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RFID-Based Security System for School Children

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ABSTRACT

The crime against children is getting out of hand and it is high time to offer safety system for the children in order to prevent them from the abuse. The school authorities cannot check their students individually and the suitable solution for this problem is by designing an automatic identification system, which can trigger if a student is going out of boundary.
According to United Nation Convention on the Rights of the Child and other human rights, the goal of child protection is to promote, protect and fulfill the right of every child from abuse, neglect, exploitation and violence. Therefore, RFID is a rising technology and one of the most promptly growing segments of today's automatic recognition data collection. RFID security system offers admirable performance over other automatic recognition systems. Hence, a wireless non-contact system, used for transmission of data from a tag attached to a child; this type of system uses radio-frequency electromagnetic fields, which can help to avoid a human requirement in monitoring and keeping of record at the entrance of a secured area.
The system identifies children entry and exit time with RFID that notifies school in the form of notification simultaneously GPS gets all coordinates from satellite and send it to your database server by using GSM/GPRS service module with highly precise and encryption format. The system gives a high level of security for schoolchildren as well as an educational institute.

Keywords: RFID, GPS, GSM / GPRS, Schoolchildren, Institution, Automatic recognition,

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1. BACKGROUND TO THE STUDY

The kidnaping of children is increasing in our society nowadays. Every child is entitled to be protected from harm. The security and monitoring of child is a difficult task to accomplish in this developing country. According to United Nation Convention on the Rights of the Child and other human rights, the goal of child protection is to promote, protect and fulfill the right of every child from abuse, neglect, exploitation and violence.

A Safe and conducive learning environment is fostered through collaboration among school staff and community-based service providers, also integrating existing initiatives in the school. Conducive learning environments provide equivalent resources to support instructional components, organizational/management components, and learning supports (e.g., mental health services). Security plays a vital role in blocks unknown entry into a secured area, which may contain both physical and intellectual property, without being recognized.

According to statistics, over 770,000 children are victims of child abuse and neglect each year. This piece of information shown that the rate of crime is frequently associated with negative effects on children and schools are at capacity in terms of taking on new initiatives to determining how to protect children and keep them safe. Among many automatic identification technologies that is used in security system are barcode, magnetic stripe and Radio Frequency Identification otherwise known as RFID. RFID is a rising technology and one of the most promptly growing segments of today's automatic recognition data collection. RFID security system offers admirable performance over other automatic recognition systems. A wireless non-contact system will be used by RFID for transmission of data from a tag attached to a student; this type of system uses radio-frequency electromagnetic fields which can help to avoid a human requirement in monitoring and keeping of record at the entrance of a secured area. This type of system establishes secured access control and record keeping.

1.2 STATEMENT OF THE PROBLEM

Nowadays, parents are worried about their children because of the high rate of kidnapping. Majority of parents nowadays are having long working hours and they simply do not have as much time to spend with their children. The crime against children is getting out of hand and it is high time to offer safety system for the children in order to prevent them from the abuse. The school authorities cannot check their students individually and the suitable solution for this problem is by designing an automatic identification system which can trigger if a student is going out of boundary. RFID is an automatic identification system. Like a barcode or the magnetic strip on a credit card, an RFID tag provides a unique identification code that can be read by a scanning device. Radio waves used in RFID to communicate with readers.

1.3 AIM OF THE STUDY

The aim of this research is to design a security system for school children to ensure safety using radio frequency identification device (RFID) technology to track the student thus enhances the security in selected zone.

1.4 OBJECTIVES OF THE STUDY

The objective of this project includes to;

a. Ensure the safety of children in school using an RFID technology in tracking and monitoring students
b. Evaluate the effectiveness of RFID in tracking human movement
c. Implement the above mentioned using a software design.

1.5 SIGNIFICANCE OF THESTUDY

School safety and positive school climate are not achieved by singular actions like purchasing a designated program or piece of equipment but rather by effective comprehensive and collaborative efforts requiring the dedication and commitment of all school staff and relevant community members. Schools require consistent and effective approaches to prevent violence and promote learning, sufficient time to implement these approaches, and ongoing evaluation. This works mainly indoor & outdoor environment like inside the school as well as outside the school environment.

1.6 RESEARCH METHODOLOGY

The method of designing this project is based on RFID technology and it consists of two parts. One is hardware and another is software. In the hardware part, many components are used such as RFID reader and tag etc. In the software part, a program based on the C# language will be used. The RFID reader used to compile data from an RFID tag to trace individual objects. Transmission of data from the tag to a reader is done by using radio wave. RFID tag contains an integrated circuit that is used to store, process the data and then modulate and demodulate the RF signals which are being transmitted. The proposed system will be designed using Microsoft Visual studio as frontend. Microsoft SQL Server backend and a Data Manipulating Language (SQL).

2.0 LITERATURE REVIEW

2.1 Review Of Related Works

Going by literature review, research has shown that some studies make use of Radio Frequency identification (RFID) as a system that transmits the identity of an object using radio waves. According to Kumar (2016) the RFID system consists of an RFID reader and an RFID tag. The tag consists of the microchip that is connected to an antenna; microchip can store a maximum of 2 KB of data, which may include data and information about the product, manufacturing date, and destination. Further, the author also observed that the ability of the reader field decreases quickly with increasing distance, which defines the area of reading to 4-5 meter distance using VHF 860-930 MHz.

However, Vidyasagar K. (2016) also proposed the total security for school children. Range and Obstacle detection and accident detected sensors are implanted on the front surface of the bus in order to avoid collision with another vehicle on the Road. Each student is tagged with unique code. Two counters used at the entrance and exit location of the bus. Wireless communication technology (IEEE 802.4.15) is used to inform the status of the bus to the school principal. Maryam Said Al-Ismaili (2015) proposed another solution to solve the problem by developing a bus safety system that will control the entry and exit of students from the buses through an energy efficient methodology. His system will control the entry and exit of students to and from the bus using RFID (Radio Frequency Identification) and GSM technologies to ensure the entering and exiting of all students to and from the school bus in a safer manner.

Anwaar Al-Lawati (2015) Proposed web-based database-driven application that facilities its management and provides useful information about the children to authorized personal. A complete prototype of the proposed system where implemented and tested to validate the system functionality. M. Navya et.al (2016) Proposed GSM-GPS technology is used to track and identifying the students' location, information send to the parent android mobile and monitoring database is provided at the control room of the school.

Rohit N. Bhoi, Dr. V. V. (2018) Shete did develop Children tracking system using ARM7 (LPC2138), Global positioning system (GPS), Global system for mobile communication (GSM).Loganathan.M1, Aswathi Dileep, Kamatchi.K3 did develop children tracking system including ATMEGA 162, GPS, GSM module, Voice playback circuit. Mohammed Rafi, K. Niranjan Reddy (2015) did develop Android based children tracking system using voice recognition. The system includes atmega controller, Global positioning system (GPS), (GSM), Voice recognition develop module, RFID, ATMEGA644 controller. Children tracking system is also designed by Yuichiro MORI, (2019) using autonomous Clustering technique. It consists of tags which collect the information of child group, android terminals are attached to each children and server which stores tracking information.
Tag consist of wireless LAN which construct a mesh network and also receives and transmit the information from one tag to another about the position of child and it is given to computer server which is located at school control room. This system will alert the school that one of the children

is missing but its fails to tell where the child is at the current moment. Also it does not concentrate whether child is crying or not. There are no. of schools in a city, and so many areas around a single school. So it is difficult to place the tag in such large areas. There is possibility that child may missed the android device, so it become difficult to implement Yuichiro MORI"s child tracking system.

Saranya. J, Selvakumar. J (2015), the author proposes a framework that traces location of youngsters using a child module that transmits the following data to a database and a cell phone. The drawback of this framework is that the module may not be suitable for children and wide-scale deployment is costly. Mori, Y.; Kojima, H.; Kohno, E.; Inoue, S.; Ohta, T.; Kakuda, Y.; Ito, A (2016), by Mori recommends a system that uses Bluetooth technology to form clusters and communicate among them using android terminals. The major failure of this technique is high deployment cost.

Shu, C (2013) this kind of tracking units can be connected with a cell phone application which alarms the parents if their kid went outside a range defined by them. If the child walked outside this range, the unit will send an alert to the parents. In addition, the application sends the location of the kid by using a geographical map. One of the down sides of this type of applications is that they work in a limited scope.

Akshay Shetty, Harshad Shinde, Ashwath Kumar, Ankit Verma, Popat Borse (2015), presents a system using biometric features for e.g. the school children track biometric system, while entering into the bus pupils scan their palms across a palm reader. To replicate the palm's specific pattern, palm reader uses IR light. For cross-verification the results of scanned palms are sent against original patterns stored in secure database. The inconvenience is that it is manual and small kids feels difficult to place their palms correctly on the scanner.

Nitin Shyam, Narendra Kumar, Maya Shashi, Devesh Kumar (2015) titled "SMS Based Kids Tracking and Safety System by Using RFID and GSM" by Nitin Shyam proposes using two different modules for tracking the child with the help of RFID, GSM and GPS. One module is to be carried by the child and the other module is fitted in the bus. The problem with this system is it uses two different modules to keep track of the child. It increases the operational cost of the overall system and also it is not feasible for the child to carry an extra kit every time he goes to the school.

Khaleed Shaban (2013) 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. This seems to be a good solution for keeping a track of the child; but it lacked with some of the security mechanisms that should have been included like prevention of drunken people to drive the school bus.

T.S. Lim, S.C. Sim and M.M. Mansor, (2017) has published a paper on "RFID Based Attendance System" in 2009, this method is accustomed take attendance for student in class, college, and university. Its ability to uniquely identify everyone supported their RFID tag quite ID card make the tactic of taking the attendance easier, faster and secure as compared to plain method. Ankita Agrawal, Ashish Bansal (2016), has published a paper on "Online attendance Management System Using RFID with Object Counter " in 2013.

In this Attendance is recorded in some ways like using web based ,web wide comprehensibility ,web based attendance is most commonly attendance system available. Web service for management system during, which we have got work on the premise of the presence of scanning the QR code with scanner. Pushpa S Gagare, Priyanka A Sathe, Vedant T Pawaskar, Sagar S Bhave (2014), has published a paper on "Student Attendance System supported Data Analytics"

in 2017.In this paper using RFID reader and passive RFID chip and tag the monitor to students. The system can reduces manpower our system is incredibly easy to handle.

Moth Moth Mymt Thein, Chaw Myat Nweand Hla Myo Tun, (2013) as published a paper on "Students attendance management system supported rfid and fingerprint reader" in 2015.The system is developed by the blending of ubiquitous computing systems into classroom for managing the students" attendance using RFID and fingerprint reader. From an accurate analysis of positive points and constraints on the component, this method is safely concluded that the merchandise may well be a highly efficient GUI based component. This application is functioning properly and meeting to any or all user requirements.

Unnati A Patel, Dr Swami Narayan,Priya R, (2013) has published a paper on "Student Attendance Management System Using Rfid and face recognition" in 2014.In this paper problem of student attendance management is defined which is traditionally taken manually by faculty RFID will take automatic attendance for all students enter in class which is in a position to get rid of the timeless of professor.

H.BEN, & ABDULLAH, K (2013) introduced a system that monitors children inside the bus in a safe manner. It uses a combination of RFID, GPS (Global Positioning System), and GPRS (General Packet Radio Service) technologies. Each student carries a unique RFID card. The card is embedded in each of the student's school bags. Whenever a student enters or exits from the bus, the reader records the time, date, and location and then transfer the data into a secure database and this does not require any action from the drivers and students.

2.2 Radio Frequency Identification (RFID)

2.2.1 What Is RFID?

Radio frequency identification as known as RFID is a generic term of technologies that use radio to automatically identify people or object. The acronym refers to small electronic devices that consist of small chip and an antenna. The chip typically is capable of carrying 2,000 bytes of data or less. The RFID provides a unique identifier for that object. The RFID device must be scanned to retrieve the identifying information. RFID is a method of string and remotely retrieving data using devices called RFID tags or transponders. The RFID tag is a small object that can be attached to or incorporated into a product, animal, or person.

2.2.2 The RFID System

An RFID system may consist of several components: tags, tag readers, edge servers, middleware, and application software. In a typical RFID system, individual objects are equipped with a small, inexpensive tag. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal. The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing. In some RFID solutions a return receipt can be generated. An RFID system consists of two main components, RFID tag (transponder) and RFID reader. RFID tag is usually attached to the object to be identified and carries information in an electronic microchip. RFID detects tags and performs read/write operations on RFID tags (Lara Srivastava, April 2005). Lara Srivastava (2005) states normally readers are connected with an additional interface to forward tag information to another system, like a PC or robot control system.

The most common RFID system, the reader transmits a low-power radio signal to the tag, which receives the signal and uses it as a power source to activate the embedded integrated circuit, and then transmits the information stored in it back to the reader through the antenna. The information carried by the RFID tag is the identity of the tag and other relevant information.

2.2.3 TYPE OF RFID

Type of Power Supply

There are three types of RFID,

a. Active,
b. Passive, and
c. Semi passive RFID tag.

Active RFID and passive RFID are fundamentally different technologies. Active RFID tags have an internal power source (battery).The battery that can be used as a partial or complete source of power for the tag's circuitry and antenna, and may have longer range and larger memories than passive tags, as well as the ability to store additional information sent by the transceiver. Some active tags contain replaceable batteries for years of use (JR Tuttle, 1997).

Passive RFID tags have no internal power supply (battery).The power is supplied by the reader. When a passive RFID tag encounters radio waves from the reader, the coiled antenna within the tag forms a magnetic field. The tag draws power from it, energizing the circuits in the tag. The tag then sends the information encoded in the tag's memory and temporarily stores a very small amount of energy from the reader's signal to generate its own quick response. Music or clothing store placed the reader at entrance to detect an asset or person with a passive tag moving through the door. As quoted by Dempsey (2004) "The key point here is that these systems don't really provide location at all; since the readers have such a limited range, location is surmised from which reader last read the tag.

Even though active RFID offer best performance than passive RFID, most of the researcher prefers to use passive RFID in their system. Chatterjee et al. (2004), Science Application International Corporation (2002) and Larsson and Qviberg (2004) stated that passive RFID is a low-cost to install and can function for a number of years without maintenance. According to Mr. William Sharp, President of Advanced Research Company, most tags being targeted for use today are passive RFID. Hayashi et al. (2003) and Ni et al. (2004) are some researchers who prefer long life active RFID tag for their research.

Semi-passive tag, which employs an embedded battery to achieve better performance. Normally, such tags are only activated when they are in the reading range of a reader. For development school children monitoring system, passive RFID tag will be using to accomplish this project. This RFID are choosing because the tag functions without a battery; these tags have a useful life of twenty years or more. The tag is typically much less expensive to manufacture the tag is much smaller where some tags are the size of a grain of rice. These tags have almost unlimited applications in consumer goods and other areas.

Table 2.1: RFID tags classified by the power source

NAME	POWER SOURCE	TRANSMISSION MODE	RANGE(WITHIN)	LIFE
Passive	Scavenging	Reflective	3 meters	Unlimited
Semi-passive	Battery	Reflective	10 meters	5-10 years
Active	Battery	Active	100 meters	1-5 years

2.2.4 Operating Frequency

The frequency of an RFID system defines the relationship between the tag and reader, and impacts both the transmission range and speed. RFID systems can work in the low frequency (LF), high frequency (HF), ultra-high frequency (UHF), and microwave parts of the spectrum. Common frequencies for RFID systems are 125-134 KHz (LF), 13.56 MHz (HF), 860-930 MHz (UHF), and 2.45 GHz (microwave).

Table 2.2: RFID tags with different frequencies

Name	Frequency	Range	Data Rate	Ability To Read In The Vicinity Of Water And Metal	Passive Tag Size	Typical Applications
LF	125 KHz	<0.5 m (1.5 ft)	Slower	Better	Larger	Access control, animal tracking, vehicle immobilizers, POS applications.
HF	13.56 MHz	1m (3ft)	|	|	|	Access control, smart cards, smart shelves, item level tracking
UHF	860-930 MHz	3m (10ft)	|	|	|	Pallet tracking, electronic toll collection, baggage handling
Microwave	2.45/5.8 GHz	1m (3ft)	|	|	|	Supply chain applications and electronic toll collection
			Faster	Worse	Smaller	

2.2.5 Cost

Tags and readers are the main components of an RFID system. The reader's price depends on its features and functionality. UHF readers range in price from N 160,000 to N 960,000 Passive tags is cheaper than active tags. The cost depends on frequency, amount of memory, antenna design and packaging around. According to ABI Research (Oyster Bay, N.Y.) analyst Sara Shah, RFID readers using the UHF band are among the most expensive purchases for companies complying with supply chain mandates from Wal-Mart and others. These companies consistently cite UHF reader costs as verging on the prohibitive.

2.2.6 Advantages and Limitation of RFID

RFID technology offers many benefits for business, manufacturing and tracking process. According to Stanford (2003), RFID related application and benefit. As quoted from the study, “Make no mistake about it at the high end, RFID tags are wireless, networked, pervasive computers, successfully integrated into their environment. They are easily attached, often of negligible weight and bulk.” Grajales (2003) stated that RIFD could enable full control of inventory content and location for vehicles in the facility.

Tuttle (1997) stated that the technology overcome other automatic identification approaches such as infrared. Apart from benefits mention above, Ollivier (1996) stated RFID could utilize as car theft prevention. However, RFID system also has its limitations. Two main limitations of RFID are false negative reads and false positive reads. According James Brusey at el. (August 2003) stated false negative reads where RFID tags are not read at all, and false positive reads where RFID tags are detected when they are not in the interrogation range of the reader. Apart of limitation mention above, Christian Floerkemeier, and Matthias Lampe (April 2004) stated that these failures could be caused by collisions on the air interface, tag detuning, tag misalignment, metal and water in the vicinity of the RFID system.

2.3 CHILDREN SAFETY

Road accidents involved by children are 1,232 in 2001 (Malaysian Vital Statistics Bulletin). This is equivalent to death of three children every day in road accident. Abuse is another danger that threatens the lives of the children. As it is largely a hidden affair, abuses are more difficult to tackle. Unicef representative, Gaye Phillips pointed out the challenges in preventing physical and sexual abuse among children. Brownlee and Mcdonald (1998) study a safe place for children place to play, safety going to and from school, teenagers traveling to entertainment, safety problems and crimes. Problems children have to face are has to cross busy roads, violence on public transport, fear of attack by someone in the street, fear of kidnap, being picked up in the street and other problems e.g. no footpaths (A Safe Place for Children: Views From The Outer Suburbs).

2.4 Children Monitoring

Brittan Elementary School in Sutter, CA, has abandoned an experimental RFID program after InCom, the company that developed the technology, pulled out of its agreement with the school. Last week, EPIC, along with the Electronic Frontier Foundation and ACLU-Northern California, urged the Brittan School Board in a joint letter to terminate the program that used mandatory ID badges to track children's movements in and around the school with RFID technology. The letter argued that the program breached children's

2.5 RFID Based Security System

In present days, because of the higher rate of kidnapping parents are worried about their children. Moreover, parents are having long working hours, so they simply do not have as much time to spend on their children. Recently in our country Police found the body of a missing school student in Kashimpur area of Gazipur. His name was Saidur Rahman and he was 13 years old, went missing on September 8, 2017. He was a student of local Dhanshiri School. It is also occurring internationally. A 10-year-old boy who went missing after his mother dropped him off at school Monday morning at Ecole Viscount Alexander, Canada. Here RFID (Radio-frequency identification) based security system has been used for Kindergarten school.
Since RFID is an automatic identification system. Like a barcode or the magnetic strip on a credit card, an RFID tag provides a unique identification code that can be read by a scanning device. Radio waves used in RFID to communicate with readers. After these waves reader converts them into digital data that identifies the object that contains the tag (Figure 2.1).

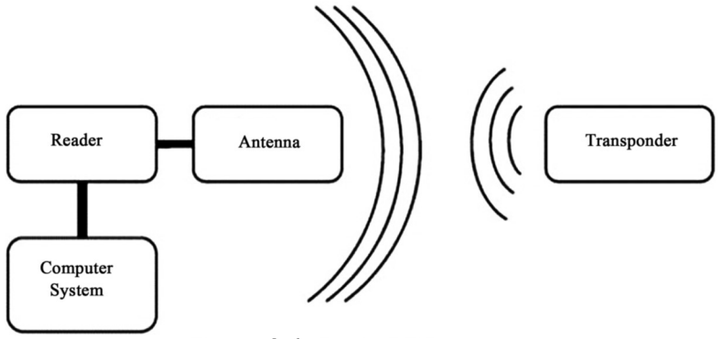

Figure 2.1: Basic RFID system.
Source: S. N. Rahman *et al*. (2020)

2.5.1 Hardware Design

The hardware of the system mainly comprises RFID Tag, RFID Reader, Arduino UNO, LCD Display, Buzzer, Servomotor, GSM Module, Tactile Button and power supply.

2.5.2 RFID Tag

An RFID tag is an electronic tag that transfers data with an RFID reader over radio waves. Maximum RFID tags are consists of at least two main parts. First one is an antenna, which used to receive radio frequency (RF) waves. And the

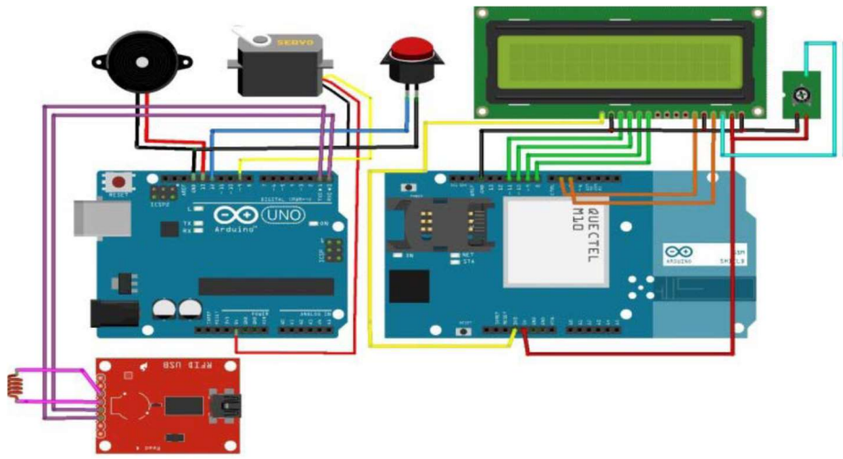

Figure 2.2: Circuit diagram of RFID based security system.
Source: S. N. Rahman *et al*. (2020)

Second part is an integrated circuit (IC), which is usually used for processing and accumulating data, along with modulating and demodulating the radio waves transmitted or received by the antenna. An RFID tag is also familiar as an RFID chip. Two types of RFID Reader are available, Such as Active and Passive. Active RFID systems are battery-powered. These types of systems continuously transmit their own signal. Active RFID tags can precisely trace the real-time location of assets. Active tags maintain a longer reading capability than passive tags, but they are too expensive. No internal power source is required in the passive RFID system as they are powered by electromagnetic energy transfer from an RFID reader. The passive RFID systems economical for many industries due to lower price point per tag. RFID card is distributed by school authority among every students and parent. Identification number of every RFID tag is unique. For the entrance in the school, every student must carry this card for scanning (Table 1).

2.5.3 RFID Reader

The RFID reader used to compile data from an RFID tag to trace individual objects. Transmission of data from the tag to a reader is done by using radio wave. The direct scan is not needed for RFID tag. For successful reading, RFID tag must be within the ranges from 3 to 300 feet of an RFID reader. Fast identification of a specific product is enabled by RFID technology, even when it is surrounded by other items (Figure 2.4). When student scans their RFID card to the scanner, the scanner reads the tag number. It passes authorize people and blocks unauthorized people. The reader reads the students RFID card once a day before school starts. After school starts student card won't work anymore.

2.5.4 Arduino UNO

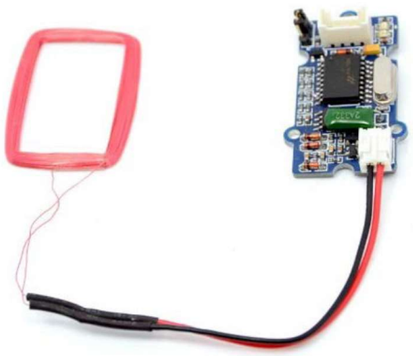

Figure 2.3: Grove-125 KHz RFID reader.
Source : S. N. Rahman *et al*. (2020)

Table 2.3: Comparison of active and passive RFID tags.

Attribute	Active Tags	Passive Tags
Power Sources	Built-in Battery	Electromagnetic Induction
Reading Capability	Higher (22 to 102 m)	Lower (Up to 2.5 m)
Required Signal Strength	Lower	Higher
Tag Cost	Higher ($14 to $100)	Lower ($0.15 to $5)
Data Storage	Large read/write data (128 kb)	Small read/write (128 kb)
Size	Larger	Smaller
Weight	Larger	Smaller
Tag Life	Smaller (3 to 8 years depending upon tag transmission rate)	Larger (Up to 10 years depending upon the environment the tag is in)
Tag Readers	Cheap	Expensive

Source: S. N. Rahman *et al*. (2019)

The ATmega328P is used in microcontroller board of Arduino Uno. This board contains 14 digital input/output pins, 6 analog inputs, a USB connection, a power jack, a 16 MHz quartz crystal, an ICSP header, and a reset button. To use this device we connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery. "Uno" means one in Italian. Uno was chosen to name the release of Arduino Software (IDE) 1.0. The first board in a series of USB Arduino and the reference model for the Arduino platform boards is the Uno board (Figure 2.4).

2.5.5 GSM Module

The international standard for mobile telephones is GSM. GSM stands for Global System for Mobile Communications. As it is a second-generation cellular network, it also referred to as 2G. For internet access purpose GPRS is used, and for the Arduino to request or serve web pages (Figure 2.5).

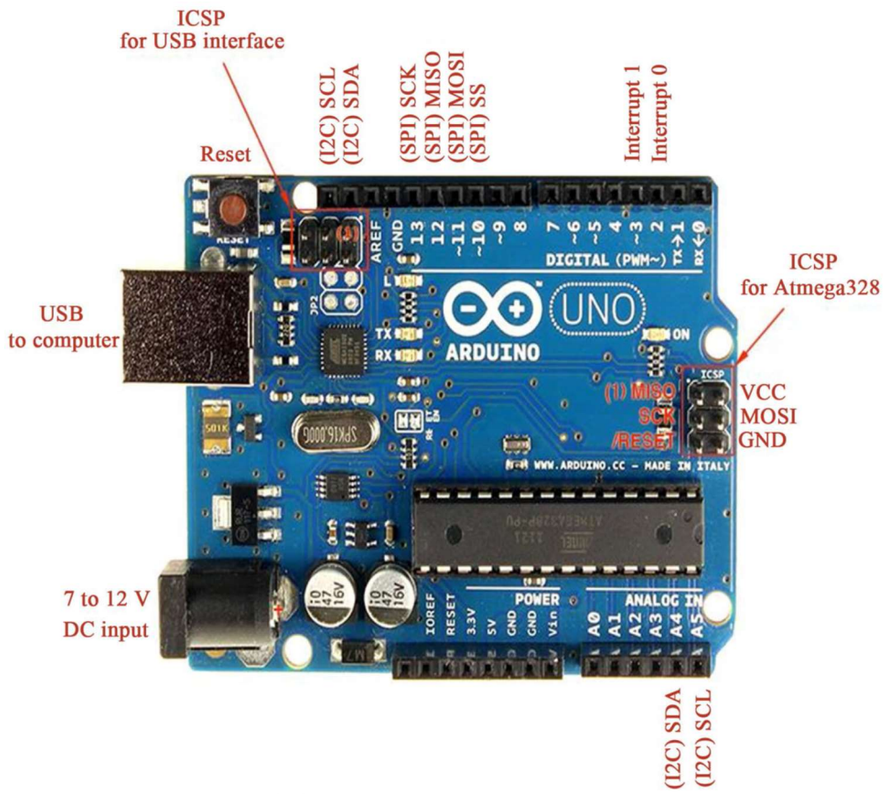

Figure 2.4: Arduino UNO's PIN configuration.
Source: S. N. Rahman *et al*. (2020)

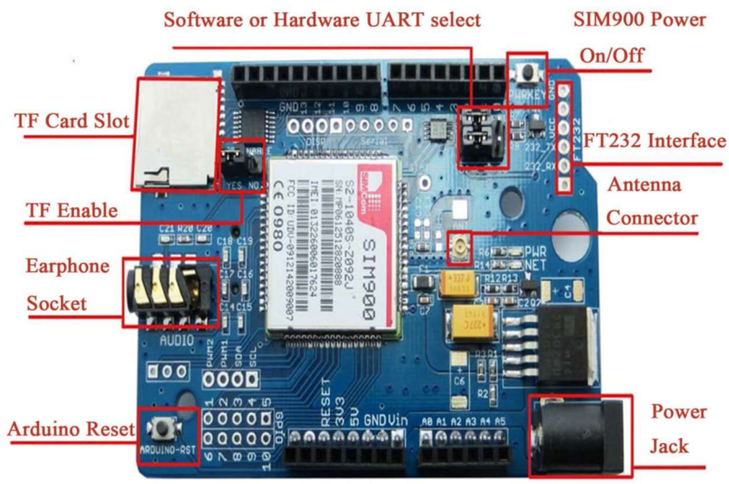

Figure 2.5: Arduino GPRS Shield's PIN configuration.
Source: S. N. Rahman *et al*. (2020)

Outgoing and incoming voice calls, Simple Message System, and data communication via GPRS are also supported by GSM. The Arduino GSM shield is a simple GSM modem. The Arduino GSM shield seems just like a mobile phone, in term of mobile operator perspective. But the Arduino GSM shield looks just like a simple modem, in term of the Arduino perspective. It mainly creates a network with any operative SIM. Whenever student stays absent in the school an automated message has been sent to the parents.

2.5.6 Software Design

Here the program for our project is loaded previously in the Arduino. C language is used as our program language.

2.6 MODERN LOCATION AWARENESS TECHNOLOGIES

With the improvement and advancements experienced in terms of technologies, location awareness and determination technologies have evolved over the years. Today, there are a number of such technologies, all with their pros and cons depending on their applications.

2.6.1 Global Positioning System

Global Positioning System (GPS) is a technology developed by the United States Department of Defense (DoD), as a satellite based navigation system. Two pseudorandom noise (PRN) codes are transmitted by GPS, viz. C/A and P-code, on two L-band frequencies (*f1* = 1575.42 MHz, *f2* = 1227.60 MHz), which a GPS receiver processes and in turn provides information about position, velocity and time. GPS was originally designed for military use, but was released forcivilian use at no cost in 1983 by President Ronald Reagan, following the Korean Air Lines Flight 007 that was shot down by the Soviet Air Force after entering Soviet airspace mistakenly. The President believed that the tragedy could have been averted if better navigation system was available to the flight crew.

GPS is designed to provide users with information pertaining to position, navigation and timing. The GPS is designed with three segments, which are space, control and user segments. The space segment comprises the GPS satellites moving in defined pattern in orbit around the earth while the control segment is coordinated by the United States Air Force to maintain and control the activities and movements of the satellites in orbit. The United States is committed to maintaining at least 24 operational satellites in orbit per time but in the past few years, there are about 31 operational GPS satellites in orbit. These GPS satellites fly in medium Earth orbit (MEO) at an altitude of approximately 20,200 km (10,907.13 Nautical Miles). Each satellite circles the Earth twice a day.

2.6.2 Mobile Phone Tracking

Mobile phones, when switched on, send out a signal to cell towers within its vicinity and the mobile phone can be identified with this signal. By comparing the time for the signal to arrive and relative signal strengths from multiple towers, an estimated location of the handset can be obtained. Mobile phone identifies itself in two ways when it connects to the mobile phone network. The SIM card sends its unique IMSI number - standing for International Mobile Subscriber Identity. The IMSI number starts with the country code of the user’s account, followed by the network code and finally the telephone number. The second number is the IMEI - International Mobile Equipment Identity. This is the number of the handset and remains constant even if the SIM card is changed. Mobile phones transmit these numbers each time they make a call and when they regularly "check in" to the local base stations; making it possible to track even without making calls.

2.6.3 Radio Frequency Identification

Radio Frequency Identification (RFID), is a technology used for the automatic identification and tracking of goods, animals and people. RFID uses radio-frequency electromagnetic fields to transfer data wirelessly without making contact, for the purposes of automatically identifying

and tracking tags attached to objects, which contain electronically stored information. Some tags can be powered by and read at short ranges (a few meters) via magnetic fields (electromagnetic induction) while others use a local power source such as a battery, or else have no battery but collect energy from the interrogating EM field, and then act as a passive transponder to emit microwaves or UHF radio waves (i.e., electromagnetic radiation at high frequencies). Battery powered tags may operate at hundreds of meters. The major difference between bar code and RFID is that the RFID tag does not necessarily need to be within line of sight of the reader, and may be embedded in the tracked object unlike bar code which is required to be in the line of sight of the reader.

2.6.3.1 Components of an RFID System

The following is the list of the major components of an RFID system.

i. RFID Tag/Transponder
ii. Reader
iii. Control Software

2.6.3.2 Current Application of RFID

RFID technology has been implemented in various areas and fields of life. Some of its recent application includes but not limited to the following;

i. Automated toll payment system
ii. Metro station fare payment
iii. Protection of infants in hospitals
iv. Automated entry/access system.

2.7 COMPARISON OF MODERN LOCATION AWARENESS TECHNOLOGIES

This section considers the pros and cons of all three (3) modern location awareness technologies discussed under the parent section, which are; radio frequency identification (RFID), global positioning system and mobile phone tracking. The comparison is based on a number of factors, which include;

i. Cost of deployment
ii. Ease of handling
iii. Rate of Power Consumption/ Power requirement
iv. Line of sight requirement
v. Indoor performance of the technologies

Table 2.4: Comparison of modern location awareness Technologies

	RFID	GPS	Mobile Tracking
Cost	Minimal Cost of deployment	High Cost of deployment	Medium to high cost of deployment
Ease of Handling	Tags can be in form of Identity cards or embedded in pupil's school bag or shoes without damage to the tag	GPS device cannot be easily managed by little school children and they can easily be detected and disposed by assailant	Mobile device cannot be easily managed by little school children and they can easily be detected and dispose by assailant
Power Consumption	Passive tags used is powered by the external reader and do not require internal power to run	Internal power is required for the GPS device to run	Internal power is required for the mobile device to run
Line of Sight	No Contact nor line of Sight necessary	Line of sight required for communication with the satellites	Line of sight not required
Indoor Performance	Works perfectly in an indoor environment	Works optimally outdoor where the device has access to the sky view	Works perfectly in an indoor environment

Source: Matiluko and Aremu (2019)

From table 1 above, Radio Frequency Identification (RFID) has a plus over the other two (2) technologies in terms of Cost of deployment, ease of handling, power consumption and indoor performance. The ease of handling is the major factor considered in the choice of technology employed in this design as young pupils are involved.

3. METHODOLOGY OF THE STUDY

3.1 Description Of The System

The description of the proposed system RFID-based security system for school children uniquely identify and track a child. This requires a unique device, which has the capability of distinguishing different person. This is possible by the new emerging technology RFID (Radio Frequency Identification). The main parts of an RFID system are RFID Tag (with unique ID number) and RFID reader (for reading the RFID tag). In this project, the design of security for school children is based on RFID technology. RFID technology consists of two parts. One is hardware and another is software. In the hardware part, many components are used such as RFID reader and tag etc. In the software part, a written program is used. The system uses automatic clustering technique to monitor the children and each child is provided with a tag. Groups of dangerous places are indicated as DP. When a child comes near DP, the child information is collected and sends to the server through mesh network. It uses Bluetooth to send the information which is one to one.

There are three types of RFID based on their frequency ranges, low frequency, high frequency and ultra-high frequency. We decided to use UHF RFID visitors, because it provides a faster bandwidth than the others. There are two types of RFID tags, passive and active tags. Figure 3.1 describe the block diagram of the RFID based security system.

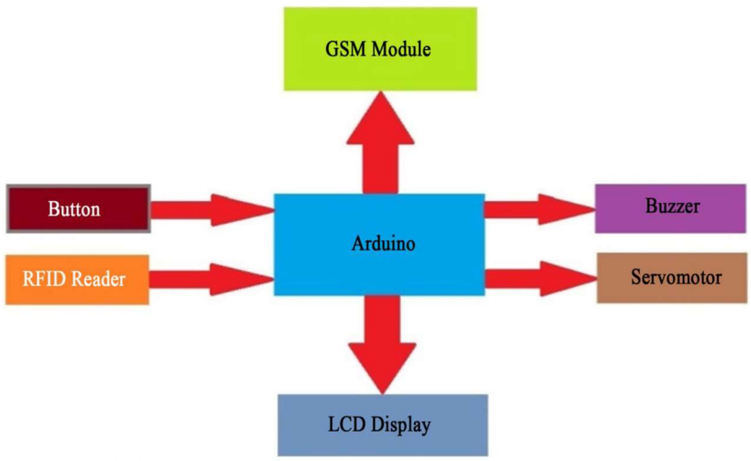

Figure 3.1: Block diagram of the RFID based security system.

A passive RFID tags is selected since there's a brief studying range which fit the requirement to recognize faster. In addition, a passive RFID tags are less costly than active RFID tags and wish no maintenance instead of active tags that need maintenance and regular substitute of battery. The RFID will be situated at every dangerous place in the school premises and each child will placed on a card with RFID tag installed on it. Whenever any card is shown to the hardware system then reader gets the data of RF card with the help of 125 KHz frequencies. Reader gets the data and transfers this data to microcontroller immediately microcontroller process this data, identifies the child using internal alphanumeric code within the RFID tag and using a GSM module and display a message on LCD display about the current location of the child.

3.2 Main Function Modules Of The System

The functions of this system are mainly divided into several major modules, namely, the school gate information acquisition module, the child information module and the dangerous area information module. Information can be obtained, recorded, displayed and reminded in each module, as shown in Figure 3.2.

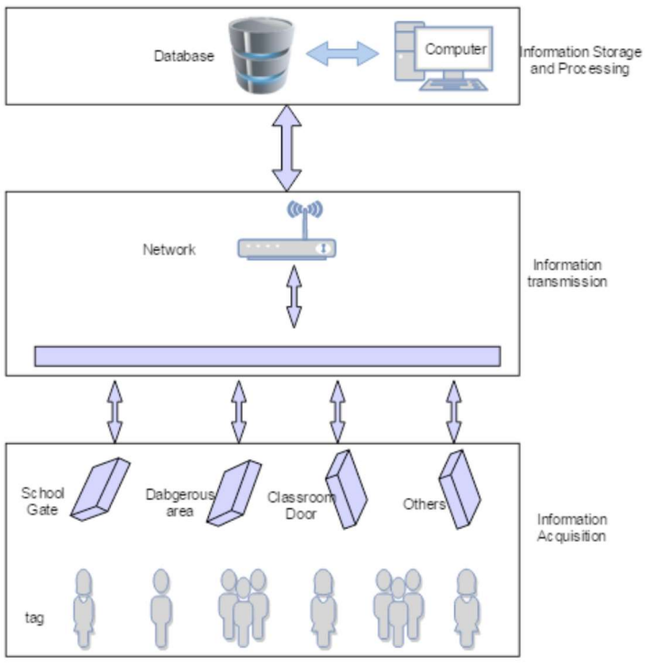

Figure 3.2: System module

3.2.1 School gate attendance module

The main function of this module is to get information when a child comes near the school gate at the time which is not expected. In this module, the information is classified to different group according to its special number. Therefore, the child information is obtained in time and send to server.

3.2.2 Child information module

The function is to record details of each child, the time a child enter the school and the time he/she leaves.

3.2.3 Dangerous area information module

To monitor the dangerous area of the school and get the information in the area in time. Once a child comes near dangerous areas, the system sends an alarm signal, and the location of the alarm is determined based on the reader number.

3.3 COMPONENT RFID BASED SECURITY SYSTEM

Table 3.1: Components used in the system

Components	Specifications
RFID reader	MFRC522 13.56 MHz (high frequency) Reading Range (10cm – 1m)
RFID tag	Passive tag S50IC Card 1kbyte EEPROM
Controller	Arduino Mega 2560 Clock Speed (16MHz) EEPROM (4KB) SRAM (8KB) Flash Memory (256KB)
GSM Module	SIM900A

a. **RFID reader:** Electronic a device used to transmit signals from RFID tag
b. **RFID tag:** ID system which contain information about the object.
c. **GSM module Unit:** used for sending SMS massage and transferring data.
d. **Controller/ Host computer:** receives tags data from a reader.

3.4 DATABASE DESIGN

The database used in the system is the SQL Server database. According to the demand of the system, the main database table;

a. Dangerous area information table,
b. Child information table,
c. School gate information table and
d. Authentication table.

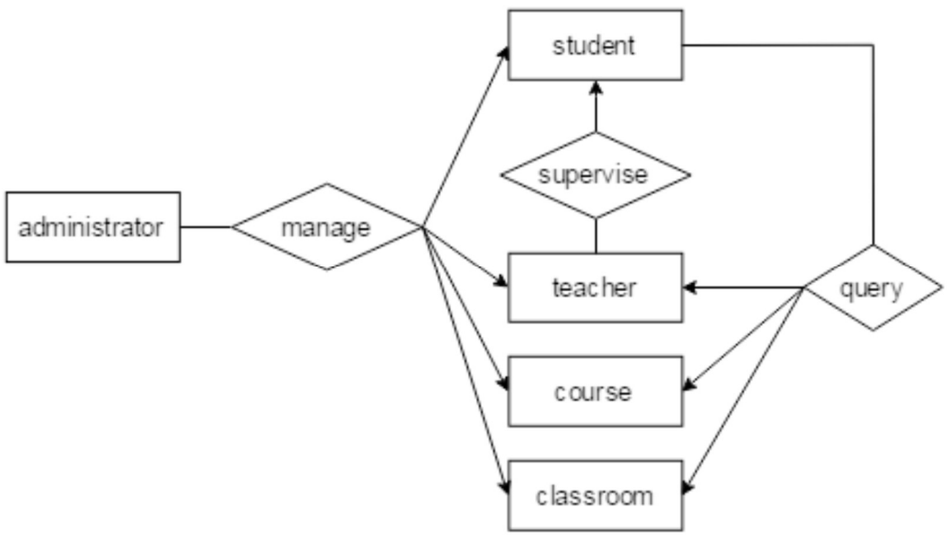

Figure 3.3: Entity relationship

The main entities included in this system are teachers, child (students), system administrators and classrooms. System administrators not only manage all of the teachers' and students' information and attributes, the distribution of the classroom and the course arrangement, but also conduct the system maintenance and management, notification and release. Teacher is responsible for the management of child, extracurricular activities and learning, the subject achievement etc. Figure 3.3 shows the entity relationship diagram of the system showing the relationship between all identified tables.

3.5 ALGORITHM STEPS

Step 1: Start the system when switch on the smart watch.
Step 2: a. Turn on tracking system
b. Sensing whether any RFID system presence
c. Tracking Health of the children by sensing _BP'
and _Glucose' level.
Step 3: If RFID tracking system is found then Smart Watch
will integrate with the system.
Step 4: Periodically send the messages collected after from
interacting with RFID system.
Step 5: repeat step 3 until go out of the school campus.
Step 6: if Child status == _Returned'
Then
Update the history and send messages
Else
Set TrackTimePeriod
If TrackTimePeriod == Expired &&
BP=='Abnormal'
Send Message —Child Under Problemsǁ
&& Frequent Beep Sound
Step 7: Restart the system flow from the beginning

4. SYSTEM IMPLEMENTATION AND EVALUATION

4.1 Introduction

This chapter explains the implementation part of the entire research work. The software tools and as well the requirement module that was used to generate outputs are all documented. It is advice to deploy the solution software on a desktop or a laptop computer for evaluation purposes.

4.2 Choice Of Tools

Microsoft Visual Studio was selected because it provides easy access to underlying server functionality by giving developers access to server functions like message queuing and event logging, as well as a variety of designers from the VS environment. Designers are the key component of Visual Studio; allowing developers to be guided through complex development of specific components. These designers, including XML Data Designer, Web Services Designer, Windows Forms Designer, and Web Forms Designer, provide easy access to generated code based on class frameworks. The generated code is accessible to the developer, allowing the developer to modify or add code. This is a fully object oriented programming tool excellent for window based, application, web and other related software development. It ensures readability and ease of debugging.

The following are other features of Microsoft visual studio:

i. **Flexibility**: Visual makes the code easily modifiable and debugging a breeze.
ii. **User Friendliness**: Allows a very easy interaction between the users and the computer, even a novice can operate it.
iii. **Easy linkage to the database**: With the use of MS SQL and ASP.NET, web pages can easily be linked to the database.
iv. **Compatibility and Convertibility**: Compatibility with other operating systems. The new design can easily be converted to operate on web pages designed with different languages.
v. **Security**: Provision of security mechanism that prevents unauthorized person from tampering with the records.
vi. **Interactive Querying**: Provision for data retrieval through interactive querying

4.3 Installation Requirements

Installation requirements are the required specifications a device must have in order to use certain hardware or software. For example, a computer may require a specific I/O port to work with a peripheral device. A smartphone may need a specific operating system to run a particular application. However, in the case of this research software design, the installation requirement for both software and hardware specification that system must have in order to run a software application successfully is listed below;

4.4 Hardware Requirement

The following hardware configuration is required to successfully complete the installation of this project software:

i. 2.0 GHz processor, or faster.
ii. 2GB for x32 processor, 3GB for an x64 processor, of available, physical RAM for better experience.
iii. Video (1024 × 768 or higher resolution) monitor with at least 256 colors.
iv. CD-ROM or DVD-ROM drive.

4.5 Software Requirement

The following software's are required to complete the installation of this project software:

a. Microsoft Windows operating system such as (Win10 is recommend for better experience)
b. Microsoft Visual Studio 2015 Standard, Visual Studio 2015 Professional, or Microsoft
c. Antivirus Software

Table 4.1: Summary of Software and Hardware Specification

EQUIPMENT	MINIMUM	HIGHER PERFORMANCE
COMPUTER	Shared desktop computer (not recommended)	Dedicated desktop computer (performance) `
OPERATING SYSTEM	Windows 7 Pro, 8 Pro, 8.1 Pro, 10 Pro for desktop computer	
RANDOM ACCESS MEMORY	4 GB (minimum requirement with SQL Express)	8 GB (minimum requirement with SQL Express)
DISK SPACE	20 GB of free disk space (minimum requirement) May vary according to the data and documents	
HARD DISKS	SATA type	SAS type (recommended)
PROCESSOR	Intel Core i5 / Core i7 or equivalent *(Celeron brand not recommended)*	

4.6 Prototype Of The Program Design

4.6.1 Installation Procedure

The installation procedure explains series of process that user take in completing a software installation. The steps below explain installation guideline of the designed program.

a) **Procedure on how to install the software**

Step 1: *Put or Insert the software CD into computer CD-ROM*
Step 2: *Click the start button on the desktop*
Step 3: *Click on This PC (for win 8 and above)/ my Computer (for win 7 and lower version of OS) from the start button*
Step 4: *Open the CD inserted from my computer/ This PC*
Step 5: *Double Click on the SETUP icon from the CD opened*
Step 6: *Follow all instructions given by the software and click on next button to continue setup at every stage*
Step 7 *Click Finish to end the installation process*

b) **Procedure on how to lunch the software**

Step 1: *Click on the start button on the window task bar*
Step 2: *Click on all app from the start pallet displayed*
Step 3: *Locate "RFIDSecurityForChildren" from list of program displayed*
Step 4: *Click on "RFIDSecurityForChildren" to lunch the application.*

4.7 System Implementation/ Result Discussion Of Objectives.

Implementation (Result)

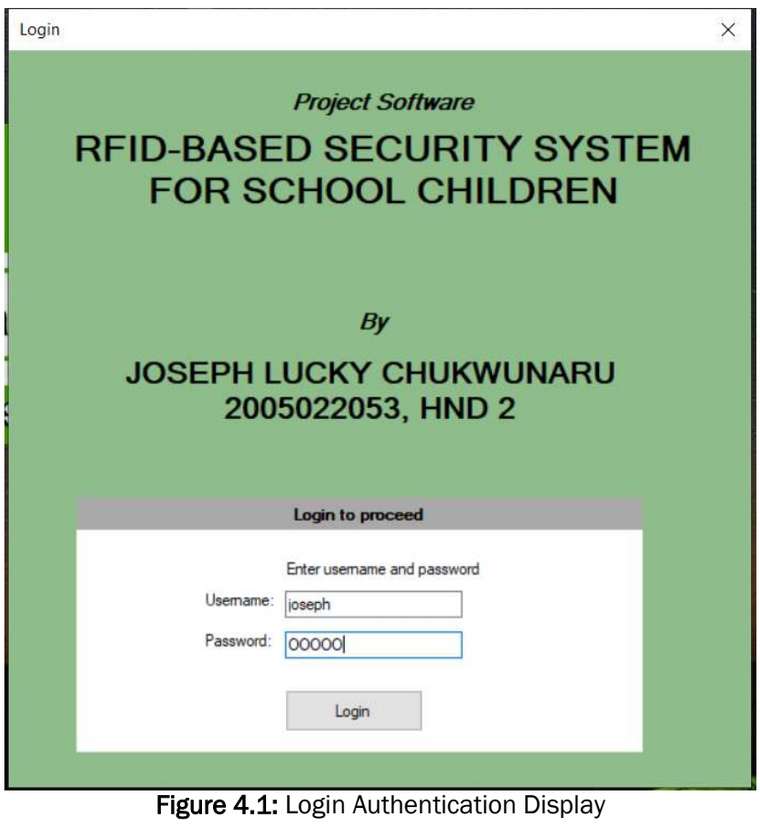

Figure 4.1: Login Authentication Display

After a successful login, user will be redirected to the software main menu see figure 4.2 below

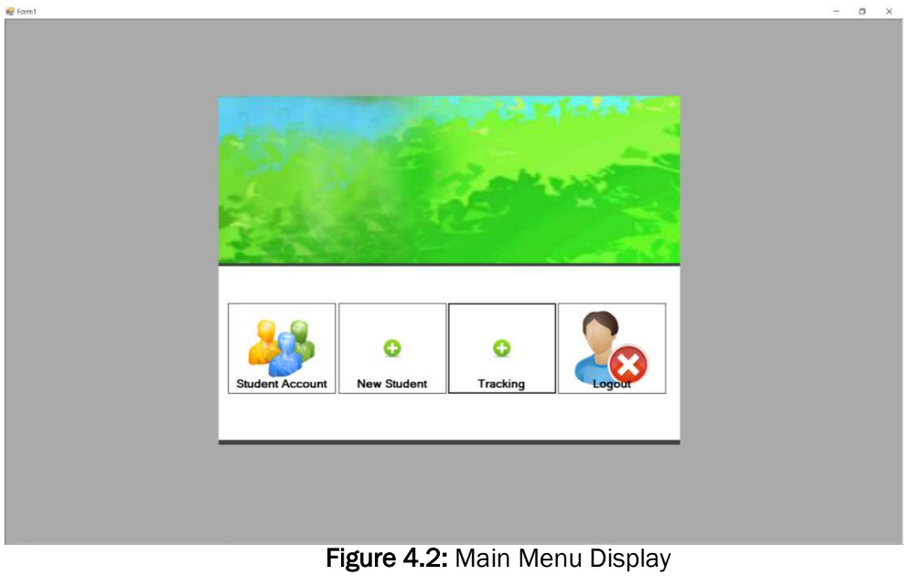

Figure 4.2: Main Menu Display

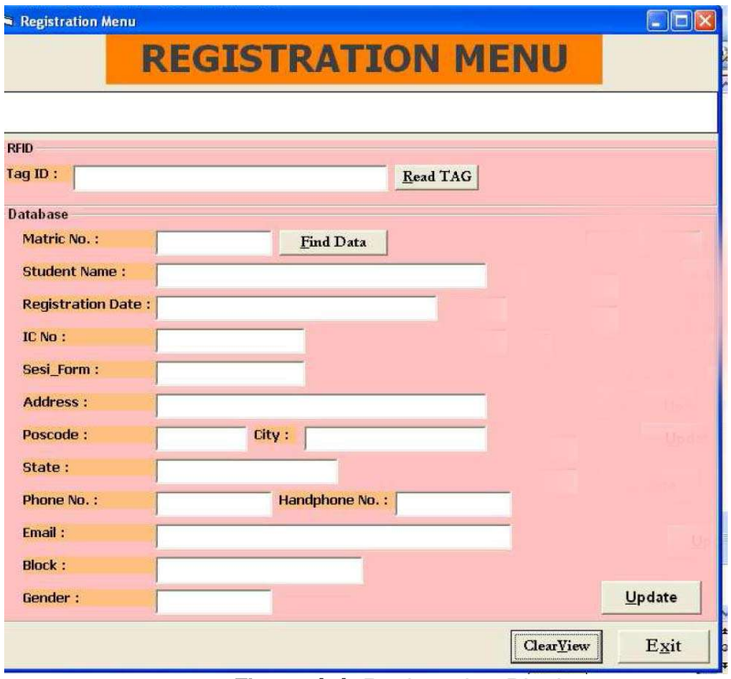

Figure 4.4: Registration Display

4.8 System Testing/ Discussion Of Predicted Result.

The various units and files were all bundled together; the system was deployed on Microsoft Windows 10 32bit framework platform. The software program is tested at each level of design to ensure that they work as intended.

Debugging

All the platform files of the system were carefully checked syntactically and error codes that could make the system not to behave as intended were all corrected.

4.9 Unit Testing

This is the testing of the individual module that makes up the whole system. Each of the form was viewed to see how it would appear to runs successfully.

4.10 DOCUMENTATION

This consists of the programmer's documentation and the user's documentation information in order to assist the user on what to do if an option is not clear about the system.

4.10.1 Programmer Documentation

This is to show the state of work on the system to the programmers, so that they can know where to start from in case of expansion or adapting the system to another environment. The entire user interface was written in Microsoft Visual Studio 2015.

4.10.2 The User Documentation

This is the categorical analysis of how the user can make use of the system perfectly. The user needs a login credentials to access the system page after he/she must have must have registered for accessibility.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This project implementation primarily focuses on alert if a child nearly approaches danger area or zone. RFID-based detection unit located in every child. The system checks and detects which child falls wanting and issues an alert message to this effect. In addition, the system checks the children absence list and updates the database. The integration of RFID for safety and security purpose is very important nowadays due to increase in accidents of children which may lead to death. The project also shows that that RFID technology based tracker system is still acts as one of the best solution to enhance the safety in the school, which will reduce incidence.

This whole project is designed for the safety of the school. The system is more secure than any past security system. The authority of the school provides a unique identification number among every student. They can enter the school by scanning their own card and the data will be recorded in the administration. If anyone remains absent, an automated message will be sent by the database system to the administrator.

5.2 Conclusion

The system identifies children and entry, exit time with RFID that notifies school in the form of notification simultaneously GPS gets all coordinates from satellite and send it your database server by using GSM/GPRS service module with highly precise and encryption format. The system gives a high level of security for school children as well as an educational institute. The earlier part of this article reveals the requirement to develop E-ID, which was proposed to monitor students' movement; E-ID was experimented in three different conditions, to investigate whether RFID is influenced by noise. It was found that tags give better performance when they are aligned with the transmit antenna, the radiation pattern of an RFID tag antenna determines the ability to read the tag in any orientation and RFID performance is low when it operates in the presence of an interfering signal. To this point, this study has fulfilled the first two aims. In short conclusion, based on the above two findings, this study deduces that RFID is suitable to be implemented for monitoring students.

5.3 Recommendation

Future research expansion, some system defensive mechanism will be added to enable the system to be immune outside knock such as manipulation, sniffing of radio signal for replicate/ modify signals and viruses.

REFERENCES

Anwar Ali-Lawati, Shaikha Al-Jahdhami, Asma Al-Belushi, Dalal Al-Adawi,MedhatAwadalla and Dawood Al-Abri, Department of Electrical and Computer Engineering, Sultan Qaboos University, —RFID BASED SYSTEM FOR SCHOOL CHILDREN TRANSPORTATION SAFETY ENHANCEMENT‖ proceedings of the 8th IEEE GCC Conference and Exhibition,Muscat,Oman.1- 4 February,2015.

Akshay Shetty, Harshad Shinde, Ashwath Kumar, Ankit Verma, Popat Borse, " Proposed BLE(Bluetooth Low Energy) – Based Safety

Ankita Agrawal, Ashish Bansal (2016) SCHOOL SECURITY SYSTEM USING RFID International Research Journal of Modernization in Engineering Technology and Science Volume:02/Issue:03/March-2020

Chaturvedula, K. (2012). RFID Based Embedded System for Vehicle Tracking and Prevention of Road Accidents. International Journal Of Engineering Research & Technology (IJERT), 1(6), 2278-0181.

Exposito, J. A. Gay-Fernandez, I. Cuinas. (2013). A Complete Traceability System for a Wine Supply Chain Using Radio-Frequency Identification and Wireless Sensor Networks.IEEE Antennas and Propagation Magazine, 55(2):255-267. https://doi.org/10.1109/MAP.2013.6529365

Fang, Z.Y., Wei, L., Chen, W. and He, Y.J. (2012) A RFID-Based Kindergarten Intelligence Security System. In 2012 IEEE Ninth International Conference on e -Business Engineering, Hangzhou, 9-11 September 2012, 321-326.

Hemalatha, R., Divakar, S., &Logesh, D. (2017). RFID basedschool children security system. International Research Journal Of Engineering And Technology (IRJET), 4(3), 12-17. Retrieved from https://www.irjet.net/archives/V4/i3/IRJET-V4I3474.pdf

Hau-Ling Chan, Tsan-Ming Choi, Chi-Leung Hui, etc. (2015). Quick Response Healthcare Apparel Supply Chains:Value of RFID and Coordination. IEEE Transaction on System,Man, and Cybernetics:Systems. 45(6):887-900.

Kumar (2016) Radio Frequency Identification School Security System Enhancement Journal of Management Information Systems& E-commerce

Khaled Shaaban, Abdelmoula Bekkali, Elyes Ben Hamida, Abdullah Kadri,"Smart Tracking System for School Buses using Passive RFID Technology to Enhance Child Safety," Journal of Traffic and Logistics Engineering, Vol, 1,No. 2, December, 2013.

Maryan Said Al-Ismaili, Ali Al-Mahruqi, Dr. JayavrindaVrindavanam, Department of Computer and Electronic Engineering,Caledomin College of Engineering, —BUS SAFETY SYSTEM FOR SCHOOL CHILDREN USING RFID ANDSIM900 GSM MODEM —International Journal of Latest Trends in Engineering and Technology (IJLTET)

Mohammed, A., & Kameswari, J. (2013). Web-Server based Student Attendance System using RFID Technology. International Journal of Engineering Trends And Technology (IJETT), 4(5), 2231-5381. Retrieved from http://www.ijettjournal.org/volume-4/issue-5/IJETT-V4I5P50.pdf

M.Navya,— Android based children tracking system using voice recognition‖, International journal of Computer science and information technology,Vol 4 (1): pages 229-235, Jan 2015.

Mon Kyaw, A.S & MyatNwe, C. (2016). Implementation of Student Safety System Using RFID. International Journal of Scientific And Research Publications, 6(6), 373-376. Retrieved http://www.ijsrp.org/research-paper-0616/ijsrp-p5451.pdf

Nitin Shyam, Narendra Kumar, Maya Shashi, Devesh Kumar, " SMS Based Kids Tracking and Safety System by using RFID and GSM,"International Journal of Innovative Science, Engineering and Technology, Vol. 2, Issue 5, May, 2015.

Rohit N. Bhoi1, Dr. V. V. Shete2 International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 6, June 2015

S. Mohammed Rafi2, K. Niranjan Reddy3International Journal of Computer Science and Mobile Computing. A Monthly Journal of Computer Science and Information Technology.IJCSMC, Vol. 4, Issue. 1, January 2015, pg.229 – 235

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

Shu, C., “Guardian Uses Bluetooth Low Energy Tech To Keep Your Child Safe” Available at: http://techcrunch.com/2013/10/09/guardian usesbluetooth-low-energy-tech-to-keep-your-child-safe/

System for School Bus Network,” International Journal of Technical Research and Applications, Vol. 3, Issue 5, 5th (September- October 2015), pp.272-274.

Ranjana, R., & Vinoth, K. (2016). Enhanced Security System For School Children And Woman Transportation Using Arduino . International Journal of Computer Network and Security(IJCNS), 8(1), 6-10. Retrieved from http://www.ijcns.com/pdf/ijcnsvol8no12016-2.pdf

RFID Imparted Student Monitoring System. (2017). International Journal Of Computer Trends And Technology (IJCTT), (Special Issue), 2231 - 2803. Retrieved from http://www.ijcttjournal.org/Special%20issue/NCRTTC-2017/NCRTTC-P148.pdf

Shaaban, K. (2013). Smart Tracking System for School Buses Using Passive RFID Technology to Enhance Child Safety. Journal of Traffic and Logistics Engineering, 1(2), 191-196. Retrieved from http://www.jtle.net/uploadfile/2013/0903/20130903024043135.pdf

Yahaya, C. K. H. C. K. , et al. (2011). A framework on halal product recognition systemthrough smart phone authentication, in Lecture Notes in Electrical Engineering. 49-56.

Vidyasagar, K., Balaji, G. and Narendra Reddy, K. (2015) RFID-GSM Imparted School Children Security System. Communications on Applied Electronics (CAE), 2, 17-21.

Vidyasagar, K., Balaji, G. and Narendra Reddy, K. (2015) RFID-GSM Imparted School Children Security System. Communications on Applied Electronics (CAE),2, 17-21.

Yuichiro MORI, Hideharu KOJIMA, EitaroKOHNO,Shinji INOUE, Tomoyuki OHTA, and Yoshiaki KAKUDA, “A Self- Configurable New Generation Children Tracking System based on Mobile Ad Hoc Networks Consisting of Android Mobile Terminals” proposed in 2011 tenth International symposium on Autonomous decentralized systems. W.-K. Chen, Linear Networks and Systems (Book style). Belmont, CA: Wadsworth, 1993, pp. 123–135.

Zhu, X.W., Mukhopadhyay, S.K. and Kurata, H. (2012) A Review of RFID Technology and Its Managerial Applications in Different Industries. Journal of Engineering and Technology Management , 29, 152-167.