

An Intelligent and Secured Tracking System for Monitoring School Bus

Pre-print

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Abstract— The use of private vehicles intensifies the existing unbearable traffic jam and majority of the parents consider school buses to be largely unsafe for their kids. However, safe and user friendly school buses can reduce the use of private vehicles and will eventually cut back the traffic jam in cities especially in school hours. All buses can be tracked by the guardians using the proposed intelligent and secured tracking system for school buses. This proposed system includes an Android application that can be employed to send notifications during entry and exit of the students using radio frequency identification (RFID) as well as Fingerprint scanner, ensuring arrival confirmation of the student by dual authentication. The system will also notify parents when the bus is a 15-min distance away from the home. To ensure on-board safety, ‘Window Signalling’ will also be used. The focus of the research is to display the feasibility of a safe and intelligent school bus using secured tracking system based on dual authentication procedures. It is expected that the offshoot of this research initiative will regain the confidence and reliability of parents in school bus and reduce the use of individual transport. A smart school bus will keep the student safe, easing the tension for parents and the city will have a smooth traffic system.

Keywords- School Bus; Safety System; GPS; RFID; Fingerprint; Window Safety; IoT.

I. INTRODUCTION

In the context of daily affairs, one of the common problem is traffic jam where the personal cars carrying students during school hour directly compounds the negative impacts on traffic jam. This happens because parents having private transport don’t want to take the risk of using public transport or traditional school bus for school-going children. While parents who don’t own a private transport and use the public ones to carry the children to school, often stay around the school for the whole of the school-hour duration. These parents often have to take number of different routes en route to school and back home. Another probable scenario is that the parents send their children to school alone but they stay tensed as they don’t have any regular status updates of their loving ones. There can also be issues such as the students may not go to school or just simply passing time outside the institution, while their parents having no way to locate the whereabouts of these students.

Thus there is a lack of proper safety which does create complicated traffic related issues in densely populated places like Dhaka, Delhi etc. On the other hand, Statistics from Europe, USA, Canada and Australia suggest that public transport (and school transport in particular) has a high level of safety [1]. For instance, the Australian College of Road Safety notes that bus travel is the safest form of road transport, at least 14 times safer than private vehicles, and that the record for school bus travel, in particular, is very good which is opposite of what can be seen in cities with overflowing populace [1]. Following a survey, carried out among the guardians from different schools in Dhaka, it has been found that 72% of them don’t have private vehicles to drop their children off to schools. Among them 20% uses school bus but do remain tensed as these guardians can’t have any real-time update on the movement of their children. The other 52% of the guardians who use neither personal vehicles nor school buses have to spend their own time to drop off and pick up students which puts relentless pressure in their daily lives. Remaining 28% own private transports. Even then, for some of the parents using private cars, it becomes noticeably distressing due to the highly congested traffic conditions, such regular prolonged stay inside a car is also a red-flag for their health. However, still they have to use it, in result worsening the traffic situation even further, particularly in school hours. All the sides agree that a sustainable solution providing proper safety in school buses would be beneficial to parents as well as to the students themselves. It will also reduce traffic jam in school-hours.

The Internet of Things (IoT) is a concept in which surrounding objects are connected through wired and wireless networks without user intervention. In the field of IoT, the objects communicate and exchange information to provide advanced intelligent services for users [2]. Owing to the functionalities of IoT, this paper proposes an IoT based smart school bus tracking system which can aid parents and responsible persons in real-time tracking of the buses having GPS facility. Parents will get notification of arrival of the bus, and at the time of getting on and off the bus by the students (using dual authentication). Besides, this system will provide window safety during the travel time using laser, preventing students from poking outside the window using hand or head.

This will ensure safety and reliability of the school buses considering the current conditions of crowded cities like the capitals of Bangladesh or India.

II. MOTIVATION AND BACKGROUND

In existing systems, some features are common. Such as GPS is used for tracking purposes while RFID is used for authentication. To transfer information to parents, few common mediums have been employed such as text messaging or some android application. The existing systems can facilitate to identify the location of the bus using GPS as well as to notify the parents when students enter into the bus. RFID tags are scanned to achieve the goal. H. Ben et al. [1], introduced a system that monitors kids within the bus in a safe and reasonably reliable manner. It uses a mixture of RFID, GPS (Global Positioning System), and GPRS (General Packet Radio Service) technologies. Every student carries a unique RFID card, the cardboard is embedded into every student's college luggage. Whenever a student enters into or exits from the bus, the reader records the time, date, and placement and so transfer the information into a secure server. The whole process is automatic, requiring no action from the driver and students.

Zonar et al. [4], has developed the Zpass specifically for school buses in a view to meticulously monitor the school kids. This method uses RFID with a small card kept by the student. It contains passive RFID technology that automatically records every students' entry and exit attempts once the student passes through the pre-set motorbus scanning device. Zpass provides immediate and precise answers and prioritizes the safety issue. Guardians will receive information about the student using a browser having Zpass installed.

Anon et al. [3], proposed a system called *Smart School Bus Architecture*. Under this framework, the student swipes the cardboard at the RFID reader while getting on the bus, the RFID reader then transmits the student identification to a mobile DVR. This mobile DVR will then use 2G/3G/WIFI network to send the student identification to a CMS server. Following which the CMS server will send out an SMS to parent's mobile and the bus will set out for its destination. Throughout the journey, the mobile DVR will take audio and video records at various bus stoppages, and CMS server will have access to those files through 2G/3G/WIFI network. Such a design will allow the parents to visually check the whereabouts of the bus. Besides, GPS can also be used to track the bus locations from the central monitoring website.

In another notable development, brought forward by Maryam et al. [5], a system will control students' entry into and exit from the bus using RFID (Radio Frequency Identification) and GSM to ensure that the process goes on with utmost safety. The framework does not require any additional actions by anyone. The system will execute all the steps and allow the student to be tracked while entering and leaving the bus. If the bus journey is successful from the source to destination, it will send an SMS to the guardian or authority to indicate a successful start and termination of its journey.

The abovementioned systems do provide some level of solutions but questions remain about their effectiveness in countries like Bangladesh and India. Advanced application of technological concepts has seen a rapid growth in recent times in various sectors like healthcare [6], organizational securities [7]. The proposed school bus system will also have such implementations and thus the final output will be a lot more robust, secure and accurate than the traditional frameworks described above. One such major enhancement will be the addition of *Dual Authentication*, as providing only RFID can't guarantee students' arrival in the bus in a fuller degree as it is prone to misuse. To address this, fingerprint authentication has been proposed in this research as a part of dual authentication. Thus during entrance and exit of the students, parents may get an accurate notification.

Besides, in the existing systems, safety measures are lacking while students are on-board. Considering this threat, it has been proposed that a "Window Safety" system, consisting of laser activated alarm will be included to prevent the students from poking outside. Providing Air Conditioning bus for all schools, where windows are closed anyway, is not always possible, therefore this added security feature will bring more reliability to the proposed system.

III. ARCHITECTURE

In the proposed architecture there are few domains for better distribution of tasks. These are:

- A. Admin Domain
- B. Service Domain and
- C. User Domain.

A. Admin Domain

In this portion, the website can be used to add and update the student and bus information to the database, the updated information will be reflected in the website itself. This domain is directly connected to database where other domains are also connected. So any real-time change can be executed by the admin and the whole system can be tracked.

B. Service Domain

In this domain the IoT technologies are included which is implemented in the school buses. The service is provided by RFID, Fingerprint, Laser and GPS to ensure the safety of the students. RFID and Fingerprint are used for authentication, Laser is for window safety and GPS is for tracking the bus to get the real-time navigation and send the alert even before the arrival of the bus.

C. User Domain

In the *User Domain*, an android application will aid the parents to get notifications of their children's current status. The application can also be used to obtain navigation status of the bus in real-time through a map, as well as to get certain information such as driver's contact number.

IV. DUAL AUTHENTICATION

In this paper, mechanism for a dual authentication has been proposed to ensure that the students get on and off the bus with proper identification as parents always stay tensed whether their kids are in the bus and have reached safely. When single RFID is used, there can be a probability of misusing the system as checking the tags only will not be sufficient the RFID tags used for verification may be presented to the scanner by anyone, that is, any other student can use other student's RFID tag. Again only using Fingerprint also have probability of misusing. Students may go somewhere else not entering in the bus by providing fingerprint only. RFID is necessary here to keep track of them in this situation whether they entered or not by reading tags automatically. Furthermore only Fingerprint will not be user friendly as children's have to match finger twice while using RFID just let them come out of the bus without doing anything as their tags will be scanned by default. There are few steps in proposed system. Following is a flow chart of the authentication system as shown in Figure 3.

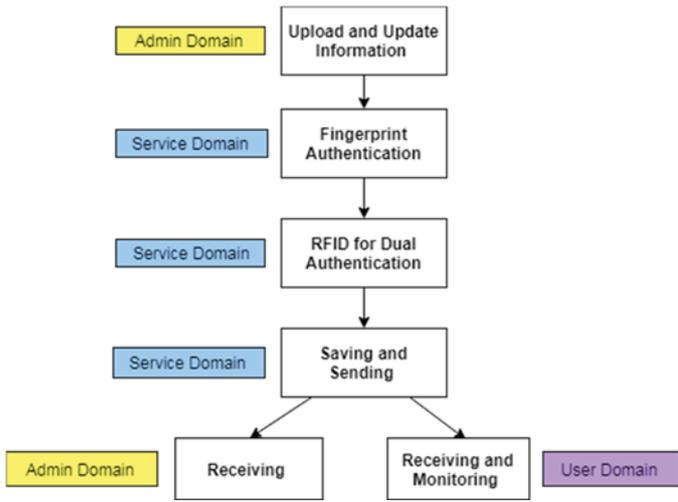


Fig. 1. Proposed System

The proposed system in figure 1 illustrates the steps, where at first admin will upload the information into the web database. Dual authentication using Fingerprint and RFID is carried out next, substantially enhancing the security and reliability. Following is the service domain which stores the information before sending it out. Next up as can be seen in figure 1, the Admin and User domains work in concert where the former receives the data from service domain and the later receives the data to use it for tracking purposes.

The overview of the whole scenario is shown in figure 2.

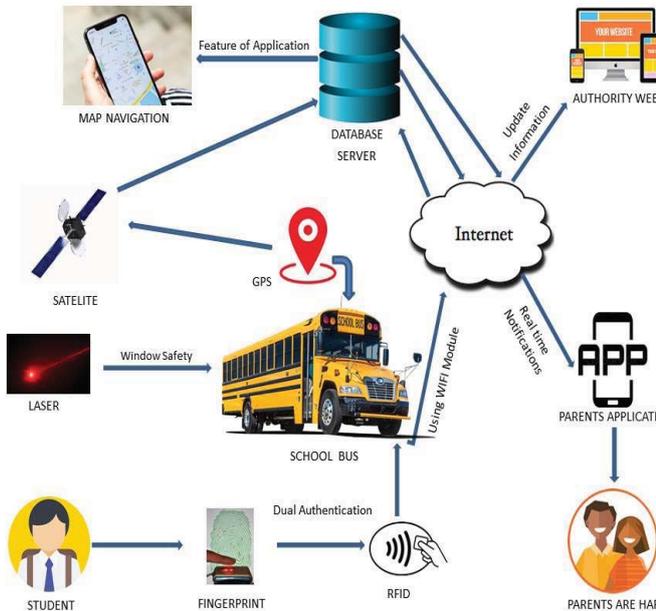


Fig. 2. Overview of the proposed system

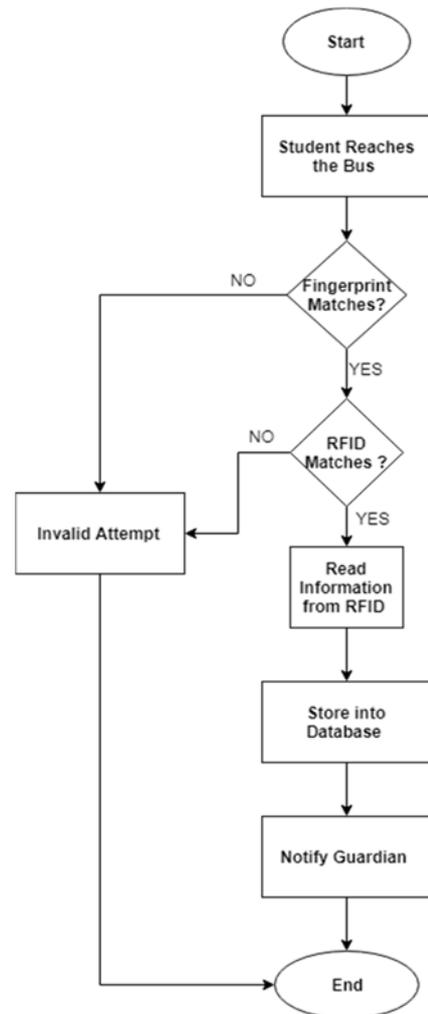


Fig. 3. Flowchart of the authentication system

Step 1: At first student's Fingerprint will be checked for the first level verification.

Step 2: If the fingerprint doesn't match, then it will be considered as invalid attempt.

Step 3: If fingerprint matches then RFID will be checked for second level verification. For each fingerprint images, corresponding RFID record is stored. When one portion has been presented for validation, the system will finally determine the result once the other part of the authentication is also presented for verification and matched accordingly.

Step 4: If a positive match occurs, data will be sent to database and parents will be notified about the student's arrival.

Step 5: If fingerprint matched but RFID doesn't, it will indicate that the student is probably carrying different ID card. So this will be considered as an invalid attempt.

Step 6: When the student is about to be dropped off to his or her destination point, both RFID and Fingerprint is checked. If both match then notification will be sent to parents; so that student can't get out of bus anywhere else or can't be late to get out of the bus when they reach at school.

The flowchart of the system is shown in figure 3.

V. SYSTEM IMPLEMENTATION

School administration will usually operate the website, under *Admin Domain*. In figure 4 the home page of the website is displayed. The user with admin credential has to log in first by a specific username and password. The page offers the option of adding and editing students', buses and driver's information. Besides, user authentication and authorization options are also included in this module. Alongside recently taken actions are shown in the status bar.

The prototype of the system, as designed, is shown in figure 5(a) and 5(b). In this prototype, RFID and fingerprint scanning and verification mechanism are attached in the door for dual authentication purpose.

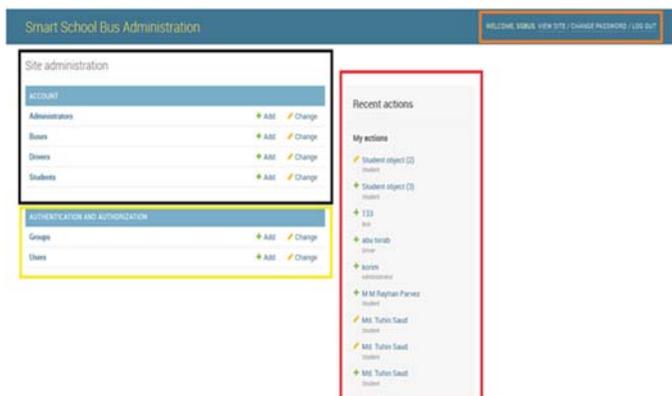


Fig. 4. Homepage of the proposed website

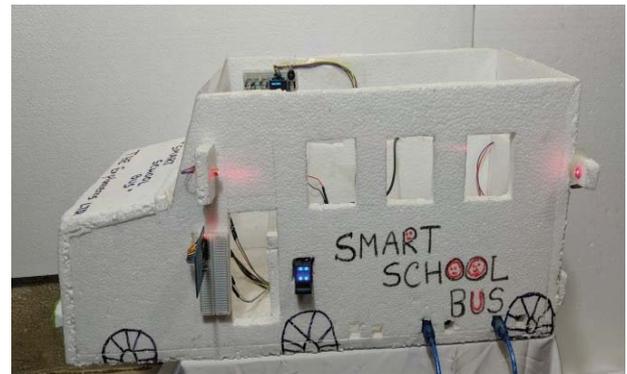


Fig. 5(a). Prototype of the proposed bus



Fig. 5(b). Inside the proposed prototype

There is a display system in the bus to show the matching result. GPS is also implemented in the bus for real-time navigation. In windows, there are lasers to protect students from poking their head or hand outside. If they do so, an alarm will ring to notify the responsible ones in the bus. All these devices are connected with a microcontroller which uses esp8266 WIFI module to send the data in the database. The overall architecture has been shown in figure 6.

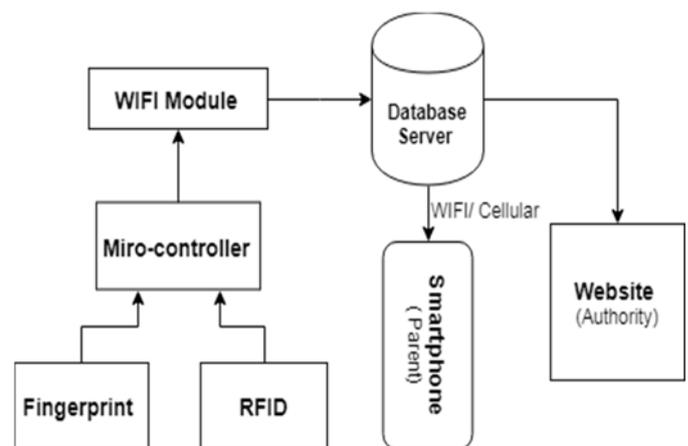


Fig. 6. Proposed System Architecture

Regarding dealing with underage fingerprints, there are some issues needing consideration. The distance between ridges of finger of a child is smaller than adults, this limited dimension can create resolution problems with the devices, which may cause problems while used in the algorithms on ridge distances, thereby decreasing the ability of the algorithms to deal with the “non-similarities” introduced by distortion effects and ill positioning of the finger. Furthermore, there are child behavioural issues that may hinder in capturing the fingerprint images properly during authentication [8].

To fix the problem fingerprinting children, images required to be stored in higher DPI. BIODEV II study shows that a resolution of 500 DPI can provide good identification using ridge distances [8]. There is also a 600 DPI *Capacitive Fingerprint Sensor* chip which provides a full synthesized image with no observable error by using a synthesis algorithm. [9]

In the *User Domain*, guardians need to log in first by a specific pin number provided by school authority for the android application.

Figure 7(a) shows the different features of the application. Where there is Google Map to navigate the bus of their children, Status to get the real time updates of student’s entrance and exit in the bus. There are two information options which provide the detail of bus driver and school authority to contact in emergency.

Figure 7(b) shows how parents can track the bus in the map to pinpoint the current location of the bus. All the destinations for students are also mapped clearly in the android application. The real-time update of their kids’ status as shown in figure 7(c). This notification will show the entrance and exit with exact detail containing time and date.

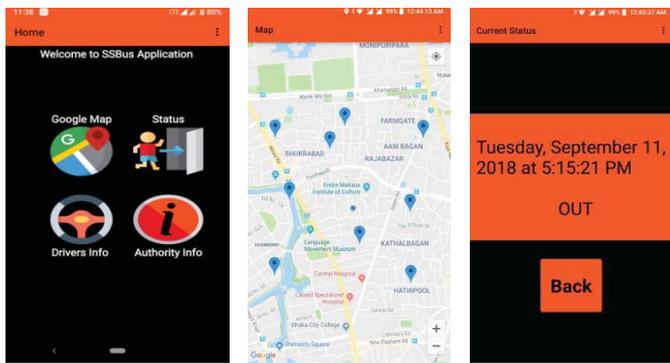


Fig. 7(a). App features Fig. 7(b). Mapping Fig. 7(c). Notification

VI. LIMITATIONS AND FUTURE WORK

Firstly, this proposed system requires students’ fingerprint images which is a sensitive issue and should be properly secured. Thus security is a prime concern. There are number of encryption techniques available for such purpose [11]. Again there are certain skin diseases that destroy the dermis and epidermis layer of the skin. As a result, it becomes

difficult to correctly identify different individuals on a regular basis [8]. Besides, the student have to carry the ID card in order to scan with the RFID scanner. If somehow the ID card is lost or forgotten, then there is no way to enter the bus and follow the system simultaneously. These are some of the limitations of the proposed system.

In this work, effort has gone into making the system reliable for the parents. Such reliability issue will be further intensified in the future. Another plan is to install for IP cameras which will produce live images from inside the bus, it will also add speed alert, road change alert, route change notification, smoke sensor, addition of stoppage ID in the entry and exit notification etc. An efficient encryption method will be developed to strengthen security. The main goal is to make the system more user friendly and helpful.

VII. CONCLUSION

In this study, a secure school bus system has been proposed and implemented for Dhaka city. This system will ensure safety; ease tension and anxiety of parents, and will without doubt, improve road conditions. It will also provide an easy pick13up system by providing notifications. Guardians will get notifications through an Android application; this app can be used to see the current status of the bus in a map, thus it will be easy for the parents to track the movement of the bus and get notified at the appropriate times. Hence, they will have a highly reliable, secure and intelligent system to depend upon.

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