

Application of Radio Frequency Identification (RFID) and Biometrics in School Security System (SSS)

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ABSTRACT

In the light of the recent child kidnapping, targeting the girl child has been not only worrisome, but enormously lean the country toward a lawless nation. Amazingly, this menace has been fueled by the seeming vulnerability of the pupils in question, and the fact that parents cannot always accompany students to the school during school hours or to the house while returning from the school and also do not know the exact time of their entering or exiting the school premises. Therefore, this study is aimed at development of a school security system using Radio Frequency Identification (RFID) and biometric features (Face Recognition) in order to monitor in real time both entering and exit of school premises of the students. The objective of this study was to design a school security system application that sends automatic notification to parents on their child's arrival and leaving the school premises and record student attendance for the school. The methodology adopted was Analysis Design Development Implementation and Evaluation (ADDIE) methodology. The System was implemented using Microsoft Visual Studio 2015 and Arduino IDE as Development Environment. The programming language used were C#.NET (to program the graphic user interface (GUI)), C programming language for the micro controller programming, and MySQL for the database design. Finally, the School Security System (SSS) application helps in management of the student's security, student attendance, complexities in monitoring the entrance and exit of students and reduce anxiety among parents/guardians.

Keywords: RFID Technology, Biometrics, School Security System (SSS)

INTRODUCTION

In today's concurrent world, security is the biggest concern. Recently, countries and international organizations are being progressively challenged by the terror, kidnap and crime directed to children [1]. Some students don't come to school at the appropriate time due to one reason or the other, some leaves the school premises without taking permission while some marks attendance for their friends that are still on their way coming to school or who have been branched somewhere instead of reporting to the school. These activities do not conform to the school norm and expose students to kidnappers and other illegal activities against school children. Parents and teachers are expected to know their children's whereabouts in order to raise alarm on time if there's any casualty against any student in terms of missing or being kidnapped. There's a need for parents and teachers to be in a loop of

communication to monitor in real-time the entering and exit of the school children from the school premises. To eradicate the deficiencies, Application of RFID and Face Recognition Biometrics to the school security system is a requisite technology to manage complexities encountered in students' attendance recording, abuse of the RFID tag and illegal activities among school children which makes them violate school norms and expose them to kidnappers. The RFID and Biometrics system includes the RFID reader, RFID tags, computer system, and host system application. This system is used to record attendance, generate attendance report, send notification to parents to reduce worries and enhance faster security response. The Face recognition Biometrics is integrated to provide a more safe, comfortable, and faster user authentication method than password, token and fingerprints. Also, to prevent

body contact among students to avoid

spread of COVID-19 virus.

Literature Review

RFID (radio frequency identification) is a new technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic diapason to uniquely identify an object, beast, or person [2]. An RFID system consists of three factors an antenna and transceiver (frequently combined into one anthology), and a transponder (the label)[2]. The antenna uses radiofrequency swells to transmit a signal that activates the transponder.

When actuated, the label transmits data back to the antenna. RFID technology differs from bar canons. RFID can read the label using RF, meaning that the RFID anthology can be read from a distance, right through your clothes, portmanteau, pack, or bag. Besides the RFID label correspond to a unique ID for each label. The technology used in the development of RFID has been around since the 1920s. Figure2.1 illustrates the RFID scanner (leftism) and label right.



Figure 1 illustrates the RFID tag (left) and scanner right [2]

Related Works

Elshaiekh & Al Darai [3]designed a system technology that alerts parents and guardians on the status of their wards. Specifically, “The system is designed to check and discover any student enter the wrong school bus and control the entry and exit from school and buses using RFID, which provides great feasibility for schools and pupil’s parent. Additionally, the system can be used anywhere such as in industries and educational institutions. However, RFID systems provide better solutions for protecting children within schools”. In a study described by Mendozaet al.[4], the improvement of an Enhanced Curriculum in the Arts Program student monitoring system with RFID & SMS notification (SMSRSN) was proposed. The manual system requires the physical presence of a guard, who checks the individual identity cards (IDs), thereby wasting time. Additionally, the RFID tags are worn by the Students and they will simply skip through the RFID reader to become aware of their information and saved the time and data to the database. SMS notification is used to inform parents. The SMSRSN poses less

difficulty in the attendance process because the coordinator mans the host computer and monitors the Students. The study also assessed the impact of the application and confirmed that the goals that the authors were sufficiently addressed. Chandramohanet al. [5] developed an Attendance Monitoring System for Students based on a Biometric and GPS Tracking System The fingerprint-based attendance management system. The system consists of a fingerprint acquisition module and a GSM modem. The biometric fingerprint module was used for capturing the fingerprint and pre-treatment. GSM modem is used to send the students' attendance to their parents in the form of SMS. The Global Positioning System(GPS) is a radio navigation system that allows land, ocean, and airborne druggies to arbitrate their exact position, haste, and time 24 hours a day, in all weather conditions, anywhere in the world. After some time, intervals the details of the students who were not present were taken. Those persons' details were taken and a message of “NOT PRESENT “is sent

to their respective parent's mobile numbers. So, the parents may know about the student's presence immediately [5].

Umaret *al.* [6] designed RFID- grounded security and access control system for use in lodges inside the Punjab University premises. "The system differentiates between valid and invalid users applying radio frequency identification with biometrics technology. The system manages the security and authentication task by processing information from sub-controllers. These controllers include an entrance monitoring controller, exit monitoring controller, and mess monitoring controller installed at the entrance gate, exit gate, and mess gate respectively. These controllers read the RFID tags issued to the user and search this tag number in non-volatile RAM. On a successful match, the controllers trigger the computer camera terminal to capture the image of the user. The computer system uses a trained neural network- face detection and recognition module to verify the user authenticity and responds to the controllers by sending them "access granted" or "access denied" messages. The controllers grant the access to the user or make the emergency calls accordingly [6]. Due to the increase in abduction of school children for various reasons such as child labor, ransom, organ trade, and begging. Parents are cautious about sending their ward to school. They purely depend upon the school to ensure that their child is safe while entering and exiting the school premises. To ensure the safety of the child, Priya *et al.* [7] designed a system that implements Radiofrequency. "Student information such as check in time and check out time from the campus is saved on mobile application and thus the SMS gateway is automatically sent notification to parents about their child using SMS that the student arrived safely at the school. The development of IoT based attendance management system involves the process of confirming the students are entering the school premises by RFID mechanism. The system will automatically update the attendance onto the server and

simultaneously send a message to the parent to notify them about the arrival of their children also the assignments for the students can be updated by the teachers to the parents. Ukoima *et al.* [8] developed an RFID-based student attendance system with short message service (SMS) notification backup which is helpful in saving valuable time for both students and lecturers and helps to generate accurate reports when required. The short message service (SMS) feature is used as a backup whenever data loss occurs on the PC system. The authors addressed the means of automatically registering students, recording attendance, saving students' data on the personal computer (PC) as well as backing this data via the global system for mobile communication (GSM), and eventually making a decision on the eligibility of a student to sit for an exam course. The design has four major parts: the input section (RFID tag and RFID reader), the control section, the power section, and the display unit. When a student who enters a classroom swipes the RFID tag near the reader that is connected externally to a microcontroller-based embedded system, the system grants access to a registered student and record the attendance details on a PC database. An SMS containing the exact details is sent to the mobile phone for data backup through the GSM SIM 900 Modem [8]. Pranjali *et al.* [9] developed a School Security System using RFID" to produce security to the college students. The attendance system is time-effective and it reduces the traditional method of taking attendance in school also as it doesn't require any power consumption. "The system sends notification to parents/guardians through a text message once the child enters/exits the school premises, letting them to monitor the attendance of their children". The system was designed with the combination of the latest technology using RFID, the Internet of Things (IoT), and web-based development using Php, apache web server, and SQL. The Node MCU ESP8266 (Microcontroller) acts as an information acquisition System for the module (Pranjali, et al., 2020).

Methodology

This system is classified as an embedded system since it consists of both software and hardware elements. The hardware components include RFID reader, face recognition unit, and Arduino, an LCD, a buzzer and a passive RFID tag. Moreover, the project aims to achieve a specific goal, not to remain from its objective and can be summarized as follows:

- Data collection
- Data collection using the respective problem-solving choice approaches.
- Detection of construction tools and availability of materials.
- Construction of hardware.
- Programming selection of the microcontroller based on the availability of its shielding.
- Integration of technology and hardware for testing.

The RFID reader is connected to the microprocessor. The data (ID numbers) are registered as a part of the program into the Arduino Uno to identify each card automatically. A 12V power supply will power the RFID scanner and Aduino Uno of the system as shown in Fig. 2. During registration of the students, RFID tag is assigned to each student. The picture and biodata of the student is taken during registration while the ID numbers in the tag serves as the student’s registration number. Once the RFID tag is been scanned on the RFID reader, it will trigger the system camera to take a picture of the student. The system after taking the picture trained the picture using machine learning model, the trained pictures will be stored on the database of the system. Attendance and notification to parents is being taken only when both the input data (ID number and Face of the User) match the previous stored data.

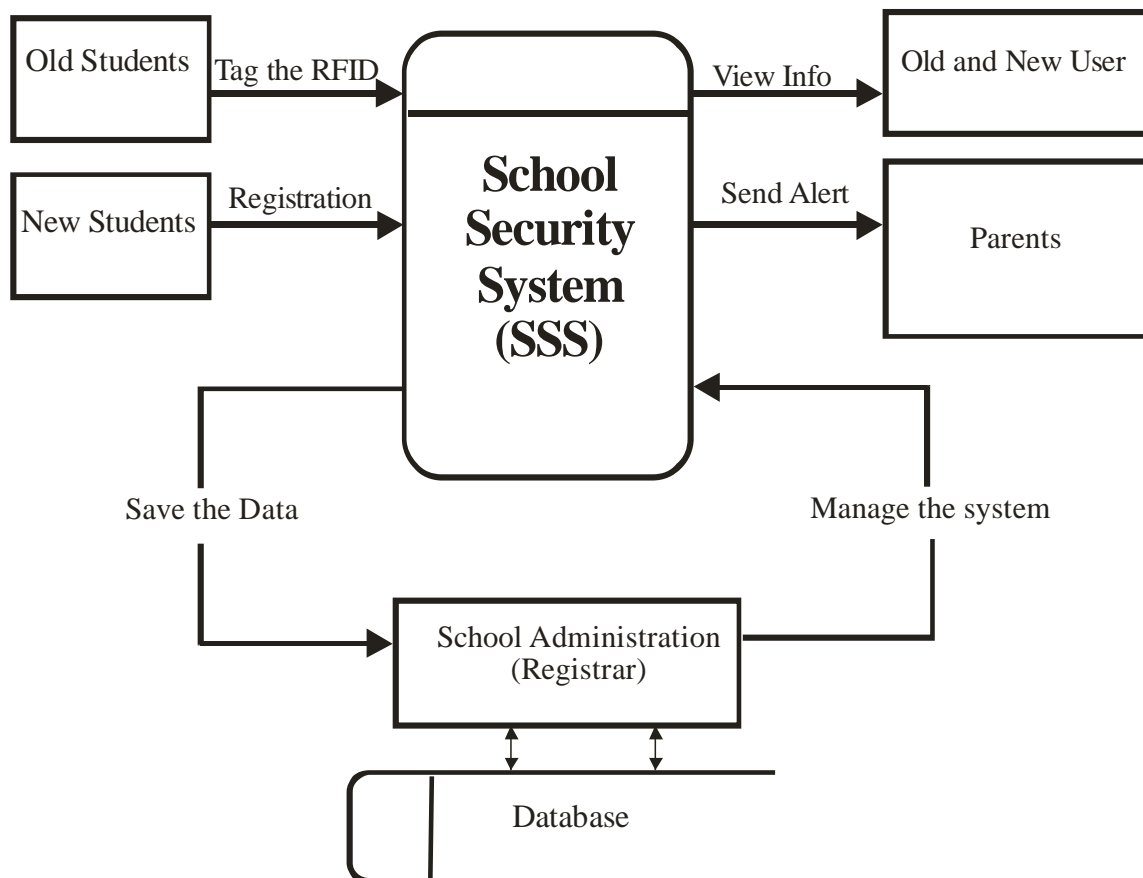


Fig. 2. Context Diagram of the System.

The design includes shielding making, connecting the power source, and supplying the proper voltage to the system, programming of the RTC

module, face detection and recognition, RFID module and SD card module, and linking them to make an embedded system. The circuit diagram is being shown in Fig. 3, and it was tested okay.

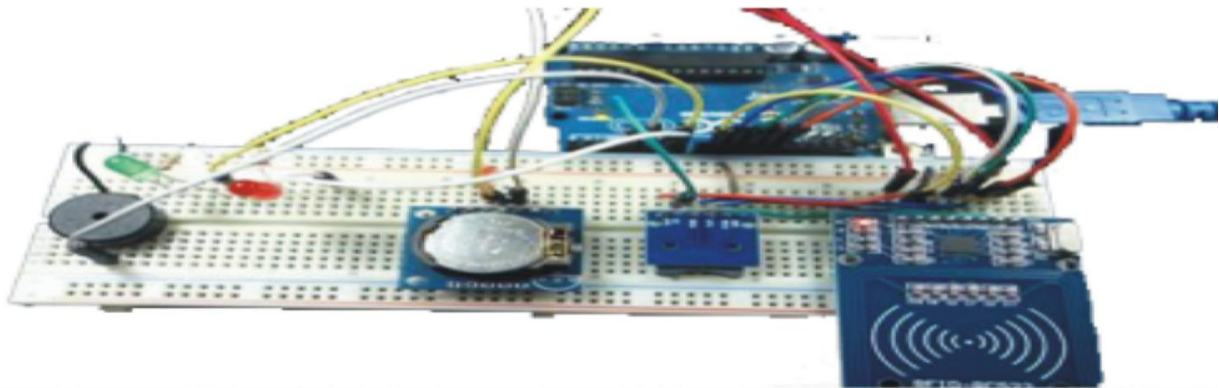
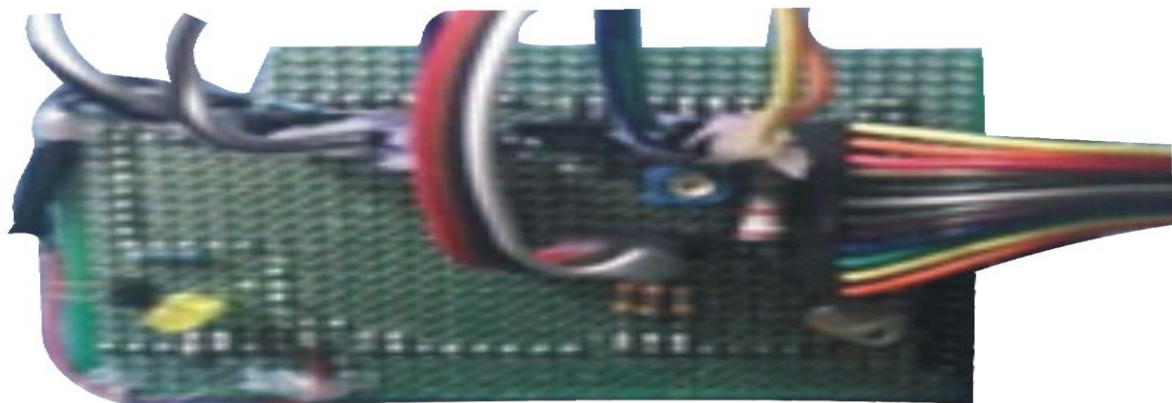


Fig. 3. Circuit Diagram of the system

On this project, standard simulation was not done due to the fact that there is no library for the facerecognition and RFID on Proteus, Fritzing, Mutism, and other standard simulation tools. As a result, in the loop simulation, HIL (hardware-in-the-loop) was implemented because it is

a technique employed for developing and testing complex real-time embedded systems. This Hardware-in-the-loop (HIL) simulation provides an active structure by transferring the control plant's complexity to the test platform. It was easy to build and test the system with the aid of the shield.

The shield is being shown in Fig. 3.



A double-sided Vero board was used to make the total system circuit shield. The shield consists of all the ports needed to make it easy to plug and remove other modules from the Arduino Mega microcontroller. All the modules were tested individually using the shield and the microcontroller. After trying all individually, then they were all assembled and coupled unto the shield. It makes it easier to connect them and is

less error-prone than to start joining a wire to a Vero board.

A lithium-ion battery of 5000mAh is being used to power the system. The battery energy storage has a nominal voltage of 3.7 V and a total voltage of 4.2 V. It was then connected to a charge/discharge module which is built explicitly for lithium-ion batteries. This module does allow charging lithium-ion batteries with a 5V USB charger. A switch was connected to the

power source to ON/ OFF the total system. A LED indicator was connected to show when the system is ON. RTC uses the I2C communication protocol, and this was connected to pin 16 and 17, which are the SDA (Serial Data) and SCK (Serial Clock) on the Arduino Mega. The communication pins were connected to pin 10 and 11 on the Arduino Mega. Pin 10 and 121 are not dedicated pins for serial communication on Arduino Mega. The Arduino Mega microcontroller used the main ports for serial communication to communicate with the personal computer (PC). So, 10 and 11 were used because there is a library ("SoftwareSerial.h") that does allow the use of non-dedicated serial communication pins for serial communication. Out of 16 pins the LCD has, a total of 12 pins were used. The first two pins were used for the power supply (+ve and GND). The next pin was used for contrast, which is connected to the variable resistor. The next pin is the register select pin which was used to switch from one selected to another. The next is the read and write pin, which was connected to the GND for reading the only purpose. And the last out of the first six pins, which are Enable (E) pins, were combined so that the LCD could latch information presented in the data pins. The next set of 6 pins includes: pin D4 to D7 to carry data and the LED +ve and LED -ve pins.

A 220Ω resistor was connected to the LED +ve and LED -ve pins to limit the backlight's current. The RFID module was first tested alone with the shield, the Arduino Mega microcontroller, and the MR55 library. This library was integrated into the Arduino IDE, which is in turn used to program the module. The radio frequency identification reader uses the SPI communication protocol for communicating with Arduino Mega. It was connected to the SD card module because the SD card module also uses the SPI communication protocol. The RFID reader has six pins, and out of the 6, 2 are outputting their contents onto the Arduino Mega microcontroller. The other four were connected with the SD card module before joining it to the Arduino Mega. The connection is possible because SPI does allow communication with more than one SPI device by using the chip select pin for the device. The Secure Digital card module also uses the SPI communication protocol for communicating with Arduino Mega. It also has six pins, and out of the 6, 2 is outputting their contents onto the Arduino Mega Microcontroller. The other four were connected with the RFID module before joining it to the Arduino Mega. The whole module was then attached to make an embedded attendance system, as shown below.

TEST AND DATA

A. Students Registration Mode Testing

- i. The adminlog into the system as admin. It can be a staff of the school. He/she can register new student, edit student information, re-assign card to students that lost their card, disable transferred students from using the card and generate report.
- ii. The admin now connects the RFID Reader after he/she might have signed in to the system, key-in the biodata of the student, take a picture of the student either by uploading from the system or using the system camera to capture the student. The RFID card is scanned to capture the USID code that serves as the registration number of the student.
- iii. Next is the student to position his/her face on the camera, the admin trainthe system for the face detection and recognition.
- iv. The RFID card is given to the student as his/her student ID card.
- v. The admin savesthe information to the database

Entry/Exit Mode Testing

Entering and Exiting mode is done as follows

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- i. The admin or staff or security long in to the system as admin, staff or security.
- ii. He connects the reader for students to mark attendance.
- iii. When a student place his or her RFID tag at close range to the reader, the reader scan the tag, trigger the camera and ask the student to place his face for confirmation.
- iv. After confirmation, the system marks attendance for the

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- student and send notification to parents.
- v. The notification comprises the students Name, Registration number, class, Time and picture of the student.
- vi. Peradventure it did not conform to the data in the database, the system will raise alarm and security operatives will take over the incidence.

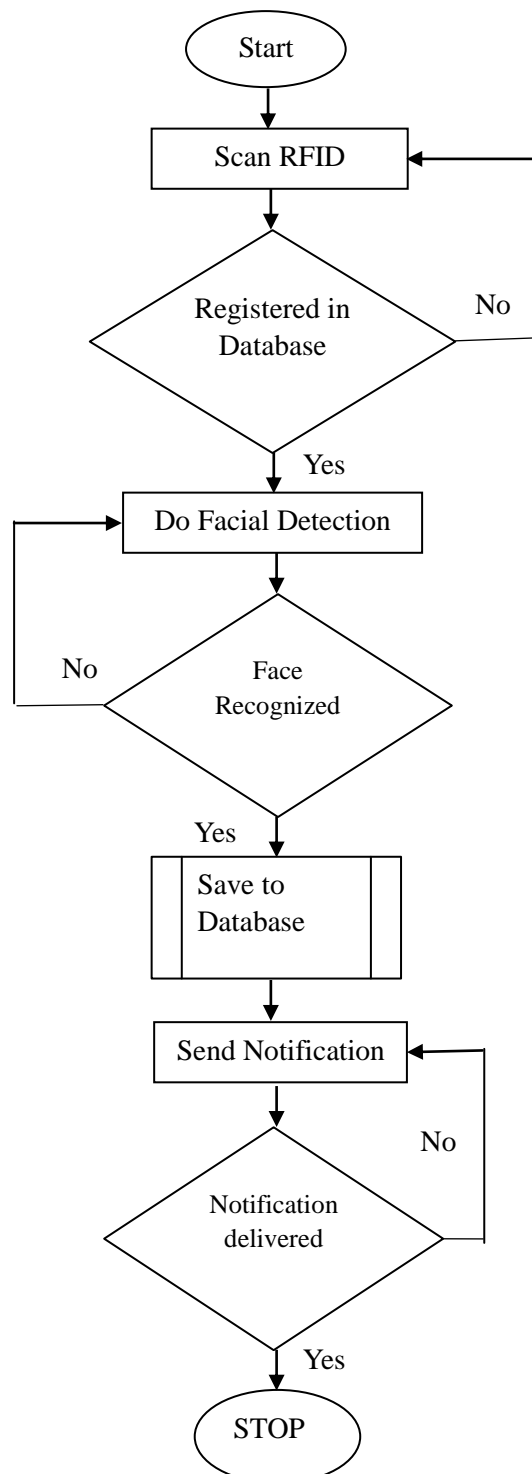


Fig 4. Steps in Entry/Exit Mode Testing

C. Report Generation Testing

- Once there's need for report, both the admin and school security can log in to the system to generate the report on the attendance of a class, a student, on a particular day, week, month or year.
- He or she clicks on generate report and select either a class, student, day, week, month, term and click on generate report.
- The generated report can be converted to Excel, MS word, CSV

files, pdf and can be stored or printed.

- The report shows the ID no, date, and time together with the status.

D. Data

The system was tested by different users and most of the users were registered already by the admin using the registration steps. Two of the

students were not registered. The result is shown in table 1 below after analyzing ten students with no 4 and 7 users.

Table 1: The result from the

No	Regno	Studentclass	Studentlevel	Date	Time	Remark
1	F9C278B3	CLASS B	JSS2	2022-06-05	07:19:42	PRESENT
2	491595B3	CLASS A	JSS 1	2022-06-05	07:20:55	PRESENT
3	491598C2	CLASS B	JSS 2	2022-06-05	07:22:10	PRESENT
4						
5	29A56AB	CLASS A	JSS 1	2022-06-05	07:25:00	PRESENT
6	A9C27833	CLASS B	JSS 2	2022-06-05	07:28:50	PRESENT
7						
8	B4C278A1	CLASS C	JSS 1	2022-06-05	07:29:30	PRESENT
9	9AB27834	CLASS C	JSS 1	2022-06-05	07:38:01	PRESENT
10	9427C33	CLASS B	JSS 2	2022-06-05	07:40:20	PRESENT

RESULTS

Effectively, the design and implementation of this project have resulted in a long-term solution to some of the challenges that schoolchildren face while entering school premises. Because of the rapid progress and bypassing of technology, this project might be faked and hacked, rendering it ineffective. This research is significant

because it addresses particular concerns about the design of a school security system that can bring together the awareness of parents, and school teachers the about of the school children. During the implementation and stages, certain difficulties were faced.

CONCLUSION

The use of a notification system performs the role of contacting the family of the students, regarding their arrival and leaving the school since the school administration cannot check their students one by one and or even notify their parents too at the same time. With this system, illegal activities such as impersonation, and leaving the school premises without authorization and before the time, which do not conform to school norms and regulations are curbed. This system scales down the degree of distressing

panic, fretting and agony among parents/guardian. Hypothetically speaking, if parents are instantly notified and alerted or if they at all times can know the status/location of their child, they will feel at ease to a large extent. Without any iota of doubt, knowledge about students in real-time will help raise their hopes in the security of the school system, which in turn allows them squarely face work that puts food on the table for the family. The system is dependable, safe, and effective.

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