Real Time Bus Monitoring System Using GPS

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Abstract

The Real Time Bus Monitoring and Passenger Information bus tracking device will serve as a viable notification system that will effectively assist pedestrians in making the decision of whether to wait for the bus or walk. This device is a standalone system designed to display the real-time location(s) of the buses in Mumbai city. The system will consist of a transmitter module installed on the buses, receiver boards installed on the bus stops, LED embedded map of the BEST bus transportation routes at the centralized controller. It will also have passenger information system software installed at the bus stops and which will provide user the relevant information regarding all the bus numbers going for his source to destination along with the route details and the cost. Assembly of these modules will enable the tracking device to obtain GPS data of the bus locations, which will then transfer it to centralized control unit and depict it by activating LEDs in the approximate geographic positions of the buses on the route map. It will also transmit its bus numbers and route names continuously as soon as the bus comes within the range of the receiver at the bus stop. In addition, the device will be portable and sustainable; it will not require an external power source, which will eliminate long-term energy costs.

Keywords: GPS, RF Transceiver, Bus, Visual Basic, Receiver, Transmitter

1. Introduction

A passenger in Mumbai often faces the decision of whether it would be quicker to wait for the next bus or to walk or to hire a cab/rickshaw to reach his/her destination. Many passengers are often late to work, students are late for classes because they decide to wait for the bus instead of just simply using a alternate transportation. The design team surveyed 30 students about their opinions on the current bus transportation service, and the following conclusions were extrapolated from the results:

1] 75% of the population asserted that they had been late to their destination because they decided to wait for a bus instead of walking.

2] 96% of the population affirmed that knowing the position of the buses on campus would be beneficial in deciding whether to walk or wait for the bus.

3] 96% of the population also affirmed that knowing the location of the buses is more indicative of wait time than an approximate arrival time.

4] The overall approval rate of the current transportation notification service was 38%.

If passengers had an easy way to see which bus is near to their location and approximate time it would take to reach the stop, in real-time, they could make a more accurate, decision of whether or not to wait at a stop. The Real Time Bus Monitoring and Passenger Information system will provide pedestrians with this convenience.

The Real Time Bus Monitoring and Passenger Information system is a standalone system that displays the real-time location(s) of the buses in Mumbai. This system, designed to be deployed at various bus stops around city, is comprised of a power source, a battery, a microprocessor, LEDs, and RF Transceiver. The RF Transceiver will be used to poll a signal from the systems installed on the buses that contains GPS data of each bus's location. The data will then be processed by a microprocessor connected to the RF transceiver and used to display on the LEDs (control unit) that will represent each bus's location and on the LCD screens on the bus stops. This system will assist pedestrians in making the decision of whether to wait for the bus or walk.

2. Project Description and Goals

The goal of the Real Time Bus Monitoring and Passenger Information bus tracking device is to provide a product that pedestrians of Mumbai city can use to help them decide whether to wait for the bus or walk or use alternate transport. The display will be on a LCD screens which can be placed at bus sites around Mumbai city.

2.1. Product Features

i. LCDs will be placed along a map of BEST bus routes
ii. LCDs will light up and display all the bus numbers along with their routes to indicate the buses which are near to the bus stop along with the estimated time it may take for the buses to reach the stop
iii. The whole system will be powered with a backup battery
iv. The device will be enclosed in a standalone weather-proof case with Plexiglas cover
v. The system will use RF devices to transmit as well as receive data.

2.2 Goals

i. Completely self-contained with easy installation, no external wires required.
ii. Low power, less than 500 mA current draw.
iii. Target cost of prototype parts, less than Rs. 12000.

3. Design Overview

The functional block diagram depicted in Figure 3.1 illustrates the holistic assembly, highlighting how each component interacts with other parts and executes its functional role.

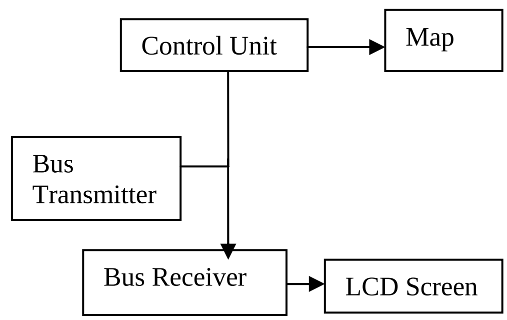


Figure 3.1 functional block diagram of Real Time Bus Monitoring and Passenger Information System.

The Real Time Bus Monitoring and Passenger Information bus tracking device will incorporate the following components listed in Table 3.1 to achieve the stated features and goals of the project design.

Table 3.1. Components of the Real Time Bus Monitoring and Passenger Information bus Tracking Device and Associated Functions

Component	Function / Feature
Battery	Will serve as a backup power source for the tracking device when lighting is limited such as during nighttime.
Power supply pcb	Will convert the AC240V supply to DC 5V to be supplied to the microcontroller boards
Switching Regulator	Implements pulse width modulation to step down the voltage supplied to all load components from 12V to 5V.
Embedded Serial to GPS Module	Connects to the satellites and find out the GPS locations of the buses, along with the speed and GMT.
Processing Platform at transmitter unit	Receive serial data from GPS module and then process it to transmit the readings along with its own specific information through RF transmitter module.
Processing Platform at receiver unit	Receive serial data from the transmitter and then process it to be displayed on the bus stop.
Processing Platform at control unit	Receive serial data from GPS module and implement programmable logic to activate LED drivers and lights.
LEDs	5mm LEDs will be used as the indicators on the map; these will have the capability of lighting any color to represent each bus route color.
Decal Map	Map of the bus routes, behind which LEDs will be placed to indicate bus locations.

3.2 Software part

Software is designed and developed so as to provide the passenger with all the necessary information as to which buses from the source will go to his destination along with their routes, ticket prices etc.

4. Modules for Bus monitoring and passenger information

Real Time Bus Monitoring and Passenger Information is implemented in five different modules:

a) Power supply module
b) Transmitter module
c) Receiver module
d) Control module
e) Software module

4.1 Power Supply Module

The power supply for the Real Time Bus Monitoring and Passenger Information bus tracking device is designed to be completely sustainable. The panel is capable of supplying enough current to power the device load. The core components of the Real Time Bus Monitoring and Passenger Information bus tracking device require 5V of power to operate; therefore, the system design implements a switching regulator to step down the supply voltage from 240V to the 12V. This 12V obtained output is then connected to LM7805[2] IC which gives a stable 5V output voltage required for the circuit.

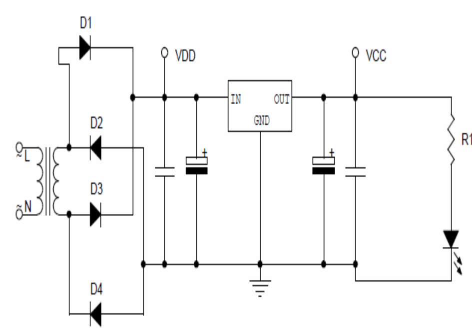


Figure 4.1 Circuit Diagram of Power supply

4.2 Transmitter Module

The initial phase of the tracking process involves requesting and receiving the GPS data through the module from the satellites. The GPS embedded module will serve as the communication link between the Real Time Bus Monitoring and Passenger Information system and the satellites. Consequently, the data received from the GPS module will be passed on to the PIC microcontroller 18F4520 using a UART serial link where it will then be processed, the latitude and the longitude coordinates of the location will then be separated from the bulk of data obtained by the GPS module using software. These readings obtained will then be transmitted to the control unit through the RF transmitter. Also the controller will regularly transmit the bus information through the RF transmitter module which will then be received and further processed at the receiver module. All the data to be sent for transmission will be sent through the SPI protocols [3].Figure 4.2 shows circuit diagram of transmitter.

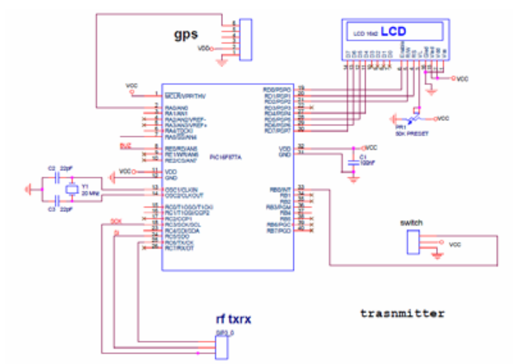


Figure 4.2 Circuit Diagram of Transmitter

4.2.2 Technical Specifications

1. Electrical Characteristics
General Frequency L1, 1575.42 MHz C/A code 1.023 MHz chip rate Channels 16
Sensitivity Tracking -152dBm typ Acquisition -139dBm typ
Accuracy Position 5 meters CEP (90%) horizontal, SA off. Velocity 0.1 meters/second Time 1 microsecond synchronized to GPS time

2. Dynamic Conditions
Altitude 10,000 meters max

4.2.1 GPS module

CPIT GPS module [4,5]SA3618/SA3618P (patch on top) is a high sensitivity ULTRA LOW power consumption cost efficient, compact size; plug & play GPS module board designed for a broad spectrum of OEM system applications. The GPS module receiver will track up to 16 satellites at a time while providing fast time-to-first-fix and 1Hz navigation updates. Its superior capability meets the sensitivity & accuracy requirements of car navigation as well as other location-based applications, such as AVL system. Handheld navigator, PDA, pocket PC, or any battery operated navigation system. The module communicates with application system via RS232 (TTL level) with NMEA0183 protocol. Main Features of GPS Module:

a) Built-in high performance NMEX chipset.
b) Average Cold Start in 60 seconds.
c) Ultra Low power consumption.(SA3618 27mA typ @ 3.3V)
d) 16 channels All-in-View tracking.
e) On chip 4Mb flash memory.
f) TTL level serial port for GPS receiver command message Interface. Compact Board Size
g) Horizontal Velocity 300 kilometers/hour max
h) Vertical Velocity 36 kilometers/hour max
i) Acceleration 2g, max
j) Jerk 4 meters/second3, max

3. Power
Main power input 3.3 ±5% VDC input.
Supply Current SA3618 26 mA @ 3.3V (Continuous mode)

4. Serial Port
Electrical interface one full duplex serial communication, TTL interface
Protocol message NMEA-0183, version 3.0 optional.
Default NMEA GGA, GSA, GSV, RMC and VTC. 9600 baud rate, 8 bits data, 1 start, 1 stop, no parity.

4.3 Receiver Module

The receiver unit of the RTBMPIS(Real Time Bus Monitoring and Passenger Information system) as shown in Figure 4.3 will consist of a PIC microcontroller board equipped with a PIC 18F4520 [4] microcontroller to receive the data through the RF receiver. The transfer of the data from the TF receiver to the controller is done through the SPI protocols. The controller will then implement custom programmable logic to interpret the data. The design team will utilize the programming language, based on C/C++, to create the algorithms and instructions for processing the data. After data processing, the processing platform will send the data to the LCD displays. To convert data into voice instead of LCD display voice over circuit (APR9600) is used. This voice over circuit is low cost high performance sound record/replay IC incorporating flash analogue storage technique which will help blind passengers.

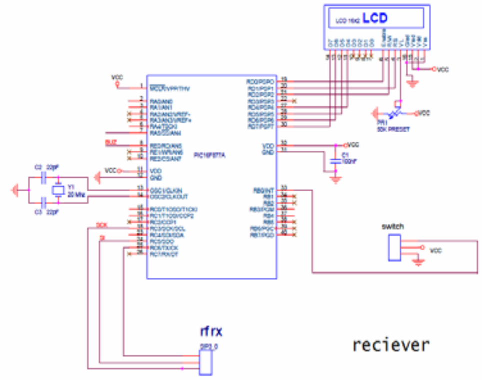


Figure 4.3 Circuit Diagram of Receiver

4.4 Control Module

Upon receiving the coordinates from the transmitters of the buses the control module will process the data and illuminate the LEDs corresponding to the coordinates obtained. In order to minimize power consumption, the LED drivers will only instruct LEDs to blink; this will reduce power consumption by 50%. For display purposes, the bus routes will be illustrated on a map decal imposed on Plexiglas. LEDs, whose locations, will be positioned to represent bus stops and intermittent locations in-between bus stops.

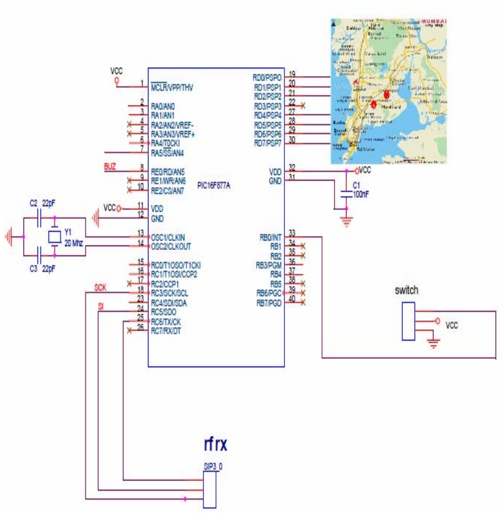


Figure 4.4 Circuit Diagram Of control unit

4.5 Software Module

This part of the project will be independent form the rest of the project. It has been designed solely for the aim to provide passenger travelling in the BEST buses with all the relevant information like bus numbers going to his/her destination, the route details, the ticket prices etc before the passenger even gets on the bus. The software will be installed on the special purpose computers designed only for the job like ATVM system currently used by Indian Railways. This part is done using Microsoft's VISUAL BASIC 6.VISUAL BASIC is a high level programming language.

5. Implementation of project

5.1 Interaction of the software with the passenger

The first window as shown in Figure 5.1 consists of the source and destination window. The software's entry page consists of a dialogue box titled BUS ENQUIRY. The box has three fields in it which the passenger can change according to his/her needs. The first field consists of mode of transport in this case it is bus but it can be generalized for all public transport modes like Railway, Metro etc. The second field is starting from where the passenger will provide the start point of his/ her journey. The third field is destination field here the passenger will feed the end point of his/ her journey. To the right a map of the city Mumbai has been displayed so the passenger can understand all available sources and destinations. Also the dialogue box contains a tab called as find where in the software considering all the inputs from the passenger will search the database and give the result. The result will contain the schedule of the next bus on the route. Here in the screenshot the passenger wants the bus from Kalyan to thane. So the output shows the result as a bus no.121 departs from Kalyan at 7.45 am and reaches thane at 8.15 am and the fare is Rs.150. At the bottom left corner there is a field called print ticket that is if the passenger is satisfied from the response of the software along with the timing then he/she has a option to get the ticket printed at the ATVM kiosk itself. The money can deduct from the smart card available to each and every passenger.

Our project aims to install these machines at each bus stop throughout the Mumbai so the passengers of the best transportation system can have knowledge of the buses beforehand.

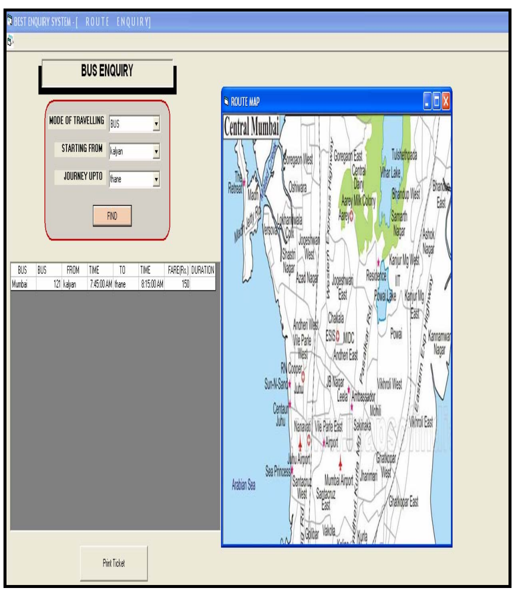
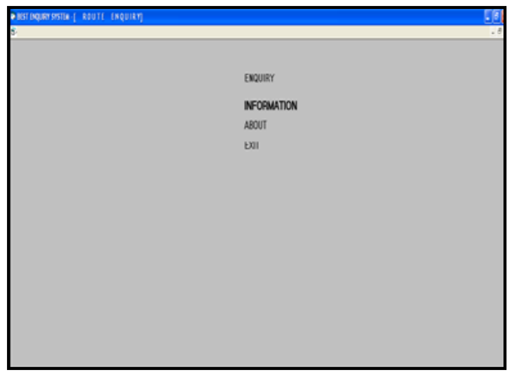


Figure 5.1 Passenger interaction screen

Figure5.2 Final printed ticket

Project also allows enquiring about the particular BUS on particular route. This comes under the heading of INFORMATION. The window will look as follows:



The Figure 5.3 shows the Enquiry window when the passenger enters the information. In this passenger should select Bus no. and name of the bus. For that particular bus no. different bus stops with arrival and departure time will be displayed.

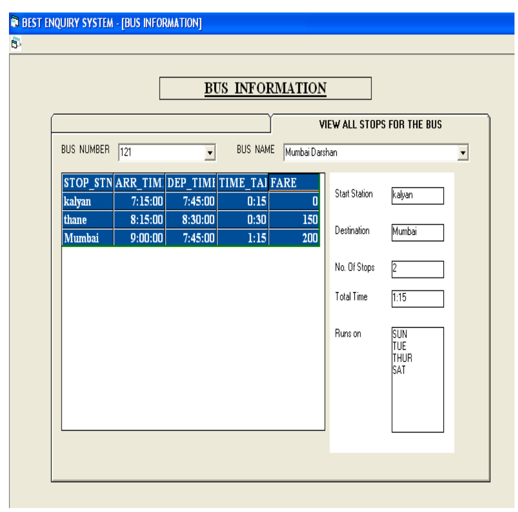


Figure 5.3 Screen showing bus information

5.2 Route Map Simulation

Now question arises that suppose two buses whose destination is same but the route for two buses are different then how passenger would know the correct bus for him. For that reason JAVASCRIPT [6] simulation is developed which gives the passenger the route of two buses having same destination. JavaScript is a prototype-based scripting language that is dynamic, weakly typed and has first-class functions. It is a multi-paradigm language, supporting object-oriented, imperative, and functional programming styles. JavaScript was designed to add interactivity to HTML pages

6. Codes and Standards

There are several codes and standards that apply to the project design; however, these regulations and standards only serve as a reference to understanding how individual components of the design operate.

1. UART[7] Serial Protocol: Serial transfer between GPS module and microcontroller
2. SPI Protocol: Communication between microcontroller and RF transceiver module
3. VISUAL BASIC: used to develop a **ATVM** system for the passengers.

7. Conclusion

With the implementation of the project a complete track can be kept of the buses around the city. The display at the bus stop saves the commuter's time. The voice over at the bus stop helps blind person. The ATVM system reduces the work of a conductor and also gives the complete details of all the buses to customer. Thus a complete system of the bus transport system is established. The system involves the tracking of every bus at the control unit, bus information on the bus stops for the passengers with a voice over of the information for the blind. Also an ATVM system is installed at each bus stop to reduce the burden on the conductor.

8. Future Scope:

1. The range of the RF transmitter can be increased to cover a wider area
2. The ATVM system can show a real time map with bus tracking
3. The project can be extended to other mode of transport such as rail system.
4. The sensors can be put on road to get the exact arrival time of the bus at a particular bus stop.
5. Sensors can be placed in the buses which do continuous monitoring of the bus and its condition.

Thus driver will be acquainted with the information about engine problems and many other performance related information.

9. References

1] http://www.ece.gatech.edu/academic/courses/ece4007/09spring/ece4007l04/dk2/ (Georgia Tech-"Wait less Bus Tracking System")

2] SageQuest, *Mobile Control from SageQuest*, Solon, Ohio.

3] www.engineersgarage.com/electronic-components/rf-module-transmitter-receiver.

4] "What is GPS?," Garmin. [Online].Available: http://www8.garmin.com/aboutGPS/

5] http://en.wikipedia.org/wiki/Global_Positioning_System.

6] http://www.w3schools.com

7] Batteries ASAP. CSB 12V Batter Vendor Catalog. [Online]. Available: http://www.batteriesasap.com/gpcsb12v71.html

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