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Design of Embedded Device for Public Transportation Management System

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Abstract: ***The innovation in technology today has made our lifestyle much easier and fun. This research work proposes and implements a solution for enhancing public transportation management services based on RFID and GSM. The system consists of three modules: In-BUS Module, BUS Stop Module and BASE Station Module. The microcontroller based In-BUS Module consisting mainly of a GSM modem and RFID Readers on the entry and exit gates. When driver press the INIT button, IN-Bus module sends the bus number and license plate number to BASE station and starts transmitting its location to BASE Station Module about a particular bus location out of BUS stops. BASE Station Module equipped with a microcontroller unit and GSM modems interfaced to PCs is designed to keep track record of every bus, processes user request from Android mobile application about a particular bus location out of BUS stops and updates buses location on bus stop's LCD display. BUS Stop Module is installed at every bus stop and consists of a GSM modem, RFID tags and LCD display all interfaced to a microcontroller. This module receives bus location information coming towards that stop from BASE Station module and displays the information on a LCD display.***

Keywords: RFID reader, GSM, RFID Tag, LCD.

I. INTRODUCTION

Radio-frequency identification (RFID) is an automatic identification method, relying on remotely retrieving data using devices called transponders or RFID tags. The technology requires some extent of cooperation of an RFID reader and an RFID tag. An object called RFID tag that can be applied to a product, person or animal for the purpose of identification and tracking using radio waves. Some tags can be read from meters away and beyond the line of sight of the reader.

The RFID has come up as emerging technology which started evolving in World War II. A RFID system has several components which include tags, antennas and readers. This set up can be used either in high frequency or ultra-high frequency. In 1946, Leon Theremin invented a toll for the Soviet Union which retransmitted radio waves with some audio information attached to it. Though it was not an identification device it can be considered a predecessor to the RFID technology. The IFF transponder was used by United Kingdom in 1939 which was then used for identifying planes as an ally plane or enemy plane as early in 19th century in World War II. The transponder of this kind is still used in today's aircrafts wherein the transmission

and receiving of waves is used. The patent from Mario Cardullo's in 1973 which talks about a passive radio transponder attached to a memory was the true ancestor of modern RFID. [6]

What is RFID?

The RFID system is consists of three components:

a) Coil or An antenna

b) RF tags or transponder.

c) A transceiver with decoder.

These components are electronically programmed with unique information. In the market there are many different types of RFID systems. These systems are categorized according to their frequency ranges.

Some of the RFID kits that are used commonly are as follows:

1) Low-frequency (30 KHz to 500 KHz)

2) Mid-Frequency (900 KHz to 1500MHz)

3) High Frequency (2.4GHz to 2.5GHz)

These frequency ranges tell the RF ranges of the tags from low frequency tag ranging from 3m to 5m, mid-frequency ranging from 5m to 17m and high frequency ranging from 5ft to 90ft. [3]

When designing this system, the following constraints have been considered:

- Modularity and expandability constraints: the system must be modular in design. Both software and hardware should be divided into small components or modules to ensure easy scalability for further feature expansions. Modules must be independently produced from each other, so that the crash of one module cannot affect the other ones or changes to module will not affect other.
- Economic constraint: In economic constraint we should take into account cost to performance ratio so as to design a cost-effective solution.
- Environmental constraint: In our implementation and design, we should keep in mind the impact on environment. To keep the system power very low, low power consumption devices should be. Energy optimization should be involved in all the design's steps.[3]

II. LITERATURE REVIEW

Due to non-availability of prior information about the buses arrival schedule, people have to wait for longer on bus stops especially in morning when they have to reach the offices in time. When buses get overloaded it results in bus fault and people gets late further. [1]

The travel time of buses varies depending on several external parameters such as accidents, traffic and snow. In fact, buses are stuck in traffic and are thus hampered by the passage of junctions which makes the management of the bus schedule in the bus stations a difficult task. Bus station follows fixed schedules and routines, and don't make use of intelligent systems for vehicle tracking and control. Many administrators are deployed at the station who controls the exit of buses and the entrance of buses and he prepares the trip sheets containing the schedules manually which are time consuming and inaccurate. Even transport departments have no visibility over utilization of its fleet on real-time, which leads in underutilization of resources. All these results in avoidable costly errors and mistakes, stress and sub cost optimal fleet utilization and finally dissatisfaction and inconvenience to millions of commuters. The provision of accurate and timely transit travel time information is so important.

With the help of new technology the administrator can monitor the buses traffic while increasing the satisfaction of transit users and reducing cost through efficient operations asset utilization.

Features	RFID	GPS And GPRS	RFID, GIS, And GPS	GPS, GPRS, And GIS	RFID, GSM and Android(Proposed System)
Data Transmission	Slow within range	Moderate; delay due to satellites blocking	Moderate	Faster	Faster
Data Information	Only RFID	Only coordinates	RFID data and coordinates	Position, picture and vehicle information	RFID data, Position, Vehicle Information
Control center	No	No	No	Yes	Yes
Hardware Cost	Low	Moderate	High	High	Low
Hardware Implementation	Simple	Simple	Complex	Complex	Moderate
Reliability	Less	Less	Moderate	Moderate	High
Application	Specific	Specific	Limited	Limited	Wide
GUI	No	No	No	Yes	Yes

Table 1: Study & comparison of existing systems

Well-known examples of identification technologies include Closed-Circuit Television (CCTV) and Global Positioning System (GPS). CCTV can be deployed at each entrance gate and image processing techniques can be utilized to identify the arrival of buses, where image recognition was performed to detect the bus in the traffic. This testing has shown poor performance in tracking based detection (~20% precision). During the past, GPS integrated to Geographic Information Systems (GIS) was used to monitor buses traffic. GPS receiver communicates with at least 4 satellites before giving the location of the bus. It gives a very good forecasting. However, line of sight between the satellites and the receiver is required otherwise the GPS signal is attenuated. The main limitation of this technology is especially when it comes to monitor bus traffic inside an underground bus station. [7]

Due to the limitation of these technologies, the RFID technology can be used to track buses. RFID technology can be effectively applied for real-time tracking and identification. RFID was developed in the 1940s by the US department of defence (DoD) which used transponders to differentiate between friendly and enemy aircrafts. Since this time, RFID technology has been evolving to change the way people live and work. Many research projects have explored the possibility of integrating RFID in different areas, from toll collection, agriculture, access control, supply chain, logistics, healthcare, and library. RFID technology can response to our tracking needs that's why we used RFID in our design to identify buses entering and leaving the bus station.

III. PROPOSED METHODOLOGY

The proposed system architecture for the bus monitoring and management system is shown in Figure 2. A black box containing RFID reader, GSM modem is equipped in the moving bus. As the bus approaches a bus station with an RFID tag, the distance between the reader and the tag decreases so that they can interact with each other. This communication also produces data and the data gained is sent to the BASE station via GSM.

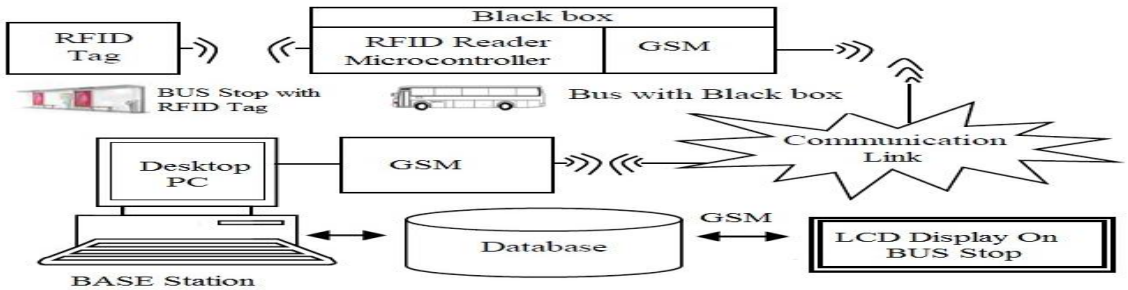

Figure 2: Architecture of Intelligent Bus Monitoring and Management System

The data circulation of the RFID and integrated communication technologies in the constructed system are shown in Figure 3. The system is automatically turned on once the bus is ignited. When the bus nears a tagged bus stop, RFID devices interact with each other. The reader then reads and retrieves the information saved inside the tag once it recognizes the tag. If the communication is successful, the information of the bus and the respective bus stop is saved in the database; with the condition that GSM is ON. The data retrieved are then sent to the BASE station via GSM, and this action initializes the data utilization. These data are stored in the database. Filtered, clean information is sent to the BUS stop module, which shows the data received from BASE station i.e. bus positions on the LCD display.

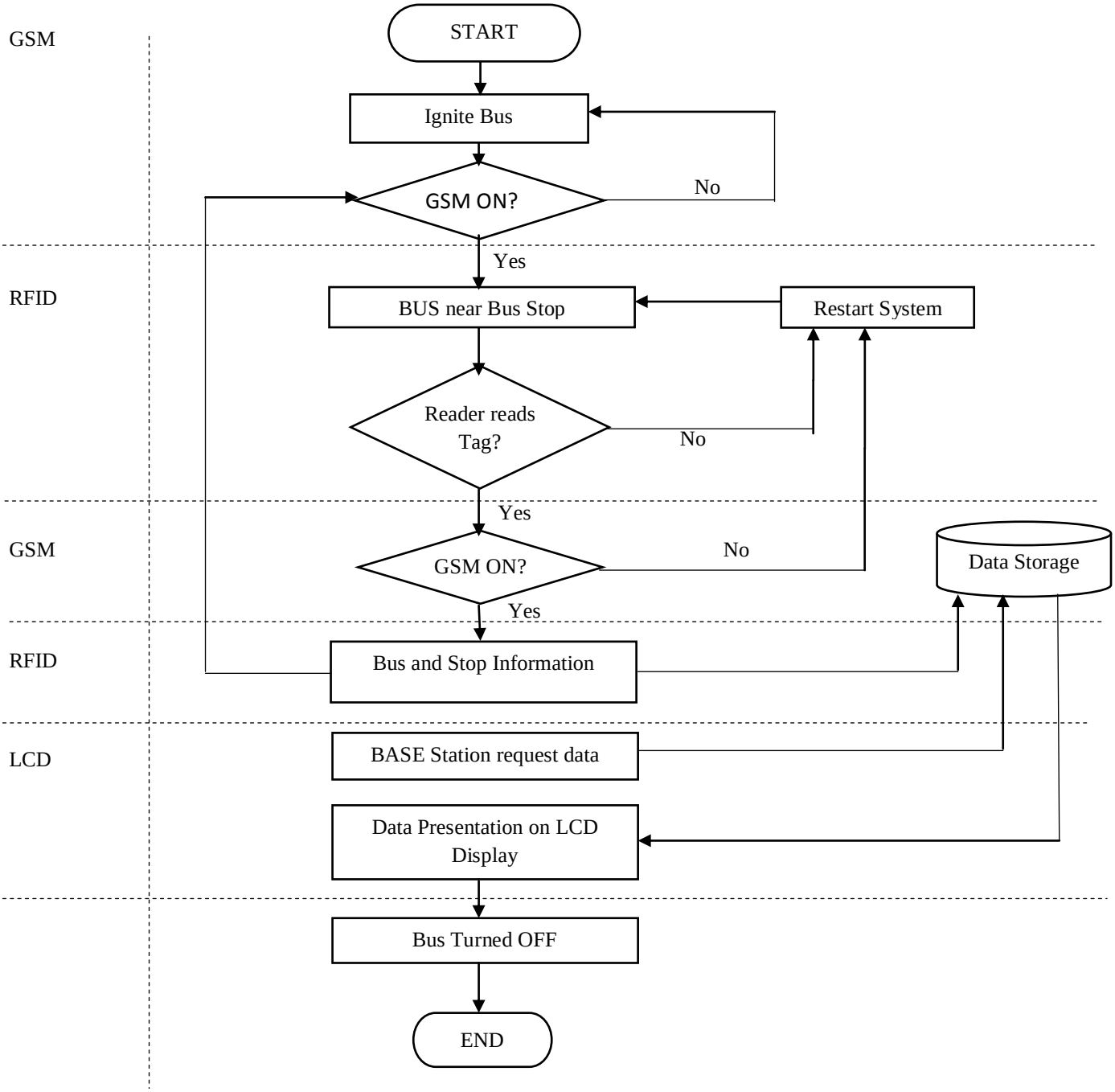

Figure 3: Functional flowchart of Integrated System

In-BUS Module is installed inside every bus and consists of a RFID reader, a GSM modem and an emergency button; all interfaced to AT89S52 microcontroller. After sending the initialization signal to BASE Station Module, this module starts transmitting bus location to the BASE Station. At each stop, RFID reader reads the RFID tag on bus stop and sends data to BASE station. In case of an emergency situation (e.g., when fault occurs in bus), driver can press the emergency button to

inform 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. The block diagram for this module is shown in Figure 4.

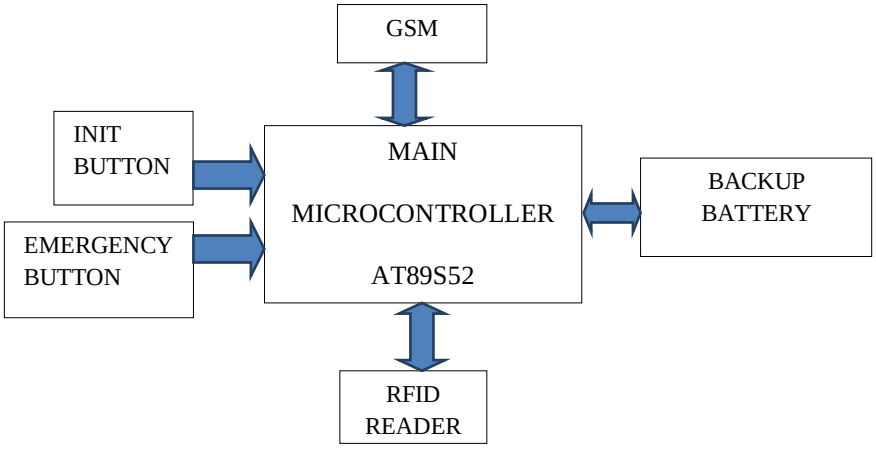

Figure 4: Block Diagram of In-BUS Module

BUS Stop 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, LCD display; all interfaced to AT89S52 microcontroller. Microcontroller after retrieving the stored information displays it on LCD display. The location of next incoming bus is displayed in case of an emergency situation. The block diagram of this module is shown in Figure 5.

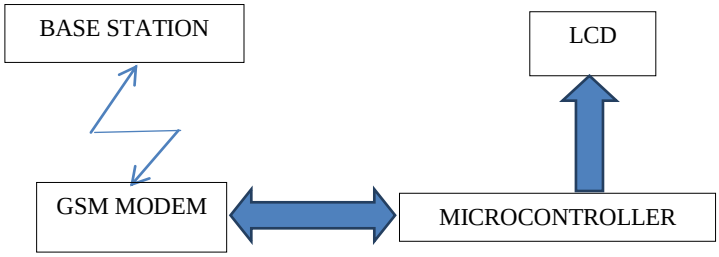

Figure 5: Block Diagram of BUS Stop Module

BASE Station module is the central part of the network. Through respective GSM, it accepts location information of buses. The PC after processing the data sends desired location information in form of bus stop name to microcontroller at BUS Stop module. BASE station also monitors the emergency situations transmitted from In-BUS Module. The block diagram of the module is shown in Figure 6.

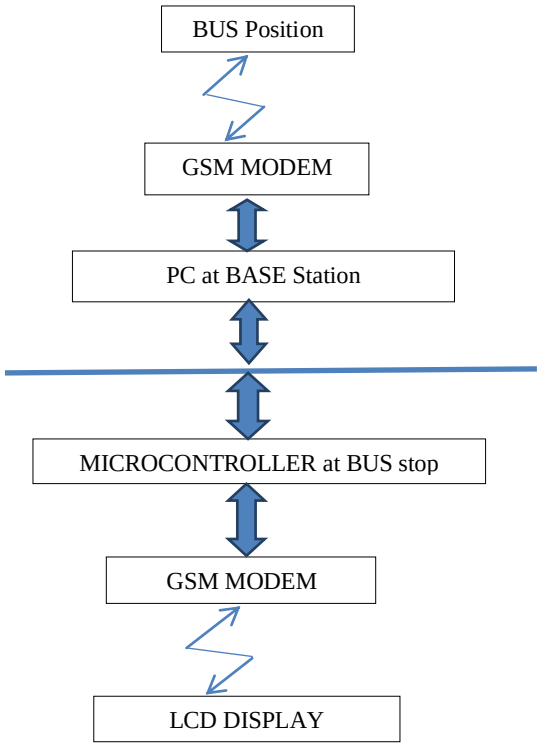

Figure 6: Block Diagram of BASE Station Module

IV. CONCLUSION

Thus we proposed the design and development of a low cost transportation management system based on integration of RFID and GSM. The system consists of different modules which are wirelessly linked with GSM modems. SMS service of GSM network is cost effective which is used for the transfer of data between different modules. To facilitate the people, a new service is introduced to make use of public transport for traveling, is introduced inside the city. User is provided with the service, which gives them the current location information of desired buses based on which the user can adjust his schedule accordingly. The service therefore vanishes the need of waiting at the bus stop and hence it saves lot of time. For the passengers not utilizing the service, to let them know the buses location coming towards that stop, displays are installed at every Bus stop. The system is also efficient and beneficial in handling an error and the emergency situations e.g., in case some kind of technical fault occurred in bus, the operator at bus terminal is informed and the departure time between the buses is reduced so that it will save time of the passengers.

It is believed that by the implementation of this system, problems such as underutilization of buses fleet and long waiting time at the bus station will be reduced. So, both passenger and bus station administrators will benefit from the system as real time information is provided.

V. FUTURE WORK

An automatic route guider display can be installed in buses to better update the alternative route in case of serious road congestions. We can connect RFID reader wirelessly to the host application. There are different advanced wireless technologies that can be used such as Bluetooth (802.15.3) and ZigBee (802.15.4) to extend the range of an RFID reader. 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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