

## **IoT Based Smart School Bus Security System**

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### **Abstract:**

Students travelling by school buses are likely to be in danger. Children, especially from primary schools, are susceptible to getting lost or getting into other school buses and it's extremely frightening for the parents. This smart school bus tracking and security system ensures the security of students traveling in the bus. This is made possible by RFID (radio frequency identification) a technology which will identify people or objects using radio waves and a smart camera. This system consists of two main parts which include: the hardware and the software. The hardware consists of the RFID reader, arduino and smart camera. The RFID reader is connected to the host computer via a serial to USB converter cable. The Smart School Bus Security System provides the functionalities of the overall system such as displaying live ID tags transactions, registering ID, recording entries and other minor functions. When the child enters/exits the bus the parent will get notified by sms/mail of their child's whereabouts. For extra security, there is a face recognition system employing an ESP-32 camera module which with the help of powerful image processing tools given by python and CV (computer vision) can help to acknowledge whether the student embarking and disembarking to their respective stops alongside the RFID card in order that there's no evil or proxy and to stop unauthorized people from entering the bus.

### **1 Introduction**

This Smart School Bus Security System ensures the safety of students traveling in the bus. It is made possible by Radio Frequency Identification (RFID) and a smart camera that is used for face detection of the registered students.

A major problem faced in education institutions is the time consuming manual management of school buses which often create problems due to human error. Sometimes children miss their school bus or go into the wrong bus and get lost. To handle this manually, whenever a student boards a bus someone has to record the entry and manually inform the parents if the student misses the bus. This manual process has some flaws because in a case if a student boards or disembark wrongstop there is no way to know and prevent without constant monitoring. This would be a big problem because it is exposed to human mishandling.

### **Related Work**

According to National School Safety and Security Services various attempts have been made like screening of employees, and employing the effective use of technology, such as two-way

communications capabilities and surveillance cameras, on schoolbuses[1].

School authorities in the Japanese city of Osaka are now chipping children's clothing, backpacks, and student IDs in a primary school. Similarly, Whitcliffe Mount School in Cleckheaton, England uses RFID to track pupils and staff in and out of the building via a specially designed card. In the Philippines, some schools already use RFID in IDs for borrowing books and also gates in those particular schools have RFID ID scanners for buying items at a school shop and canteen, library and also to sign in and sign out for student and teacher's attendance.[2]

This paper, it recommends an SMS based solution which assists parents to track their children's location in real time using a GPS module and RFID. [3]

According to this paper, GSM and RFID based systems can also be used to secure and overcome the major problem of human based error. Various similar attempts have been made to track and notify the parents about their children's presence using RFID. [4]

The suitable solution for this problem is not only to detect the presence or absence but also to make sure to notify parents if a student has boarded or disembarked at the wrong stop or bus. That can be achieved using RFID technology, IoT based Smart Camera and Real Time notification without any human intervention.

Following are the objective of this paper:

- Inculcating smart technologies in school buses to ensure the safety and security of school students traveling by buses.
- Ensuring that the right students get in and off at the right place.
- Taking attendance without human intervention.

## **2 Theory**

RFID technology works mainly with the help of a reader, known as RFID Reader, and RFID cards. The RFID cards have a unique identification number and that is one of the main benefits of the system as this makes the system very reliable. The card saves the personal details of the user saved across its identification number. Since the card saves all the personal details of the user, there has to be a very high security system to secure the information[5].

RFID technology was first introduced in late 1960's but was not very functional back then [6]. With the advancement of technology in the last decade, this technology is becoming more widespread. It serves mainly two purposes. Firstly, to record movement along with time of entry and time of leave and secondly its work is for authentication and authorization purposes. At present, this system is taking over schools, hospitals, industries etc. The RFID tag is actually a transponder which transmits information through radio frequency[7]. No other human is required other than the student itself which achieves the purpose for less human intervention and human error.



*Fig 1: RC522 13.56MHZ RFID reader*

Smart cameras are cameras that can perform tasks far beyond simply taking photos and recording videos.

Thanks to the purposely built-in intelligent image processing and pattern recognition algorithms, smart cameras can detect motion, measure objects, read vehicle number plates, and even recognize human behaviors[8]. A Facial recognition system is a technology capable of matching a human face from a digital image or a video frame against a database of faces, typically employed to authenticate users through ID verification works by pinpointing and measuring facial features from a given image[9]. As technology advances exponentially the demand for this is also increasing. It also doesn't require any human intervention.

The ESP32-CAM is a tiny module based on ESP32 chip and OV2640. You can even program the ESP32-CAM through the ESP-IDF by installing the ESP32 Core. It equips the ESP32 with everything necessary to program,run and develop on the wonderchip. It also features a LiPo charger (IP5306), so your ESP32-CAM can be battery-powered and truly wireless. Fully compliant with WiFi 802.11b/g/n/e/i and bluetooth 4.2 standards, it can be used as a master mode to build an independent network controller, or as a slave to other host MCUs to add networking capabilities to existing devices.

ESP32-CAM can be widely used in various IoT applications. It is suitable for home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals and other IoT applications. It is an ideal solutionfor IoT applications[10].



*Fig 2:ESP32-CAM with ESP32 chip*

Time and management with less human intervention area major part of today's human resource

systems, take organization towards better human resource practice, systems and excellence. The implementation of the Smart School Security System system has a lot of advantages for the manager with less human error. The kind of system that is implemented depends upon what the organization is trying to achieve by implementing the system.

### 3 Gaps Identified

Attendance system for the students in the bus is either manual or RFID based. If the student lost their card or gave it to another student, then it will be difficult to track that student. A system needs to be developed which not only identifies the card, but the student itself.

Children of the age group 3-8 years sometimes board the wrong bus. A system is required which automatically detects that the student is boarded in the correct bus and alerts the supporting staff in case of boarding in the wrong bus.

In most of the cities, schools are located at remote places or far away from the residential area. Then it becomes difficult for any parent to pick and drop a child every day. Parents have to opt for school buses, but a feeling of fear is always in their mind. Children, especially from primary schools, are susceptible to getting lost or getting into another school bus and it's extremely frightening for the parents.

To design a tool which can be helpful for the school going children's parents to not worry about their ward whether reached home or school successfully also to take care of proper track of attendance within the bus to assure safety of children

### 4 Block Diagram and Description

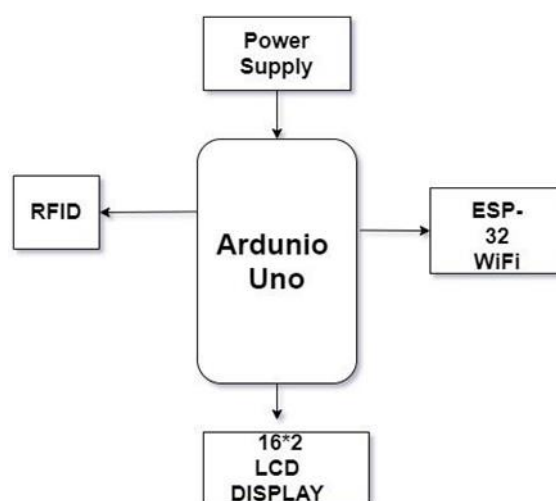


Fig.3 Block Diagram of System

#### Description:

When the child gets on the bus, he should have an RFID card that has already been pre-registered. At the bus stop. At the same time as the RFID card is issued, the child's face will be recognized.

Both the RFID card reader and the ESP32-CAM will be powered by Arduino, the primary CPU.

Whenever any child enters the bus through the door it will identify the RFID card of that child. If the child's RFID is identified successfully, the ESP32 camera will turn on and begin to recognize the child's face. If both elements are successfully confirmed, the data for the child will be marked as present on the bus.

If the youngster does not have an RFID card, the driver will be notified that the child who entered did not have a registered RFID card or was an unknown invader. It will also alert the school administration that an unfamiliar person is attempting to board the bus.

### 5 Technical Insights

The child's verification is the first phase, as shown in the flow chart (Fig. 4). If the RFID card is validated, the child will be able to have their face recognised; however, if the child does not have an RFID card, they will not be permitted to board the bus.

If the face matches the pre-registered face together with the RFID encoded with it, the attendance of that child / student will be successfully recorded, and an SMS will be delivered to the registered mobile phone with a time stamp. If another person's face is captured, the driver will be notified that an unregistered face has been detected, and they will not be permitted to board the bus, nor will their attendant receive a record.

Radio-frequency identification (RFID) (Fig. 5) uses electromagnetic fields to automatically identify and track tags attached to objects. This system consists of a tiny radio transponder; a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track the records.

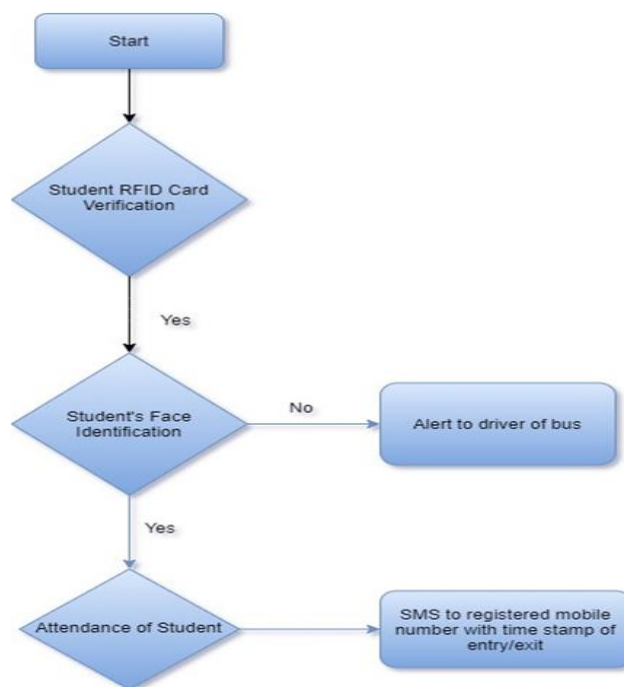
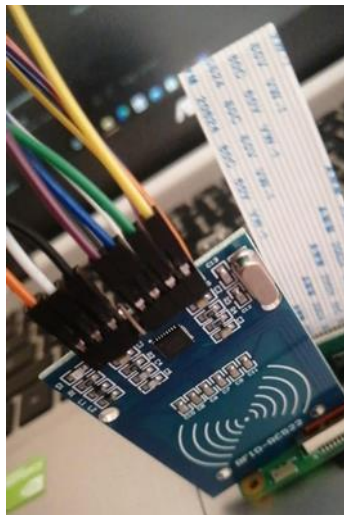


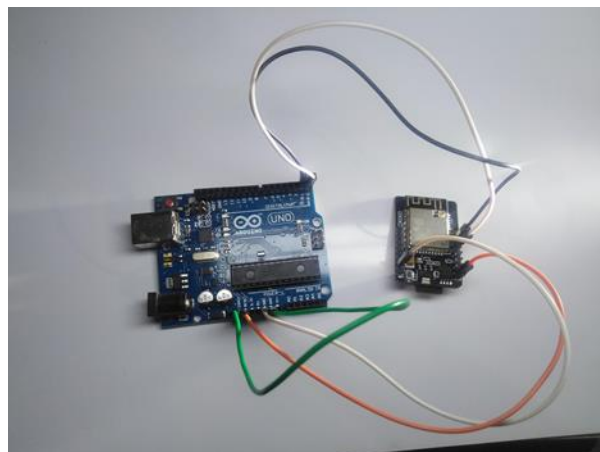
Fig 4: Flowchart of the system

Children will be having this card with them for safely commute and proper tracking of attendance with precise timing, RFID cards will have an unique ID and it will be with each children every child entering the bus will have tap the card on RFID reader and it will record the timings each time the card is taped.



*Fig 5: RC522 Reader*

Arduino is the main processor we used which helps to give power source to both RFID and ESP32 cam Module. It plays a vital role as it is also the main power bridge for ESP32 cameras. Pins TX and RX of Arduino are connected to UDT and UDR pins of ESP32-CAM (Fig. 5) with 3.3 volt pinout connected to 3.3 volt of ESP32-CAM, connecting to ground, making the circuit complete.



*Fig 6: ESP32 setup*

The ESP32-CAM (Fig. 6) is a small size, low power consumption camera module ESP 32 cam works on wifi and Bluetooth which makes it easier to transmit information remotely. In our project after supplying adequate to ESP 32 Cam, Camera gets connected to wifi and creates its own IP address. This IP address is further used for streaming with different quality options[11].

## Software:

The software used was PyCharm 2021.1 [12] and packages for face recognition were OpenCV. We also used packages 'cmake', 'dlib', 'numpy', etc. Microsoft Excel is used to run the .csv files for recording the attendance. We have made the algorithm with python language because OpenCV (python library) uses machine learning algorithms to search for faces within a picture. Because faces are complicated[13].

Integrating OpenCV code with the IP address which we get from ESP 32-CAM, a window box is opened where we can see the live streaming of the ESP32 camera.

Images are already being feeded from the admin end or we can be registered from admin end only. These images then recognize the face which is in front of the camera with the images already registered in the algorithm. Once the face is recognized, data of that student is stored in a.csv file with date and time.

## Features:

- Onboard ESP32-S module, supports WiFi so it is accessible from remote locations using the Internet.
- Onboard TF card slot, supports up to 4G TF card for data storage
- Supports WiFi video monitoring and WiFi image upload
- Control interface is accessible via pin header, easy to be integrated and embedded into user products

## 6 RESULTS AND DISCUSSION

In this section we will discuss the output of the system. We can see the result in different ways. We can see the RFID entries from the 16\*2 display and real time SMS notification after identifying and recognizing if the student board or disembark to the right stop.

### A. Result from RFID display

When the cards are brought closer one by one to the RFID reader, the program starts saving the recorded data in list form along with date and time of the entries. This recorded data will be saved in .csv format and the accessed student name will be shown in the display along with alert.



Fig 7 : Result Obtained From RFID with Time stamp



In (Fig. 7), we can see that the student name, time, date and notified alert are all mentioned sequentially with all the entries. Users can see their entries and time at which notification is sent.

### B. Result from ESP32 Camera

When the student boards the bus, the camera captures the face and matches it with the database. If it matches successfully no alert will be sent, if it fails to match or students don't belong in that bus an alert is sent along with the details of the bus boarded to the concerned person.



Fig 8:Result Obtained and Camera Setup

In (Fig. 8), we can see the camera setup along with real time face identification with student name and time at which student board or disembark from the bus.

### C. Result of Real Time Alert

After all the successful criteria an automated Sms based alert will be sent using an sms server to their concerned parents. (Fig. 9) represents the alert sent in real time.

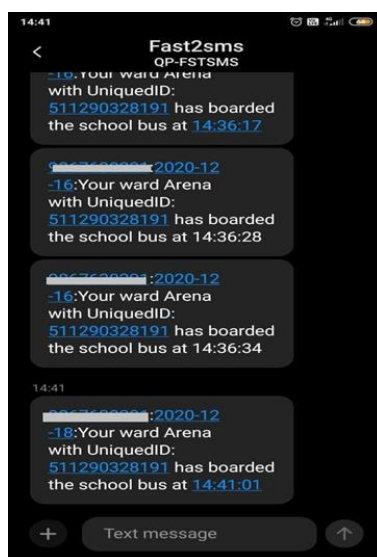


Fig 9: Real Time Notification with Time Stamp



## 7 Conclusion

We are successfully able to detect and identify the students boarding and deboarding with the respective stops or buse. We are able to double check the identity of the student boarding the bus with the help of RFID and face recognition, sending live updates about the student's whereabouts to the registered parent, ensuring that only the registered students board the bus, checking whether the right student is getting off at the right stop, taking record without any human intervention, avoiding malpractices or proxy during the attendance, keeping the school students safe.

### Benefits to the Society

Working individuals can send their children by a school bus without worrying as they will be receiving live updates about their child's whereabouts. Any situation where a student is accidentally left behind by the bus or the student goes into the wrong bus can be avoided. RFID containing student's details will help in identifying which bus the student belongs to.

### Future Scope

With the increase in the number of individuals that are working nowadays, in the future picking up and dropping children to school will be very difficult. This smart school bus technology will be the safest way for children to go to school. We can make a mobile application with the live location of the school bus on a map and live notifications of the entry/exit status of the student. With two setups at the entry and exit we can also count the number of students in the bus. With increasing processing power and reach of the internet it can be shifted to cloud .

### Limitations

- There is a chance of hardware failure as it requires huge computation power and might consume more power.
- If there is downtime in software/service there can be delay in real time messages.
- It is easy to hack so data has to be stored outside the system.

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