School Children Transportation and Safety Enhancement System Based On RFID

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Abstract: The aim of the project is to design a transportation safety system for school children based on RFID technology. The existing technology over school transportation and child safety system do not exercise any advance technological in electronic devices that may acknowledge the child parent about the arrival of their child to school, the parents are unaware about the information whether their child has attended the school or not, so to eliminate this problem, we design a RFID Based System for school children transportation and safety enhancement that confer an acknowledgment message to the respected parents about the child’s arrival to the school at the boarding point itself. The proposed system utilizes RFID Technology, GPS Technology and GSM Technology and all together integrated into a single system which results in advanced and sensible implementation. This system would be much flexible and reliable with respect to its functionality, since the design includes both RFID and GSM systems for communication.

Keywords: RFID, System Integration, Engineering Design, Transportation Safety, Detection.

I. INTRODUCTION

School buses transfer millions of children daily in various countries around the world. While there many issues that might disturb the parents regarding the travel safety of school going children, the paper intends to look into introducing access safety in respect of school buses through bus tracking system that will help the school children’s transportation in a secure and safer way. The supervision of the regularity of students during their entry and exit from the bus is difficult to be controlled by drivers, which led to endangering child safety. The phenomenon of forgetting kids on the bus is one of the problems suffered by the children, which has increased significantly in recent years. This has often led to the death of many students on account of suffocation due to the lack of attention of derivers. This project, through entry and exit recordings, aims to create a suitable environment by following certain set of criteria of security and safety for school bus that will have a positive impact on the student and their family. The paper proposed a bus safety system which was designed to control the entering/exiting of students from the bus. This system does several tasks, including identifying personal information (Eg. Name) of each student using RFID tag, which will exchange the data with the RFID reader via radio waves and displaying each student name into LCD display. This will let the driver to know the number of students inside the bus and the students who departed from the bus. Moreover, the system has an emergency system that will alert in case if there is a child inside the bus after the bus stops at the destination by sending an SMS to the school management via GSM modem. In addition, if the bus depart and arrive successful from the source to destination, it will inform the management through an SMS about its successful departure and arrival. The key novel feature of the proposed methodology is the use of energy efficient systems to support the tasks. Though not within strictly in the scope, the same data can be used to assess the time of departure and arrival, number of students travels each day.

II. LITERATURE SURVEY

Khaleed shaban adopted RFID Technology to safeguard the children from wrong identification of their destination location, method to curtail the students sleeping in the bus its self without leaving to classes. This paper also focused to provide the security to the children from starting location to the destination point with applied RF technology. Seong Shaban described the security of the children at school Zone premises. This paper adopted a wireless sensor network methodology to identify the vehicle license plate number while moving with high speed. This paper also focused to trace the unauthorized parking vehicles at the school zone premises to safe guard the children from the accidents from the hidden zone areas. G. Bharathi, L. Ramurthy proposed a mechanism to trace the missed student using GSM-GPS technology. An ARM 7 is used to process the given information and to send the appropriate location of the missed student by adopting the GSM technology. The Missed student Latitude and Altitude locations are determined by adopting the GPS Technology. V. Sivasankaran et.al proposed a RFID-GSM technology to provide the security to the school children. The RFID tags are attached to the children bags for tracking and GSM is used to send the messages to the

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parents. M. Navya et. al. Proposed GSM-GPS technology to track the children students. GPS is used for identifying the student location. GSM is used to send the information to the parent android mobile. Monitoring database is provided at the control room of the school.

### III. BLOCK DIAGRAM

![Block Diagram](image)

**Fig. 1. Block diagram.**

**Brief Description:** The system employs a microcontroller to persist the complete task as shown in Fig.1. First the RFID – Reader reads the information of the children who entered the bus at the boarding point and then forwards the information to the microcontroller, the microcontroller then forwards a message to the GSM modem informing about the arrival of student in the school bus and the GSM Module forwards that information to the respected child’s parents.

**Hardware Requirement:**
- Microcontroller
- RFID – Reader, Tag.
- GPS Module
- GSM Modem

1. **LPC2148 Microcontroller**: LPC2148 microcontroller board is based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontrollers with embedded high-speed flash memory ranging from 32 KB to 512 KB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30% with minimal performance penalty. The meaning of LPC is Low Power Low Cost microcontroller as shown in Fig.2. This is 32 bit microcontroller manufactured by Philips semiconductors (NXP). Due to their tiny size and low power consumption, LPC2148 is ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

**Features of LPC2148 Microcontroller:**
- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 KB to 40 KB of on-chip static RAM and 32 KB to 512 KB of on-chip flash memory; 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- USB 2.0 Full-speed compliant device controller with 2 KB of endpoint RAM. In addition, the LPC2148 provides 8 KB of on-chip RAM accessible to USB by DMA.
- One or two (LPC2141/42 Vs, LPC2144/46/48) 10-bit ADCs provide a total of 6/14 analog inputs, with conversion times as low as 2.44 ms per channel.
- Single 10-bit DAC provides variable analog output (LPC2148 only)
- Two 32-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog.
- Low power Real-Time Clock (RTC) with independent power and 32 kHz clock input

![Block Diagram](image)

**Fig. 2. Block Diagram.**

2. **RFID Reader**: RFID technology is a simple method of exchanging data between two entities namely a reader/writer and a tag. This communication allows information about the tag or the element carrying the tag to be determined and in this way it enables processes to be managed more easily. An RFID system comprises a number of elements:
RFID reader/writer: The reader writer is used to communicate with tags that may pass within range. The RFID reader writer will normally be located in a fixed position and will be used to interrogate an RFID tag. Dependent upon the application and the format of the system and the RFID reader / writer, data may also be written to the RFID tag.

RFID tag: RFID tags may also be called RFID transponders and are typically located on items that are mobile. They are small and generally cheap so that they can be attached to low cost (or high cost) items that need to have information associated with them. They are also generally considered as being disposable. The RFID tag contains data that is relayed to the reader, and in some systems it may also be possible to update the data within the tag to indicate that the tag and hence the item has undergone a specific stage in a process, etc.

RFID application software: Like all systems these days, RFID systems need application software to run the overall system. With many systems there will be a number of different reader / writers and the data to and from these needs to be coordinated and analyzed. Application software will be required for these.

Although each RFID system will vary according to its requirements, these are the main elements which can be found. RFID technology has become widespread in its use. It offers many advantages and RFID is a particularly versatile system, being able to be used in many areas from shops, to manufacturing plants and also for general asset tracking as well as a host of other innovative applications. The use of RFID, Radio Frequency Identification technology has become widespread within many areas of industry. RFID, Radio Frequency Identification provides an ideal technology for tracking assets and identifying them by using a simple low cost antenna attached to the item in question. Alongside RFID provides automatic data collection for which there are now several standards, and this enables RFID technology to be deployed in an effective and known manner. With RFID technology standardized, users are able to rely on the technology to provide the results they need.

RFID Benefits: RFID technology provides many benefits for organizations that use the system. RFID provide an easy way in which data can be collected and assets tracked:

- RFID technology provides a low cost form of data collection and asset management.
- RFID technology is widely used and therefore the economies of scale can be utilized to advantage.
- RFID technology enables data collection in environments that are unsuitable for workers as RFID tags can provide data in harsh environments.
- RFID is able to provide many reads and write functions per second, although it is not a very high data rate system, it is sufficient for most data monitoring applications.
- Data on an RFID tag can be altered repeatedly.
- RFID technology can be used with existing systems including bar codes and Wi-Fi

RFID Applications: RFID systems can be used in a variety of ways. There are many RFID applications which have gained popularity over the past years:

- Store product identification – RFID technology can be used within shops and stores as a form of alert for goods that have / have not been paid for.
- Asset tracking - RFID systems can monitor when RFID tags pass given points and in this way track the assets.
- Airline baggage identification - airlines need to monitor where baggage is and route it to the required destination. RFID tags can be attached to the bags to automate baggage routing
- Parts identification - Data can be written to an RFID tags defining the identity of a part. This can then be used within a manufacturing, stock holding or other process to identify and locate parts.
- Production control - when items are manufactured they pass through many stages. RFID tags can be attached to items. These can be updated each time the item passes through a stage in production. This will enable the manufacturing system to track all items and know what stage they are at, and any other information such as test failures, etc.
- Employee access control - many companies today require intelligent access control systems. RFID technology is able to provide control as well as tracking, noting when cards pass particular access points, etc.
- Supply chain control - with manufacturing working to much tighter timescales with items such as Just-In-Time techniques being involved tracking of the items in a supply chain becomes more critical. RFID tags can be added to items to enable this to be undertaken accurately and more quickly.
- Vehicle tracking - RFID technology can be used to determine when vehicles have passed particular points and in this way their location can be approximately determined.
- Livestock identification – RFID tags can be injected into animals, under the skin and this enables accurate determination of which animal is which so that injections, etc can be given to the correct animal.

These represent some of the more standard applications for RFID technology. Many more specialized applications are also in use.

Working: In this project we are designing a system to monitor physical parameters of a location like temperature, smoke, rain fall and also the presence of a person say tourist. For this we are using different sensors integrated to an ARM7 micro controller. The data acquired continuously and sent to the remote server using Zigbee module. Presence of a tourist is detected by using the contactless
RFID cards allotted to the tourist. Whenever tourist enters to the location he should show the card at entrance. This can be used as a ticket at the same time the details of the candidate will be sent to the server through Zigbee while the low frequencies of 125 kHz were initially used, systems around the 13.56 license free frequency were also developed. The use of the higher frequency allowed for higher data rates and longer ranges to be achieved. The history of RFID has shown a steady development in RFID technology. Having its routes in the earliest days of electrical science and then radio, RFID history has come out of developments such as radar and IFF as shown in Fig.3. Now RFID is a technology in its own right which is widely used and showing massive benefits to industry and society as a whole.

Fig.3. RFID Tag.

3. GSM Modem: GSM, which stands for Global System for Mobile communications, reigns (important) as the world’s most widely used cell phone technology as shown in Fig.4. Cell phones use a cell phone service carrier’s GSM network by searching for cell phone towers in the nearby area. Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication. GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz it is estimated that many countries outside of Europe will join the GSM partnership.

Fig.4. GSM Module.

GSM provides the following features.
- Dual Band 900 / 1800MHz
- GSM and GPRS Multi slot class -12/10/8

4. GPS Module: The GPS module can receive the data by connecting to PIC Microcontroller Universal asynchronous receiver/transmitter (UART1) through serial fashion. L50 GPS module is connected to microcontroller UART2 through the GPS UART port as shown in Fig.5. GPS module is a combo device, with inbuilt antenna. This location string is the universal format called NEMA protocol. E.g. $GPRMC,122825.000,A,1828.9146,N,07353.8977,E,0.04,339.41,110211,,A*60. This string contains latitude, longitude, Date, time and speed. Microcontroller received this data at every one second. On the basis of speed the firmware logic will take the decision to send SMS AT commands on UART1. If speed suddenly changes above 0.90 it will send SMS commands to GSM. When GPS received a valid signal firmware will glow LED2.

Fig.5. Interfacing Diagram.
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Quectel L50 Read only memory (ROM) based GPS used in this system. L50 has fast tracked & acquisition features. The output of GPS L50 has Recommended Minimum Specification, Global positioning system, Global Navigation Satellite System, Dilution of Precision (GNSS DOP) and Active satellite & GNSS Satellite in view Messages body format. In addition the GPS Module is designed with typical 1.8v power supply, power consumption in Acquisition, Tracking, Hibernate modes are 45Ma@-130dbm, 35Ma@-130dbm and 20μA respectively. Receiver type L1, 1575.42 MHz C/A Code.

IV. IMPLEMENTATION AND TESTING

A prototype of the system is implemented and tested. Testing is very crucial part to validate the functionality of the proposed system. It should be designed to increase the likelihood of finding an error and checking the functionality of the proposed system. The units were implemented individually at first and they were tested to check if they were working properly. Then, they were integrated and configured as required for the system. The unit test was held for all the units in our system: RFID reader and tags, GSM modems and school server.

A. Bus Unit

The bus unit consists of an RFID reader, a GSM modem and a control unit as shown in Fig.6. The RFID reader detects the children when they board/leave the bus. It is located inside the bus. The GSM modem is used to send this data to the school unit. A microcontroller is used to interface the RFID reader with the GSM modem as shown in Fig.6.

![Fig.6. Bus Unit.](image)

The RFID Reader: The Reader was connected to a PC using RS232 cable. A terminal program was used to check if the reader can read the tags by setting the reader parameters appropriately (baud rate, start bit, data bits, stop bit, parity check bit). This was used to test the reader support for multi-tag reading and verify the structure of the tags’ numbers. Fig.7 shows the form of the tag number as the reader reads them where each tag number consists of 8 bytes in hexadecimal format.

![Fig.7. Testing the RFID Reader and Tags.](image)

Microcontroller (At mega 32): ATmega32 microcontroller is used to interface the reader and the GSM modem in the bus unit for data exchanging as shown in Fig.8. The reader communicates with microcontroller using serial communication interface RS232. However, due to the difference in voltage levels, a max232 chip is used to convert signals from RS232 serial port to signals suitable for use in TTL compatible digital logic circuits (power range: 0 V to + 5 V). A C-program was written to exchange the data between the RFID reader and the GSM modem through a microcontroller to verify that they interfaced properly. The flow chart is shown in Fig.9. If the microcontroller reads the data from the RFID reader, the LED will be turned on to indicate the successful read of the tag number.

![Fig.8. Reader-microcontroller interface circuit.](image)

GSM Modem: At first, GSM modems connectivity was tested using TMAS GSM-GPRS modem test program with the AT commands that are responsible for sending and receiving SMS and calling.

B. Communication between Two Modems

Two TMAS GSM/GPRS modems were used to send data from the bus unit to the school unit. One of modems is located in the bus unit to send SMS which contains the tag serial numbers to another GSM modem in the school unit. First, the communication between these GSM modems were tested using Terminal program by sending SMS from the first GSM modem as shown in Fig.10(a) using AT commands. The second GSM modem received the SMS that the first GSM modem sent as shown in Fig.10 (b). As obvious from the Fig.10, the word “Testing” was sent successfully from the first GSM modem and the second GSM. Then, one GSM modem was interfaced with the AVR microcontroller (AtMega8) using RS232. The microcontroller contained the AT commands, written in C, for sending SMS. The code was verified using a terminal program to ensure that microcontroller sent the correct AT commands to GSM modem.
Fig. 9. Flowchart of code used to read tag number.

C. School Unit

At the school unit, there is a server, where the web-based application and database are hosted and stored. This server will receive the data sent from the bus unit via a GSM modem, analyze and save it. It is also responsible for notifying the parents in case of emergencies.

Web-based Application and Database: This section presents some tests that we had carried out to verify the functionalities of our web-based application. First, the authentication is verified by attempting valid/invalid username and/or password combinations. Whenever, the combination is wrong, the access is denied. Then, the different functionalities provided by the web-based application were verified. At the beginning, the admin functionalities were considered. The following aspects were tested:

- Accessing existing information, for example, the information of students and their relatives as shown in Fig. 11.
- Displaying the details of the students, relatives separately.
- Inserting new information as shown in Fig. 12.
- Deleting/updating existing information.

Similarly, the functionalities provided for normal users (e.g. viewing attendance record) were tested and verified.

Receiving the Data from the Bus Unit: After the SMS is sent from the first GSM modem, it is received by the second GSM modem that is interfaced to the school server via the serial communication port and RS232 cable. A code written in PHP reads the received SMS, updates the database, and notifies the parents if necessary. The code works as follows. First, it inserts a new row for each student who is listed in the school bus system in the attendance record table with the date. The first entry for entering the bus in the morning is set to “no” to indicate the student did not enter the bus yet. The rest of the columns are left empty. Next it connects to the serial communication port “COM1” and sends some AT commands to read the messages received by the modem. Then, it opens a text file and saves the messages in it. There are four text files, each for a certain time interval. For example, if it is the time where the bus is collecting students from their houses at the morning, then it opens the file for entering the bus in the morning. After that, it connects to the database and from the students table it selects the serial numbers and compares them to those in the text file. If it gets a serial number that matches one in the file, then it selects the student’s ID and updates the corresponding column to that time interval in his entry for that day in the attendance record table. For example, if it is the morning entering bus file, then it updates ATTEND_MOR_ENTR column which corresponds to this time.
After the entries for all students that appeared in the text file are updated, the system checks the students that did not enter/leave the bus. If there is a child who did not enter/leave the bus, the system gets his relative’s information from the database and sends a notification in the chosen language. The sent message contains the student name (useful for parents with multiple children) and bus driver’s phone number as shown in Fig.13.

**SMS Notifications:** The PHP code written for the SMS gateway was tested. To use the SMS gateway, the following parameters are set: user ID, password, language, recipients, and the messages. The user ID and password are given by the gateway provider. The language has to be set before writing the text so that it can be sent properly. There are many integer values for different languages. For English, the value is 0 and for Arabic the value is 64. The text can be set to whatever the user wants to send. The result of testing the code is shown in Fig.14.

**D. The system Integration Test**

The integrated system shown in Fig.15 was tested and the results are shown in table 1.

**TABLE I: Integration Test For The Whole System**

<table>
<thead>
<tr>
<th>Test name: Integration for the whole system</th>
<th>Test ID#: 11-01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test description: Verify that the project is working</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#</th>
<th>Procedure</th>
<th>Pass</th>
<th>Fail</th>
<th>N/A</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reader reads one tag</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Reader reads multiple of tags at the same time</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Reader sends the data</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Transmitter GSM modem receives the data</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Transmitter GSM modem sends the data to receiver GSM modem in the school unit</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Receiver GSM modem receives the data</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The data is processed in the server</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>SMS is sent if the child did not board the bus</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**V. CONCLUSION**

The integration of RFID and GSM technologies for safety and security purpose is very important nowadays due to increase in accidents of children gets missed out at the bus which may lead to death due to suffocation. In this project, bus safety system for school children has been developed. Using this system, concerned authorities, bus driver can be alerted as it’s visible from the RFID card. At the same time, in case if there was a student on the bus, the system will send an SMS message to the management of the school to take the right decision. The paper shows that...
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that RFID technology based tracker system is still acts as one of the best solution to enhance the safety in the school buses, which will reduce the accidents of forgetting the students inside the bus.

VI. REFERENCES