Asian Journal of Applied Science and Technology (AJAST)
Volume 1, Issue 2, Pages 154-159, March 2017

Safety for School Children Transport Enhancement System

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Article Received: 27 February 2017 *Article Accepted: 15 March 2017* *Article Published: 17 March 2017*

ABSTRACT

This paper presents a system to monitor drop-off/pick up of school children to enhance the safety of children during the daily transportation from and to school. The system consists of two main units that are school unit and bus unit. The bus unit is used to detect when a child boards the bus or leaves the bus. This information is communicated to the school unit to identify the children did not board or leave the bus. The system has a developed web-based database-driven application which facilities its management and provides useful information about the children to authorized personal. A complete prototype of the proposed system was tested and implemented to validate the system functionality. The proposed system facilitates to know about the area where the vehicle has crossed the path using RFID Formulated by merging Global Positioning System (GPS) and Radio Frequency Identification. The GPS technology connected with this system helps in acquiring updates on student's real time location. This proficient tracking structure with enriched features is designed and implemented for the purpose of protection in various streams. It is up and coming technology in the field of communication and network. The "TAGS ON ROAD" model is an evolving and justifiable technique in future world. The projected system here is planned to be implemented in school vehicles for the safety of the students and it can also be installed in the professional security system for VIP"s and politicians.

Keywords: RFID, System integration, Engineering design, Transportation safety and Detection.

1. INTRODUCTION

Children safety is of utmost importance to their parents. Despite the best safety measures, children, due to their lack of skills to protect themselves, may end up in a situation that endangers their life (e.g. crossing the road without paying attention to traffic). In this paper, we focus on a particular risk associated with the daily bus trip to and from school. There have been previous incidents where a child is forgotten in the bus and eventually die because of suffocation [1-2]. To improve transportation safety, some schools employ a bus supervisor to look after the children inside the bus. Nonetheless, human oversight or supervisor absence may still lead to a heartbreaking ending as in the previously cited stories. This paper presents a system to monitor the daily bus pick-up/drop-off of children to enhance the overall safety of the daily bus transportation to/from school. The system aims at automatically detecting when a child boards or leaves the bus and issue an alert message when a child does not board or leave the bus to reduce the parents' concerns about using the bus for the daily transport of their children without being lost or forgotten.

The rest of this paper is organized as follows. Section 2 reviews the most relevant work to the theme of this paper. In section 3, the overall system design is presented. Section 4 gives a detailed description of system implementation and testing. Finally, section 5 concludes the paper.

2. RELATED WORK

This section presents the most related work to the problem addressed by this paper. In [3], a system is proposed to track the children using a child module that transmits the tracking information to a database and a mobile device. The disadvantages of this system are that the module may not be convenient for children and wide-scale deployment is expensive. Authors in [4] report a tracking system that utilizes Android terminals that communicate among themselves using Bluetooth technology to form clusters.

The clusters communicate the relevant information using WLAN. The major drawback of this system is that the deployment cost is high. There are commercial systems for tracking children such as Bluetooth-based tracking devices which are designed to be worn by children as a bracelet or a necklace [5].

In this type of tracking, these devices can be connected with a mobile application and can alert the parents if their child went outside a range specified by them. If the child walked outside this range, the device will send an alert to the parent. In addition, the application sends the location of the child by using a geographical map. One disadvantage of this type of applications is that they work only in a limited range.

Other products may rely on biometric features such as the Kid track biometric system in which the children scan their palms across a palm reader when they enter the bus [6]. It uses an infrared light to image the palm unique pattern. It uses green and red LEDs to ensure the scan works.

Then, the scans are sent for cross-referencing against a secure database of pre-registered users' patterns. Based on this, the administration can find the information of that bus, where and when it tracked the child, and where the bus was at that time.

The disadvantages of this approach are that it is not automatic and difficult for young children to place their palms correctly on the scanner. This may lead to inaccurate data if the scanner did not detect a child's palm.

3. SYSTEM DESIGN

3.1 System Engineering Requirements

Our system is designed with the following engineering requirements:

- The system should recognize each child and detect when every child boards or leaves the bus.
- The system should have a database to store student's information.
- The system should be easy to re-configure.
- The communication should be reliable.

3.2 Design Constraints

The constraints are the restrictions on the design. They are imposed by the environment and the customer. The constraints considered in our system are:

- The system should not be harmful for human beings or the environment.
- The device should hurt the child in any way.
- The system should provide an option to choose between different Languages.
- Children's information should be available for authorized personal.

3.3 Top Level Description of the Proposed System

The system is divided into two main units: bus unit located inside the school bus, and a school unit located inside the school. The bus unit is responsible for detecting the child when he boards or leaves the bus and then this information is sent to the school unit. The school unit is the central unit where it collects data from all the buses, adds them to the system database, checks if there are missing children, and it sends a text message notification to their parents. The proposed architecture is shown in figure 1.

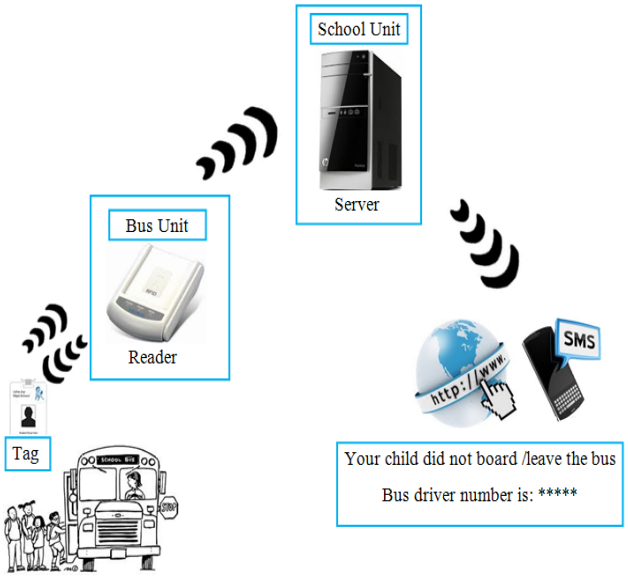


Fig.1. The Proposed System Architecture

Our *proposed system provides the following advantages:*

- The system uses RFID tags for children detection which is not harmful since it uses frequency ranges that are safe and legally approved.
- The deployment cost is reasonable.
- The system is automatic and user friendly.

A. The Bus Unit Description

The bus unit will detect the children when they board/leave the bus. It will use RFID technology to achieve this purpose. This technology consists of a reader and tags. There are three types of RFID readers based on their frequency ranges, low frequency, high frequency and ultra-high frequency. We chose to use UHF RFID reader, because it has a faster data transfer than the others. . Also, the distance can be controlled to be short or long as required [7].

The RFID reader will be located inside the school bus by the entrance. It will be positioned where it will only detect the children when they are inside the bus. But if the child was outside near the bus, the reader will not detect him. Each child will wear a card with RFID tag attached to it. The bus unit is responsible for sending relevant tag information to the school unit where it will be stored and processed. Based on the received information, other related child's information can be retrieved from the database for further processing (e.g. texting the parent).

There are two types of RFID tags, passive and active tags. We chose passive RFID tags since they have a short reading range which fit our requirement to detect the child when he is close to the reader (i.e. when s/he boards or leaves the bus). Moreover, they are cheaper than active RFID tags and need no maintenance in contrast to active tags that need maintenance and regular replacement of battery [8].

B. The School Unit Description

The school unit consists of a server interfaced with GSM modem to receive data from the bus. The server simultaneously acts as database server and web server to host the web-application developed to manipulate the system setting, update, and query the system database. In addition, the server communicates with an SMS gateway to send notification in case a child is detected missing.

C. System Database

The database of the system has to meet certain business rules. A business rule is "a brief, precise, and unambiguous description of a policy, procedure, or principle within a specific organization" [9]. It helps to determine entities, attributes and relationships of the database. The business rules of the database of our system are:

- A child can be in only one bus, but a bus may have many children.
- A child has one or many relatives.
- A relative may have many children registered at the school.
- A bus may be driven by one or more drivers, but a driver can drive only one bus.

- A child may have many attendance records, but an attendance record has one child.

The Entity-Relationship (ER) diagram of the database is shown in figure 2.

D. The System Web-based Application

One essential part in our system is the database-driven web-based application to manipulate the system, update, and query the database. There are two options to log into the website, as a parent or as an administrator. The administrator can add, modify, delete or view information about students and their relatives, buses and drivers. On the other hand, each parent can view the status of his/her children if they board/leave the bus in the morning and afternoon.

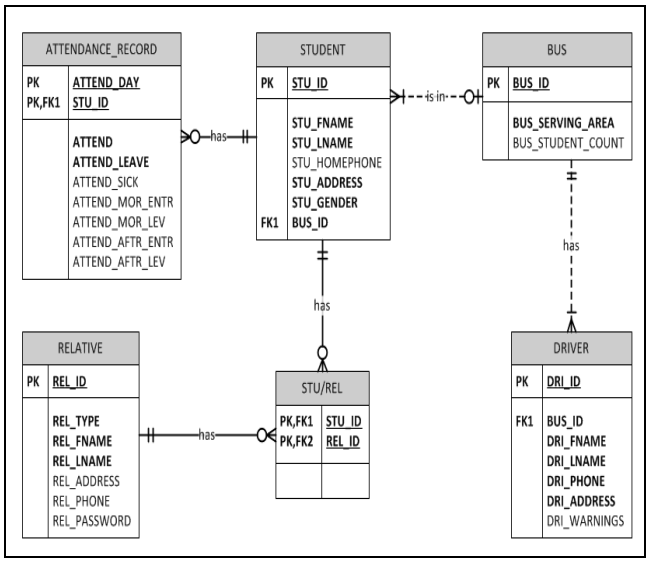


Fig.2. ER diagram of the database

4. 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.

Fig.3. Bus Unit

4.1 Bus Unit

The bus unit consists of an RFID reader, a GSM modem and a control unit as shown in figure 3. 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.

4.1.1 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 .Figure 4 shows the form of the tag number as the reader reads them where each tag number consists of 8 bytes in hexadecimal format.

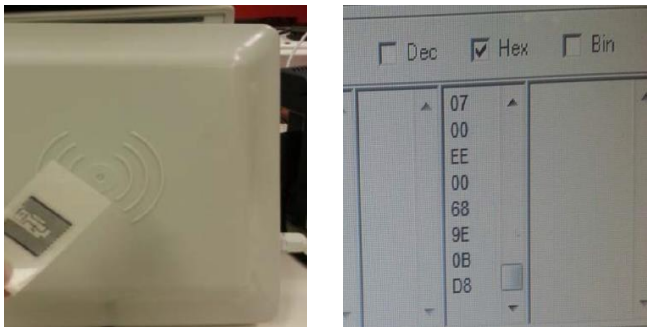


Fig.4. Testing the RFID Reader and Tags

4.1.2 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 figure 5. 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 figure 6.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.

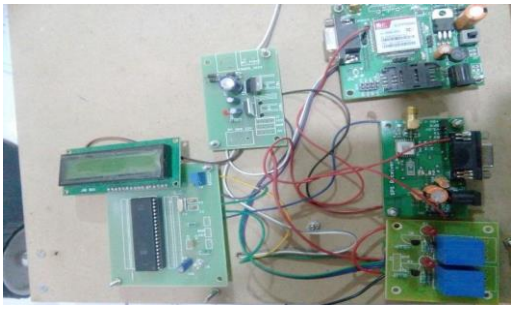


Fig.5. Hardware structure

4.1.3 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.

4.2 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.

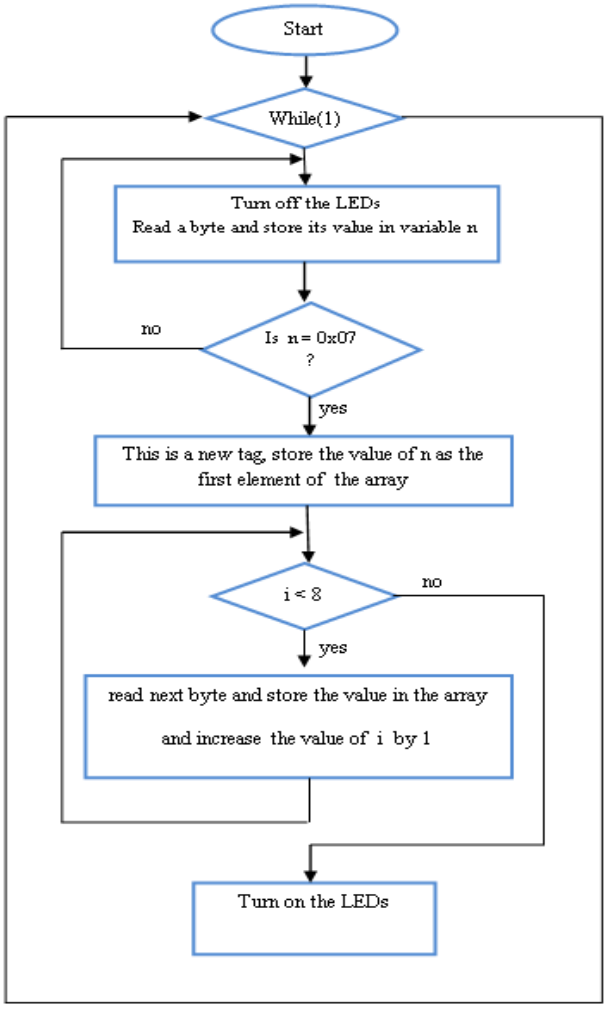


Fig.6. Flowchart of code used to read tag number

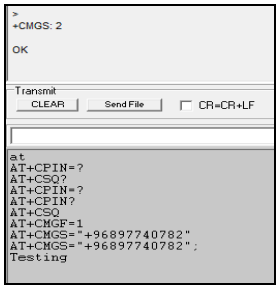
First, the communication between these GSM modems were tested using Terminal program by sending SMS from the first GSM modem as shown in figure7(a) using AT commands. The second GSM modem received the SMS that the first GSM modem sent as shown in figure 7(b). As obvious from the figure 7, the word "Testing" 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.

4.3 School Unit

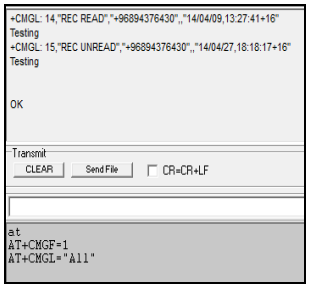
At the school unit, there is a server, where the web-based application and database are hosted and stored. This server will receive the data sent from the bus unit via a GSM modem, analyze and save it. It is also responsible for notifying the parents in case of emergencies.

4.3.1 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,



7 (a). Send SMS



7(b). Read SMS

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 figure 7.
- Displaying the details of the students, relatives separately.
- Inserting new information as shown in figure 9.
- Deleting/updating existing information.

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

Fig.7. Accessing existing information

4.3.2 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.

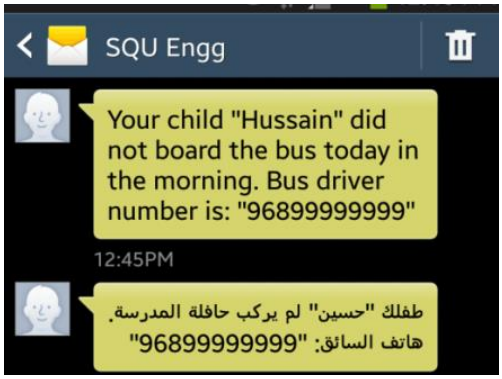


Fig.8. Add new information

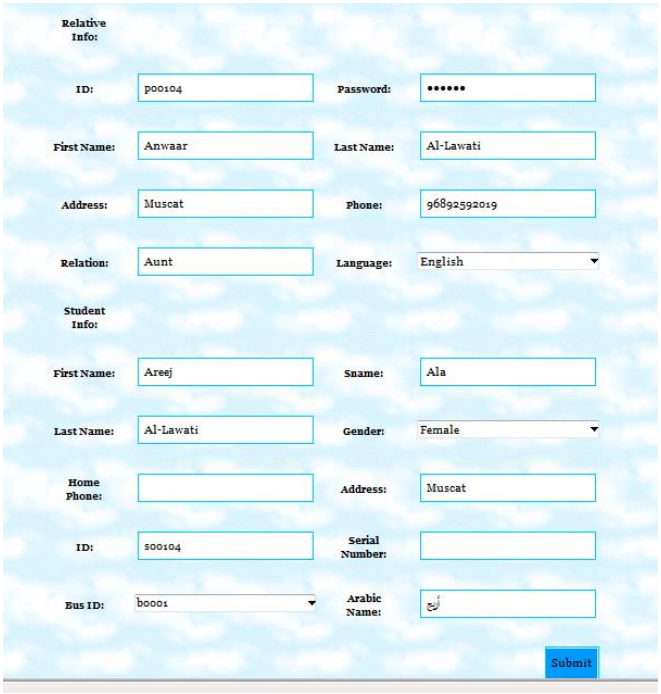


Fig.9. Add new information

Fig.10. Experimental setup

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.

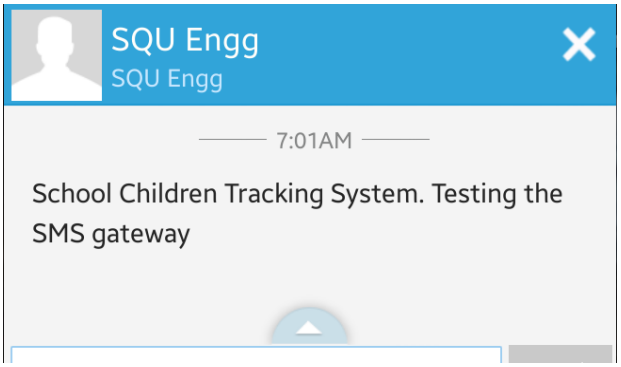


Fig.11. SMS gateway test

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 figure 11.

4.3.3 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 figure 11.

4.4 The system Integration Test

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

Table 1. Integration test for the whole system

Test name: Integration for the whole system				**Test ID#:** IT-01
Test description: Verify that the project is working				
Test information				
Name of tester: ALL	**Date:** 24/5/2014			**Time:** 2:00 PM
#	**Procedure**	**Pass**	**Fail**	**N/A**	**Comments**
1	Reader reads one tag	√			
2	Reader reads multiple of tags at the same time.	√			
3	Reader sends the data	√			
4	Transmitter GSM modem receives the data	√			
5	Transmitter GSM modem sends the data to receiver GSM modem in the school unit.	√			
6	Receiver GSM modem receives the data	√			
7	The data is processed in the server	√			
8	SMS is sent if the child did not board/leave the bus	√			

5. CONCLUSION

This proposed technique is an RFID-based system that aims at enhancing the safety of children during the daily bus trip to and from the school. RFID-based detection unit located inside the bus detects the RFID tags worn by the children. It then sends, via a GSM modem, the relevant data to the system database server. The system checks and detects which child did not board or leave the bus and issues an alert message to this effect. Addition, the system checks the children attendance and updates the database. The parents can log into system website and monitor the details of their children.

REFERENCES

[1] "4 year old, forgotten in a school bus, dies". Available at: *http://www.muscatdaily.com/Archive/Oman/4-year-old-forgotten-in-a-school-bus-dies [Accessed: 11 Aug. 2014]*.

[2] Toumi, H., "Four-year-old girl left alone in school bus dies". *Available at: http://gulfnews.com/news/gulf/qatar/four-year-old-girl-left-alone-in-school-bus-dies-1.628394 [Accessed: 11 Aug. 2014]*.

[3] Saranya, J.; Selvakumar, J., "Implementation of children tracking system on android mobile terminals," *Communications and Signal Processing (ICCSP)*, 2013 International Conference, vol., no., pp.961-965, 3-5 April 2013.

[4] Mori, Y.; Kojima, H.; Kohno, E.; Inoue, S.; Ohta, T.; Kakuda, Y.; Ito, A, "A Self-Configurable New Generation Children Tracking System Based on Mobile Ad Hoc Networks Consisting of Android Mobile Terminals," *Autonomous Decentralized Systems (ISADS), 2011 10th International Symposium*, vol., no., pp.339,342, 23-27 March 2011.

[5] Shu, C., "Guardian Uses Bluetooth Low Energy Tech to Keep Your Child Safe" *Available at: http://techcrunch.Com/2013/10/09/guardian-uses-bluetooth-low-energy-tech-to-keep-your's-child-safe.*

[6] Coxworth, B., "Kidtrack biometric system keeps track of kids on school buses" *Available at: http://www.gizmag.com/kidtrack-biometric-school-bus-scanner/26723.*

[7] Nikitin, P. V., "Antennas and Propagation in UHF RFID Systems", University of Washington, Electrical Engineering. *Available at: http://www.ee.washington.edu/faculty/nikitin_pavel/papers/RFID_2008.pdf.*

[8] Cisco, "RFID Tag Considerations", May 2008, *Available at: http://www.cisco.com/en/US/docs/solutions/Enterprise/Mobility/wifich6.pdf.*

[9] Nikitha.S.Paulin, "Pick and place robot using accelerometer sensor" *in International Journal of Scientific Research in Science, Engineering and Technology*, vol.2, issue 6, ISSN: 2395-1990, November 2016.

[10] Nikitha.S.Paulin, "Glass Climbing Robot for Glass wall cleaning" *in International Educational Scientific Research Journal*, vol.2, issue 12, ISSN:2455- 295X, December 2016.

[11] Coronel, C.; Morris,S.; and Rob, P.,Database Systems: Design, *Implementation, and Management, Boston, Ninth Edition*, 2011.