Implementation of Smart Public Transport System Using ARM7TDMI-S Processor and GPS-GSM Technologies

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Abstract: *Now-a-days buses are major source of travelling for everyone. In several bus stations many people are waiting for buses. Due to traffic buses may not come to their destinations in time. It is the major problem for everyone. In this present scenario, we are designing a GPS-GSM based system which identifies bus exactly at which location it has started recently. For this purpose here we are using GSM-GPS connected to the bus. The project implements solution for enhancing public transportation management services based on GPS and GSM .The system consists of IN-Bus module which is equipped with GSM, GPS modules and GSM module with the persons who are waiting for the bus. The project is designed with ARM7TDMI processor. In this project we are using different modules such as LPC2148, GSM, GPS, IR pair, 16*2 LCD. The project is implemented by using a mobile and In-Bus module. The In-Bus module consists of IR pair to count the number of persons in the bus and to find out exact location of bus we are using GPS and the information can be obtained as a message by using a GSM module.*

Keywords: ARM7TDMI-S, GPS, GSM, Smart Public Transport

1. Introduction

With the increasing number of people in opportunistic cities already existing problem of poor transportation services has grown to an alarming extent. Due to non-availability of prior information about the buses arrival schedule, people have to wait longer on bus stops especially in morning when they have to reach the offices in time. The buses are overloaded for most of the times which often results in some kind of fault occurrence in buses and people get late further. In addition, rapid population growth and spatial expansion is adversely affecting this ratio. Consequently the dissatisfaction with the level and quality of public transportation service has leaded those people who can afford it to turn to private modes of transportation. Owing to poor infrastructure of roads in country, the annual growth rate of vehicles has created problems in controlling the traffic flow resulting in traffic congestion on roads. Also with the increased number of vehicles, the content of carbon mono-oxide and particulates matter concentration is found to be 10 times higher than World Health Organization (WHO) in central parts of Lahore city thereby deteriorating the environment and causing lung diseases. To reduce the number of private vehicles and improve the public modes of transportation, the idea of introducing Light Rail Transit (LRT) is proposed. This will also help in reducing the accidental. Although LRT seems to be a promising solution for enhancing public modes of transportation, it is costly to deploy. Another approach would be to introduce a technology based transportation management system that will help the passengers in getting informed about the exact schedule of buses and send recommendation report after performing rush statistical analysis on per stop basis for regulating the transport services. In this paper, a transportation management system is developed for enhancing public transportation services based on integration of GPS and GSM. GPS is used as a positioning device while GSM is used as communication link between different modules. These modules include BUS Station Module, In-Bus Module, BASE Station Module and BUS Stop Module. Bus Station Module contains a GSM engine interfaced to PC and transmits the bus index and its license plate number to BASE Station. At the same time, it turns on GPS receiver installed in the bus. The bus then starts transmitting its location to the BASE Station. The BASE Station comprises of a GSM engine interfaced to a microcontroller for processing user request of bus location as well as a number of other GSM engines interfaced to various PCs each reserved for a separate bus to update the location information of that bus. The buses location data from BASE Station is sent to each bus stop. BUS Stop Module after receiving buses location data through GSM engine displays it on dot matrix display installed at each bus stop.

2. Specifications of Hardware

The following hardware components are used in building the entire system:

a) GPS Receiver
In order to keep track record of bus, a Garmin GPS35receiver, powered from the bus main battery, is installed in each bus. The Garmin GPS35 is a complete GPS receiver and embedded antenna designed for a broad spectrum of OEM system applications. The GPS35 tracks up to twelve satellites at a time while providing one-second navigation updates and low power consumption. Its far-reaching capability meets the sensitivity requirements of land navigation as well as the dynamics requirements of high performance aircraft. Internal memory backup allows the GPS35to retain critical data such as satellite orbital parameters, last position, date and time.

b) GSM Modem

A wireless link between the modules is provided with Nokia 12i GSM module. Nokia 12i offers advance GSM connectivity and supports EDGE/GPRS and HSCSD with automated GSM connection establishment It is equipped to provide reliable remote connections and offers application level watchdogs, inbuilt self check mechanisms and a reliable Virtual Machine (VM) for JAVATM. Nokia 12i also supports reliable inbuilt internet protocols: TCP/IP for reliable data transfer, UDP/IP for audio and video streaming and HTTP for accessing web pages. The module can also be connected to an external GPS device that supports National Marine Electronics Association (NMEA) standard. The inbuilt NMEA parser can parse the location data from the output that it receives from the GPS device. External microcontroller can use AT commands to communicate with Nokia 12i and simple remote I/O applications can easily be controlled via text messages

c) Microcontroller

AT89C52 microcontroller is selected because it is a powerful microcomputer which has low power consumption and provides a highly flexible and cost-effective solution to many embedded control applications. It has 8K bytes of in system reprogrammable flash memory, 256 bytes of internal RAM, 32 programmable I/O lines, three 16 bit timers/counters, eight interrupt sources and a programmable serial channel

d) Battery Backup

In-Bus Module is provided with an internal battery so that whenever power from main battery is disconnected, microcontroller continues to transmit the location to BASE station. A message is also sent to BASE station to notify it about the disconnection of main battery. When the power is resumed, the internal battery begins to recharge.

e) Alarms

The microcontroller unit in In-BUS Module sends different alarm signals for different events to BASE Station module

- On Backup Battery: When the main battery is switched off, a notification is sent to BASE station.
- Stoppage: When the bus is stationary for more than a specified time, BASE station is informed by a stoppage alarm. In case of an accident or any other fault occurred in bus, the driver can notify the BASE station by pressing a button in bus.
- Getting Late: When the bus is not covering a certain distance in a defined range of time, an alarm signal of getting late is sent to BASE station.
- Route Deviation: When the bus deviates from the assigned route by a given margin, BASE station is notified.

3. Operation of Modules

The entire system/network comprises of four modules: BUS Station Module, In-BUS Module, BASE Station Module and BUS Stop Module. The working and interconnection of these modules is described in this section.
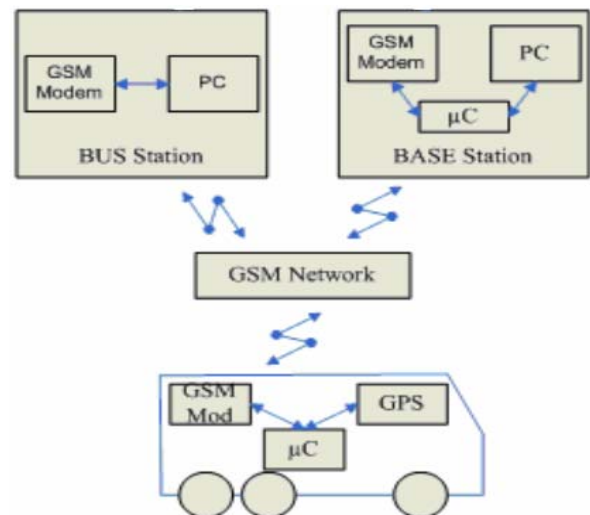

Figure 1: Block Diagram of Transportation Management System

a. BUS Station Module

BUS Station Module is installed at bus terminals from where the bus will depart. It contains a LASER and a GSM modem connected to a PC. When the bus enters the terminal pad, it is detected by the LASER sensor. The operator at the terminal enters the license plate number in database. A count number is then accordingly assigned to the bus e.g., bus leaving the terminal first will be assigned a number 1. The route number of bus along with the direction information, assigned count number and license plate number is sent to the BASE Station via GSM. An example of the transmitted header is of the form "33U01AP07AK7240" where '33' is the bus route number, 'U' is upward direction of bus ('D' will be downward direction), '01' is the count number assigned to the bus and 'AP07AK7240' is license plate number of bus. An 'ON' signal is also transmitted to the In-BUS Module installed in the bus for initialization.

b. In-BUS Module

In-BUS Module is installed inside every bus and consists of a GPS receiver, a GSM modem, a NV-RAM, infrared object counting sensors, door opening/closing sensors and an emergency button; all interfaced to AT89C52 microcontroller. After receiving the initialization signal form BUS Station Module, this module starts transmitting bus location to the BASE Station. At each stop, when the driver opens the door, an interrupt is generated and microcontroller starts counting the numbers of passengers entering and leaving the bus with the help of infrared sensors. This count value on per stop basis is transmitted to the BASE Station. In case of an emergency situation (e.g., when fault occurs in bus), driver can press the emergency button to inform BUS and BASE Station units about the location of bus. The BUS station operator can then adjust the schedule accordingly and send an additional bus for facilitating the passengers. Microcontroller present in this module continuously calculates the difference in consecutive GPS locations. If the difference remains near zero for more than a designated time, then a getting late message is transmitted to the BUS and BASE stations. In case of sparse GSM coverage, location information is stored in non-volatile RAM. After regaining the GSM network, previous locations are updated to the BASE station. The block diagram for this module is

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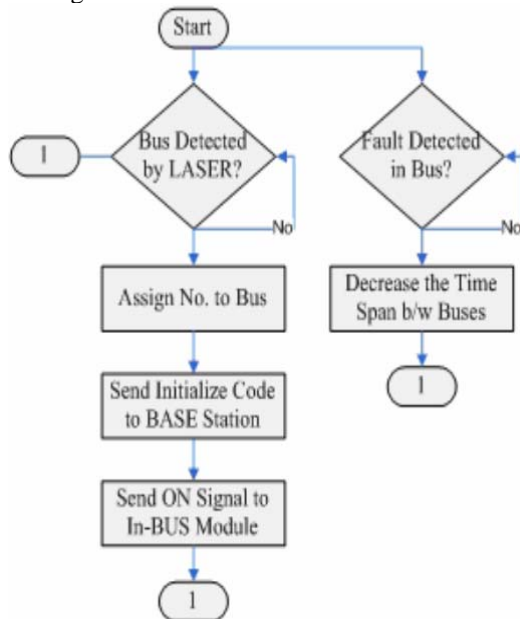shown in Fig. 3 while flow chart of module software is shown in Fig. 4.

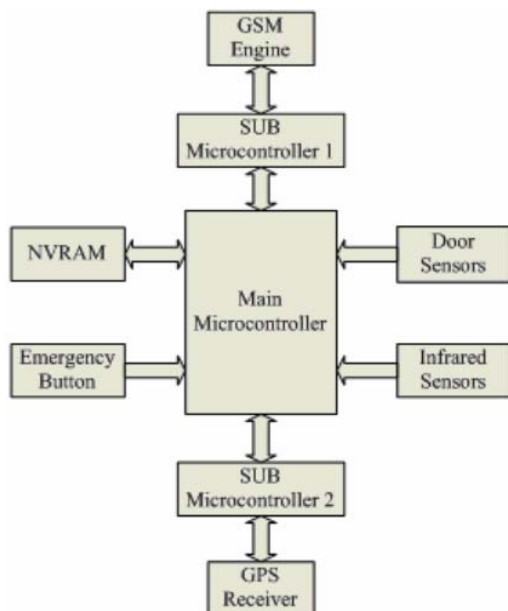**Figure 2:** Flow Chart of BUS Station Module

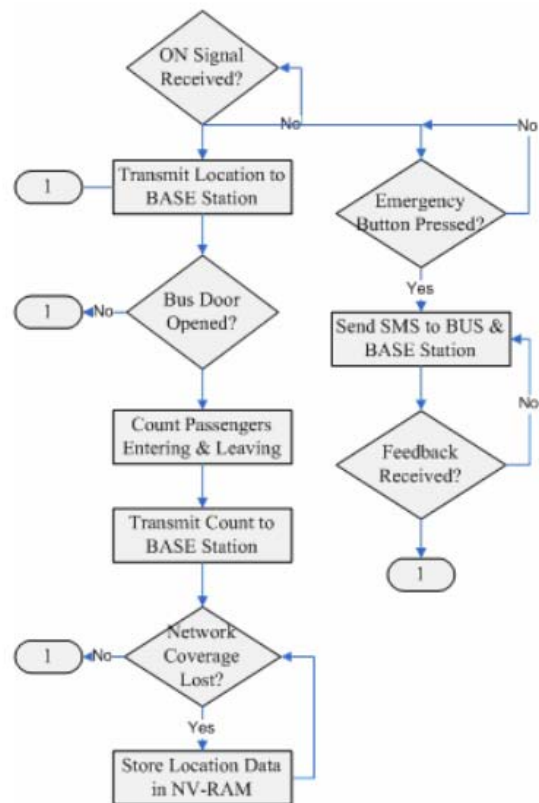**Figure 3:** Block Diagram of In-BUS Module

Figure 4: Flow Chart for In-BUS Module

c. BASE Station Module

This module is the central part of the network. It accepts location information of buses through respective GSM modems and maps the information on Google Map for visualization. It also receives the number of passengers entering and leaving the bus on per stop basis from In-BUS Module for statistical analysis. The message received is of the form "20, 10, 2345.3522N, 09022.0288E". The first two strings denotes the number of passengers entering and leaving the bus respectively and next two strings denotes the location information; all separated by commas. Another GSM modem is used to get the user request of location information of a particular bus. An example of the query put by the passenger is of the form "33U" or "33U10". In first instance i.e., "33U", '33' is the route number and 'U' designates the direction flag while in second instance i.e., "33U10", additional digit '10' denotes the bus stop number where the passenger is standing. The microcontroller attached with this GSM modem passes on the user request to the PC dedicated for that route number. The PC after processing the request data sends desired location information in form of bus stop name to microcontroller. The microcontroller then transmits this information back to the user. The information that passenger will receive contains the location of all buses out of terminal in desired direction in former query while in case of later query, he will get the location of those buses which are coming towards the particular bus stop number in desired direction along with time information. The time information is embedded in message to account for any delay in processing the user request. BASE station also monitors the emergency situations transmitted from In-BUS Module. In addition to this, the station keeps record of security issues and traffic congestion conditions and directs the driver to change the

route if desired. The block diagram of the module is shown in Fig. 5 while module software is shown in Fig. 6.
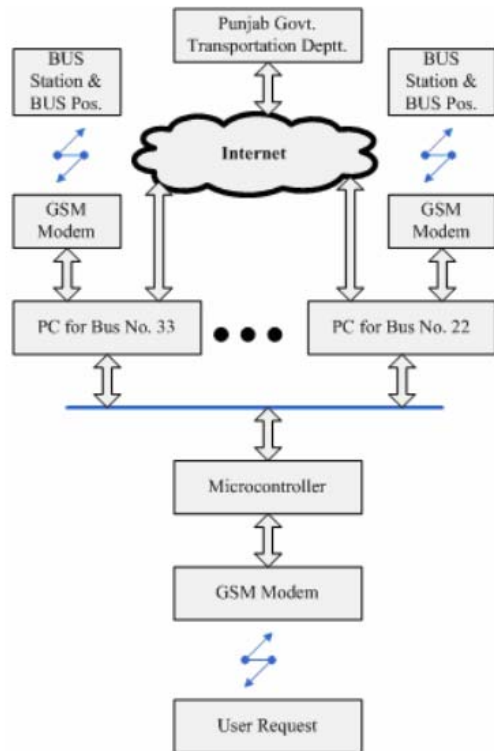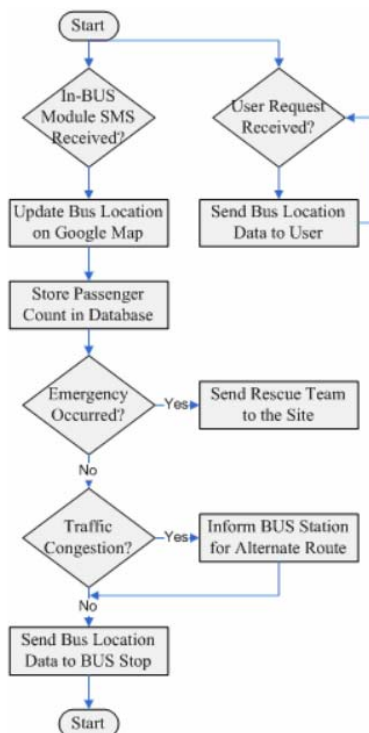

Figure 5: Block Diagram of BASE Station Module

Figure 6: Flow Chart for BASE Station Module

d. BUS Stop Module
This module is installed at every bus stop to let the passenger know about the location of buses coming towards that stop. It comprises of a GSM modem, a NV-RAM and dot matrix display; all interfaced to 89C52 microcontroller. This module is installed at every bus stop to let the passenger know about the location of buses coming towards that stop. It comprises of a GSM modem, a NV-RAM and

dot matrix display; all interfaced to 89C52 microcontroller. Message contains information of those buses only which will pass by the designated stop. First two digits of a sub-string denote the bus route number followed by the bus stop name which is the current location of bus coming towards the specified stop. Microcontroller after retrieving the stored information displays it on a 3x15 dot matrix display. The Microcontroller refreshes the information with a rate of 10 seconds. In case of an emergency situation, the location of next incoming bus is displayed. The block diagram of this module is shown in Fig. 7 and flow chart of module is shown in Fig. 8.
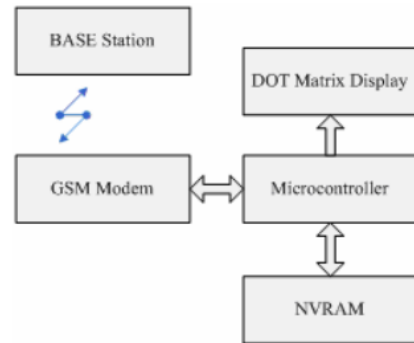

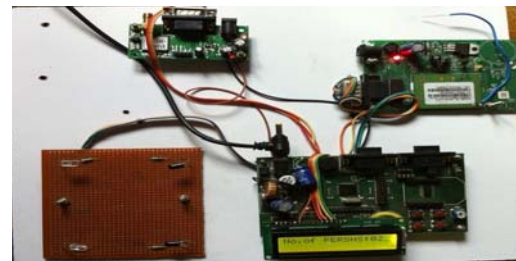**Figure 7:** Block Diagram of BUS Stop Module

4. Results/ Outputs
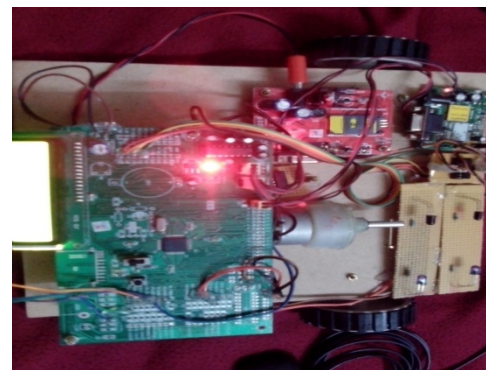

Figure 8: IN-Bus module Hardware implementation

Figure 9: Hardware implementation of in bus module

Figure 10: Initialization of the Module

Figure 11: Message format in mobile

Figure 12: Number of persons in the bus count

5. Conclusion

A low cost transportation management system based on integration of GPS and GSM data is designed. The systems consist of various modules which are wirelessly linked with GSM modems. Cost effective SMS service of GSM network is used for the transfer of data between the modules. A new service, to facilitate the people who use public transport for travelling, is introduced inside the city. The service provides the user with current location information of desired buses based on which the user can adjust his schedule accordingly. The service therefore reduces the waiting time at the bus stop. This system provides a user friendly environment to the people of a city to overcome the difficulty in finding bus route as well as saving lot of time.

6. Future Work

The system can be made automatic by installing cameras at bus terminals which can automatically read the license plate number of buses thereby eliminating the operator. An automatic route guider display can be installed in buses to better update the alternative route in case of serious road congestions. Fare collecting system can also be automated by providing another mobile service to which all the passengers using public transport are subscribed.

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