengers.
- Improving the power system by integrating power generators from renewable energy such as sunlight.

CHAPTER 7

REFERENCES

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www.newbiehack.com

www.wikipedia.org

www.youtube.com

APPENDIX A

INDIVIDUAL CONTRIBUTION

Name of the Student: Jayasekara MLP (154051J)

- Interfacing GPS module.
- Interfacing LCD module for testing purposes.
- Wrote the algorithm to extract coordinates from NMEA data.
- Wrote the algorithm to connect 3 microcontrollers.
- Designing PCBs.
- Coordinating all process.

In our project we are using a GPS module to get the position of the train and the current time.

As Sri Lanka doesn't have much signal acquisition I had to choose a better GPS module which can operate accurately in Sri Lanka.

To get an accurate coordinate (latitude and longitude) a GPS module must receive data from at least 3satellites, and to get altitude GPS module need to receive data from 4 satellites.

So I searched internet and found out this Ublox NEO 6M GPS module. GPS modules usually output NMEA (National Marine Electronics Association) standard sentences. Such as $GPGGA, $GPVTG, $GPRMC. Position data and time is given by the $GPGGA.

When I searching about GPS, I found that it has basically two types of turning on. They are,

- Cold Start
- Hot Start

Cold Start – GPS module doesn't have any kind of information what its current position, and it tries to handshake with proper satellites and start receiving data from them. This may take 30-40 seconds.

Hot Start – GPS module have a memory about what its current position in its own EEPROM, so it can quickly start receiving data. This takes only 1 second. For this purpose module consists of a small battery.

NEO-6M module supports a GUI application. So firstly I connected the GPS module to the computer with a USB to serial convertor and tested it using the GUI software. It was very successful and gave very accurate signals.

Then I interfaced a LCD display with micro controller to test out the GPS module.

I went through the data sheet of GPS module and found out that our GPS module operates at 9600bauds and uses UART communication method. So I studied about serial communication with UART and wrote few functions myself to implement UART communication. But initially I received a bunch of random ASCII characters from the module. So I had to find out what is the fault. So I went through data sheets of both ATMEGA32A and GPS module again. Then I found that the module needs an error rate of 0.2% or less to operate correctly. So I went through the data sheet of ATMEGA32A to check what options I have. I found out that I can use the double data rate of UART (by enabling U2X). After that I could interface the module perfectly with micro controller.

Then I wrote the algorithm to extract coordinates from the NMEA data received.

Our system is implemented inside a train compartment, so I decided to replace the antenna of GPS module with an external antenna.

I got help from many friends, seniors and from my supervisor in the process of correcting the fault with GPS. I would like to thank them all.

PCB Designing-

I designed the 3 PCBs in our project with Sprint Layout 5.0 software. Which help me to draw the PCBs manually and so I could design PCBs perfect for the system.

Name of the Student: Hansani TKT (154036T)

- Interfacing the GSM module
- Used an external interrupt to connect 2 microcontrollers

A specific GSM module was required to be chosen to provide the requirements of the project Eg: We use the GSM module to both receive and send a message between the system and the passenger. First when the passenger get on to the train he has to send a message to the system telling the destination that he want to get down. Then the system will automatically send back a SMS to the passenger when the train is about to reach his destination.

So accordingly SIM 900A module was selected. Then I found out information about how to connect the GSM module with the microcontroller chip. I found out that AT commands are used to communicate via UART communication method with the microcontroller.

The GSM module was connected to the Atmega 32a via its PD0 (receiver/RX) PD1 (transmitter/TX) communication ports, which connects to the TX and RX ports of the GSM module connected reversely. Since our system already uses RX and TX pins of the microcontroller, I had to take a separate microcontroller to interface the GSM module. An input voltage of 5V was required for the GSM module to work.

But initially, the connection was not successful. At first I thought that it is a problem with UART communication method. But I got to know from my supervisor that it is a problem with the stability of the power supply. Then he advised me to put some capacitors and transistors to stabilize the power. Finally I was able to implement the GSM module successfully.

The coding of delivering alert messages was done using ATMEL STUDIO. An external interrupt was used to communicate between two microcontrollers; microcontroller connected with GPS module and microcontroller connected with GSM module.

Name of the Student: Jayampathi HKDS (154048G)

- Coding and implementing the SD card
- Completing the designed PCBs.
- Designing the device case.

Our project wanted to store some data of stations which the time of arrival of the train. So I looked for an easy solution for this. I found that storing those data in a memory chip (micro SD card) was an ideal solution. First I searched how to use memory chip with a microcontroller. I got to know that I need a SD card module to interface a SD card with microcontroller. Then I searched information about interfacing SD card with Atmega 32a microcontroller. This part was highly time consuming because there were not enough resources to refer in implementing a feature like this and we had to read through a very long code and understand its functionality so that it could be used in our application.

For logged data, the SD card should be formatted in Fat32 file System. If SD card is in other file system like NTFS, the SD card does not work. It was my own experience. When there is often data logging it is really useful to have timestamp. That way we can take data by one minute apart (by checking the clock) or noting at what time of day the data was logged. To do that I needed a RTC (Real time clock). We used RTC_routines.h header file to it.

Then I tried to store a small file of text in SD card through microcontroller. But it didn't work. Then I got to know, when interfacing a SD card we need an internal clock of 8 MHz in microcontroller chip. But default the Atmega chip has only 1 Mhz. so then I searched a way to increase the internal clock. Then I found the method of hanging fuse bits method. By changing high fuse and low fuse I was able to set internal clock to 8 MHz

After that I was able to store a small text file in SD card through microcontroller. Then I connect my code with GPS code. Then I was able store station's location, date & time which received from GPS in a .CSV file.

Also I completed PCBs which were designed by another group member. Then by using a hot IORN and a ferric chloride solution. After soldering all the connectors and components on to the PCB I tested the connections and corrected the errors on the board and developed it to working condition.

Also I design the device case.

Name of the Student: Gunawardana PSM (154033G)

- Implemented the Audio module
- Preparation of Report, Presentations
- Voicing and preparing the audio announcements

To achieve this I,

Studied about Audio modules

Studied about serial communication with DFPlayer Mini

Studied about ADKEY controlling method of DFPlayer Mini

Designed the circuit to connect microcontroller, audio module and speaker

Recorded the announcements for the system in all three languages.

First of all I searched internet for available audio modules and their specifications. Then I came to know about DFPlayer Mini. I realized it will be compatible with our system, when looked at its features. So I studied further about it. As the module supports a speaker less than 3W by itself, it perfect matched to our system. Then I ordered it through eBay as it was not available here. I started coding it. I went through its data sheet and realized that there are two methods of communication between audio module and the micro controller chip. They are UART method and ADKEY method.

I understood that it supports UART communication with 9600 baud rate. But I realized is that to communicate with microcontroller chip, UART method requires RX and TX pins. But our system is already using the RX and TX pins of microcontroller chip in the communication with GPS module. So I decided to turn to the ADKEY method. I looked into the ADKEY controlling method of the module. Then I found a way to control it using micro controller.

First I took a bread board and first checked the audio module alone by giving power to it through VCC and grounding it through GND. Then connected the speaker. It worked. Then, since what I wanted to do was to play the relevant audio when train reaches a certain GPS coordinate range, I connected the audio module with the microcontroller. I used 0-6 pins of PORT A.

First I tested it with using switches as given in the module data sheet. But it gave problems with power supplying so I used transistor as a switch to control the module with microcontroller. When I wanted to play a certain audio, I turned on the relevant pin of the microcontroller by making it high, through the code. Then it turned on the base current of transistor and turned it on. So the relevant resistor was grounded through the emitter. Therefore the relevant audio played.

Finally I was able to successfully play any mp3 file using the module. Module uses a 2GB micro SD card to store the sound files. So when the train entered a given range of GPS coordinates, the code runs and plays the audio.

After all I recorded the announcements needed for the system in all three main languages.

Name of the Student: Weerasinghe SAAM (154133M)

- Coding and implementing the LED display.
- Preparation of videos

My part in the project was to find a LED display and code it so that the system can use it to display the information. Firstly, I searched on internet what are the LED displays in the market. I realized that it takes time to buy a relevant LED display. So I decided to create my own one. So I simulated led matrix display on proteus software. But the processing speed of the computer is not enough to see the real situation. Then I searched and found details about making a LED display. I created a 16x8 LED matrix using a Vero board. It was very difficult to solder LEDs. However, with my team members help I did it. And I code it to display some small texts. By doing that I understood the basics of a LED matrix display. I learnt that the LED matrix are mostly based on the theory that naked eye can't identify the things that are happening in higher frequency. But the problems occurred. One is I could never make a bigger LED display the whole train passengers can see easily.

Then I found a P10 LED display module. It uses shift registers. I checked the details on internet about this display. I learnt a lot about shift registers and how they are interconnected in this display. I started coding it by switching on lights on the board I need. Then I displayed letters and symbols I need by switching on lights on the board I need. Then I had to create a font file. Basically the font file includes what are the lights needed to be switched on when displaying a letter or symbol. Finally, I could display strings on the display. But many problems occurred. Longer strings can't be displayed using Atmega32A microcontroller. Because when the string is longer the details to be sent to the display from the microcontroller was high. Because of that frequency and the memory space of the microcontroller was not enough to display them. Then I found out that to code displays like this they are using a control card. But it will make the cost of our final product high. So I had to look for an alternative.

Finally, I found one on eBay. It is the display that now our system is using. 32x16 dual color LED matrix display module. I received this as a DIY (Do It Yourself) kit. So I had to solder all the parts and create the display. This display also uses shift registers. But the organization of these shift registers was very easy to code. And this organization doesn't need higher frequency like P10 LED module. And this organization reduces the memory space that is needed to code the display. Display was somewhat smaller than the P10. Even though I could connect two LED displays. And I can connect displays as much as I need. So that I can make a big led display. However, I had to create font files that are suitable for this display. Finally, I could display any string I need.

After all I made my display to display the information that my system needs.