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IoT based School Bus Monitoring System

Srinivas S[1], Shreyas VB[2], Sriram[3], Vishnuraata PY[4], Dr. PN Sudha[5]
[1, 2, 3, 4]ECE, KSIT, Bangalore, India
[5]HOD, ECE, KSIT, Bangalore, India

Abstract: An IoT-based school bus monitoring system is a technology solution that utilizes the Internet of Things (IoT) to monitor and track school buses in real-time. These systems use Internet of Things (IoT) devices and sensors to track the location, speed, and safety of school buses in real-time, allowing schools and parents to monitor their children's travel to and from school. In this literature survey, we will explore the past studies on IoT-based school bus monitoring systems, including their benefits, challenges, and areas for future research. Through a review of the existing literature, we aim to provide a comprehensive overview of the state of the art in this field and identify opportunities for further study.
Keywords: Fingerprint, GSM, GPS, Monitoring

I. INTRODUCTION

An IoT-based school bus monitoring system is a technology solution that utilizes the Internet of Things (IoT) to monitor and track school buses in real-time. The system can be used to improve safety, reduce operating costs, and enhance the efficiency of school bus transportation. It typically consists of sensors, GPS tracking devices, and communication infrastructure that are installed on the school buses and connected to a centralized management platform.

The system enables real-time tracking of the location, speed, and route of school buses, as well as the identification of any potential safety issues such as sudden stops, collisions, or breakdowns. It also allows parents and school administrators to monitor the location and status of the school bus in real-time, and to receive notifications in case of any delays or emergencies. The use of an IoT-based school bus monitoring system can provide numerous benefits, including improved safety and security for students, reduced fuel consumption and maintenance costs, and enhanced communication and coordination between parents, school administrators, and bus drivers. It can also help to improve the overall efficiency and effectiveness of school bus transportation, by enabling more accurate scheduling and routing, and by providing valuable data for decision-making and continuous improvement.

II. LITERATURE SURVEY

RFID tag is used as a first stage of verification. Only after successful RFID identification the students are made to undergo the 2nd stage of verification using camera. Here, the camera captures the student's image n verifies it with the image the is previously stored and also checks if the student is wearing the mask or not. This system also monitors the temperature of the student using IR sensor. Only If the temperature is found to be lesser than the threshold, the student is allowed. If the student doesn't meet all the criteria, then he/she is not permitted to board the bus and the status are sent to school website as well as the parents [2]. For monitoring the transport of children to and from school using IoT technology, the system uses RFID and GSM technologies to track the entry and exit of students on the bus and sends SMS notifications to parents when the student's travel is successful. The system also aims to detect students who may board the wrong bus or be absent, and to monitor the sobriety of the driver. The system is intended to provide greater safety and security for children during their daily travels to and from school, and to allow the driver to communicate with the management in the event of any delays or issues. The system for monitoring and tracking a school bus using various IoT components, including an Arduino uno controller, an alcohol sensor, a GPS module, a GSM module, and an RFID module. The system is designed to prevent the bus from starting if the alcohol sensor detects the presence of alcohol in the driver's system, and to send a warning message to the authorities if this occurs. The system also uses the GSM module to send messages to parents when the bus is approaching their station, and to track the bus's location using GPS. The RFID module is used to verify the identity of students entering the bus, and to open the door if the student's RFID code matches the system's records. The system also includes an LCD display to show relevant information and messages [1]. The school bus consists of the RFID module fitted in it. The RFID reader read the tags and sends the tag number to the android phone of the driver in the bus via a Bluetooth device. The driver side application receives the tag number and sends it to the database where the details required to send the message are selected and returned. The SMS is sent from the driver’s phone to all parents and also the location details are sent to the system parallelly.

The parent side application is needed to check the current location of the bus and to register for SMS service [12]. With the usage of a GPS Module, the current location of the bus is tracked, a GPRS module to update the information to the parents and the school authorities and a alcohol sensor to sense if the driver has consumed alcohol or not. They have used Google API and object-oriented programming language like JSON for using Google maps and SQL for managing the databases. All these information's will be shared using Blink App so that it can be customized according to the needs of the user [3]. The framework is an Internet of Things (IoT)-based school bus monitoring system that tracks the whereabouts and motions of school buses and notifies parents of their children's whereabouts using RFID tags, GPS, and GSM/GPRS technologies. The solution incorporates an in-vehicle gadget that uses an RFID tag to identify each student and a GPS module to follow the bus. If the school bus's predetermined route schedule changes, a GSM module is utilized to warn parents via short messages. Parents can track the school bus's whereabouts and see its route on Google Maps using a smart phone application that transmits the data gathered by the GPS device to a cloud server. Additionally, the smart phone app also establishes the school bus's arrival times at each bus stop, giving parents up-to-date knowledge about the bus' anticipated arrival time. Because it is based on widely accessible electronic gadgets, the system is inexpensive [8]. Consisting of three basic units the College unit, parent unit and the bus unit, this system makes use of the GPS location to track the live location of the bus and send the real time updates to the college and school unit. A GSM module is used to send the SMS. It also alerts the Parents in case of any fire accident with the use of Fire Sensor. It also has an IR Sensor placed at the front door to increase the count of students and an IR sensor at the back door to decrease the count of the students. The Parent unit uses a Application and sign to it using the registered mobile number and obtain the updates. The school units include server's and databases to store the data [5]. Provides the current location of the bus using GPS module and GPRS module, this system also provides the bus number that will run between the source and destination location the route details and the coordinates of the current location. All this data will be sent to the user as well as the admin database for storing the data using My SQL. A separate website is developed to access all this data [10]. Including various modules, such as an OBD-II module for collecting real-time data from the bus, an RFID module for tracking student attendance, and sensors for measuring temperature and humidity, these modules send data to an Arduino microcontroller, which then transmits the data to a cloud-based MQTT broker. An application server implemented using Node.js collects the data from the broker and saves it to a database for further processing. The saved data can also be analyzed using an analytical engine like R to generate reports for different stakeholders, such as parents, regulators, and school administrators. The system allows for real-time tracking of the location, speed, and route of the school bus, as well as the identification of any potential safety issues. It also allows parents to track their child's attendance on the school bus and ensures that no child spends an excessive amount of time on the bus [11]. Numerous research and implementations of GPS and GSM-based car tracking systems have been made, although the GPS system's accuracy is sometimes called into question because of Selective Availability. Cellular phone placement based on signal attenuation, angle of arrival, time of arrival, time difference of arrival, and time advanced is possible, however GPS and GSM positioning are sufficiently developed for civil usage. Students waiting alone for the bus, rushing to board and possibly injuring themselves, making noise that might annoy the driver, eating and drinking inside the bus, which can contaminate the floor and lead to accidents, and being unaware of the risks of standing too long are some issues with using school buses [6]. Employing a dual authentication mechanism to ensure that the students board and deboard the bus with proper identification as parents are always concerned whether their kids are in the bus and have reached safely. When single RFID is used, there are possibilities of misusing the system as checking the tags only will be insufficient. 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 a possibility of misusing. Students may go elsewhere after providing fingerprint verification. RFID is used here to keep track of students whether they have entered or not by reading tags automatically. Only Fingerprint will not be user friendly as the children have to match their fingers twice but using RFID makes the students' boarding and de-boarding process easier as their tags will be scanned by default [7]. Arduino MEGA microcontroller, which is responsible for fetching the latitude and longitude location from a GPS module and sending it to a server using a Wi-Fi chip. The system also includes an alcohol sensor that detects if the bus driver has consumed alcohol above the permitted limit and sends a notification to the bus owner if this occurs. A panic switch is also included, which allows students or other individuals on the bus to send a notification to their parents if they are in danger. The system uses a GSM module to send SMS notifications, and is powered by multiple sources, including an adapter, a battery, and a USB port [4]. The suggested method is a bus tracking system that monitors student attendance and scans QR codes to track them on school buses. On their ID card, each student is given a special QR code that is scanned when they board the bus in the morning and when they get off in the afternoon to go home. After that, a database is used to store this data. The technology also sends push-pop messages to parents and children informing them of the bus's location and anticipated time of arrival. The system has a function that shows the bus driver the quickest route to the student's pick-up location on a map [9]

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III. METHODOLOGY

A. Proposed Method

The method is based on School Bus Monitoring System. The block diagram for the complete process is given in Figure 1.

Here the boarding and de boarding of passengers on a bus can be tracked and verified with the help of an IoT-based school bus monitoring system. However, given that such a system entails the gathering and storing of personal data, it is crucial to take into account the privacy concerns. It is crucial to put in place the proper security measures, establish clear policies on data retention and access, be open and honest about the data that is being collected, and think about the system's ethical implications in order to guarantee that the system respects the privacy of the passengers and complies with pertinent laws and regulations.

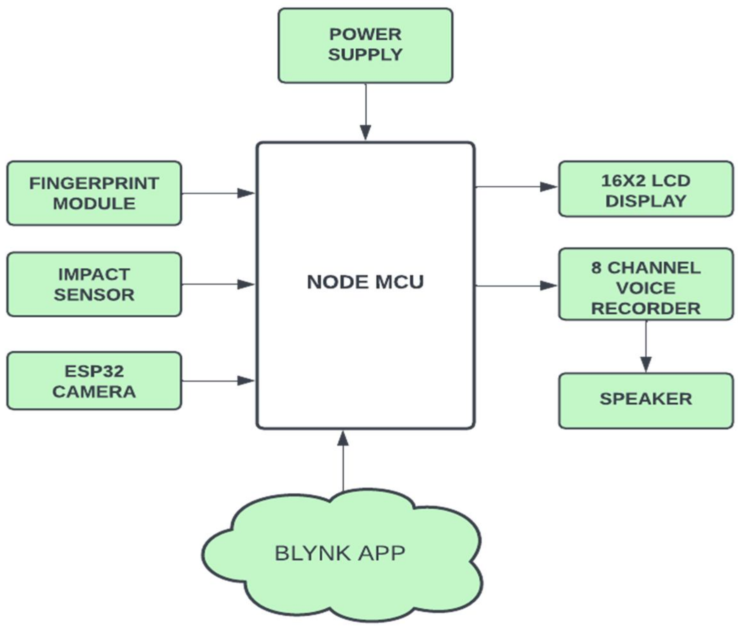

Figure 1: Block diagram

B. Algorithm

1) Module is ready.
2) Biometric module accepts the input of the passenger.
3) If fingerprint is verified successfully, go to the next step, else go to step 2.
4) Boarding time of the passenger is recorded and SMS alert is sent.
5) If the impact sensor is triggered due to an impact OR a request is sent, camera module is activated.
6) Image is sent through telegram.
7) Repeat the steps for each passenger for de boarding.

The components used are:

a) *Node MCU* - The NodeMCU (Node Microcontroller Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for Internet of Things (IoT) projects of all kinds.
b) *16X2 LCD Display* - A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix display is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data.
c) *Fingerprint Module* - R307 fingerprint module is a finger print sensor with TTL UART interface. The user can store the fingerprint data in the module and can configure it in 1:1 or 1: N mode for identifying the person. The FP module can directly interface with 3.3 or 5v Microcontroller. A level converter (like MAX232) is required for interfacing with PC serial port.

d) *ESP32 Cam Module* - ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated WiFi and Bluetooth.
e) *GPS Module* - At the heart of the module is a GPS chip from U-blox – NEO-6M. The chip measures less than a postage stamp but packs a surprising amount of features into its tiny frame.It can track up to 22 satellites over 50 channels and achieve the industry's highest level of tracking sensitivity i.e. -161 dB, while consuming only 45 mA current.
f) *IMPACT SENSOR* - Impact sensors are used to detect and record shock or impact to a product or package.
g) *8 - Channel VOICE Recorder with Speaker* - Interface the speaker pins and power on the module, then slide the switch towards the recording position, Press and hold the M1 button and speak near the microphone and then release the button M1 accordingly,To playback the recorded message, slide the switch towards playback and then just click the M1 button, then the corresponding recorded message will be played. Repeat the same procedure to record the different messages on the different channels from M1 to M8.
h) *I2C (Inter Integrated Circuit)* - Data transfers occur over a physical two wire interface which consists of a unidirectional serial clock (SCL) and bidirectional data (SDA) line. These transfers can occur over speeds of 100kbits/s in Standard Mode, 400kbits/s in the Fast Mode, 1Mbits/s in Fast Mode Plus, and up to 3.4Mbits/s in High Speed Mode.

C. Flowchart

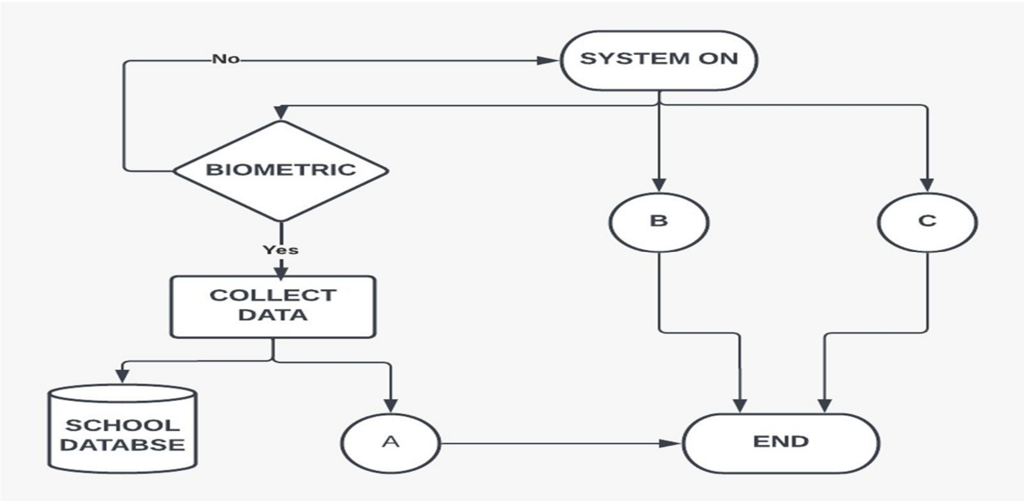

Figure 2: Main Flowchart

1) The module is powered on. It connects to the network. The module is ready and on standby mode. The fingerprints of the wards are enrolled beforehand.
2) The fingerprint module takes input from the boarding passengers and compares the same with the dataset. If there is no match, the LCD sends a message to the passenger to rescan the fingerprint. Upon finding a successful match, the LCD displays a confirmation message to the passenger.
3) The login time is recorded in the database that can be used to track the attendance by the institution. An SMS alert with login time is sent to the registered mobile number associated with the student ID.
4) Blynk app can be used to request the location of the vehicle at any desired time. The location is fetched in the Blynk application's UI.
5) An image of the passengers can be requested at any time during the journey which will be sent through a telegram bot.
6) In case of an impact, the impact sensor will be activated that triggers the ESP32 camera module to take a picture and send it to relevant authorities.
7) When the journey is completed, the process is repeated to record the de boarding of the passengers. The de boarding time is recorded in the database and the alert is sent to the guardians.

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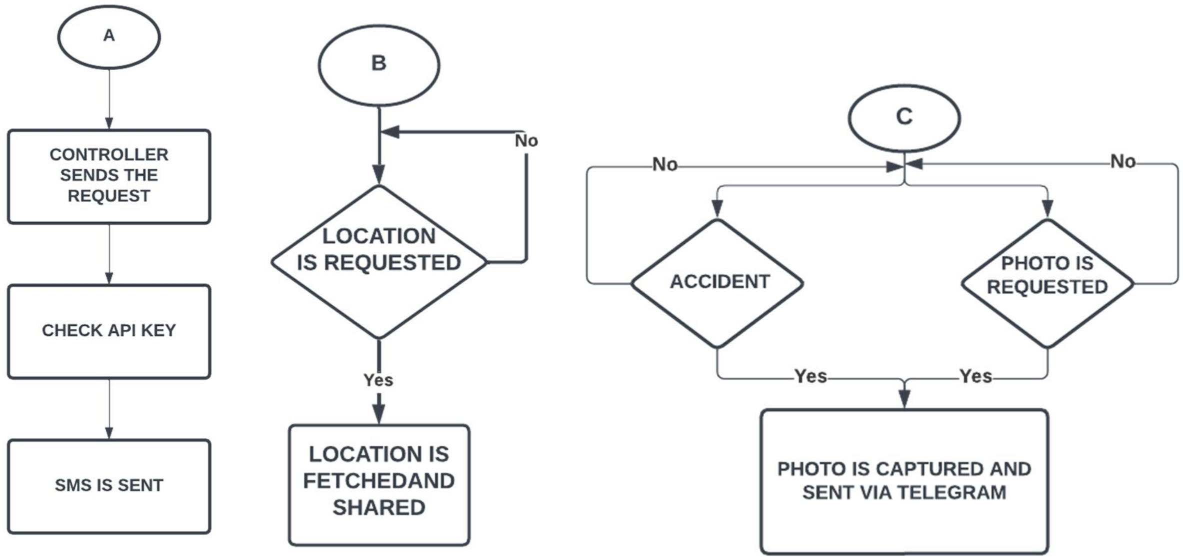


Figure 3: Sub-blocks of the flowchart

a) Sub-block A

Each student has a unique student ID which has the student's name and the mobile number associated with it. Whenever there is a match for the fingerprint, the controller sends the login/log-out details, student ID and the registered phone number to the API using the unique API key. The sent request is processes by the API. The relevant student ID/name and the login/log-out times are updated in the draft message and sent to the given mobile number.

b) Sub-block B

This block represents the operation of the Blynk IoT application. The location can be requested at any time. Whenever a request is sent, the module fetches the location of the module and sends it to the user through the Blynk IoT app.

c) Sub-block C

The ESP32 Camera module is configured with the Impact sensor. Whenever there is an impact, the sensor is triggered which activates the camera module. An image is captured and it is sent through telegram. A request for an image can also be sent manually by the user through a Telegram bot. The image is captured and delivered through the Telegram application.

IV. RESULTS

As expected, the module registers the login/log-out data of the passengers in the database. The location and photos can be fetched whenever the user desires.

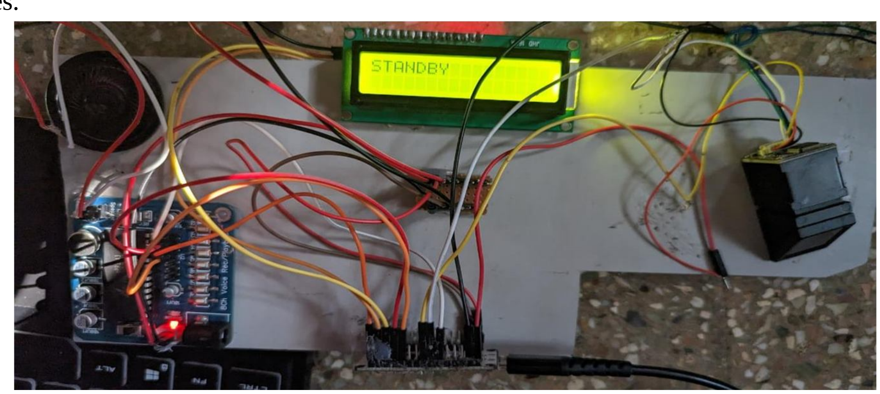


Figure 4: Setup

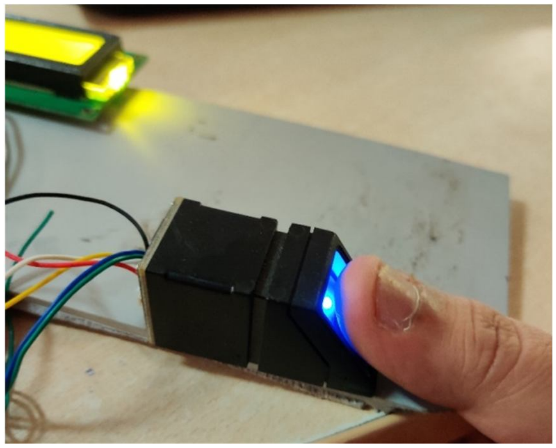


Figure 4: Passenger scans the finger

Figure 4: Fingerprint successfully verified

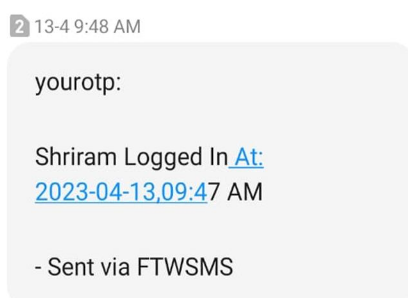


Figure 4: SMS Alert

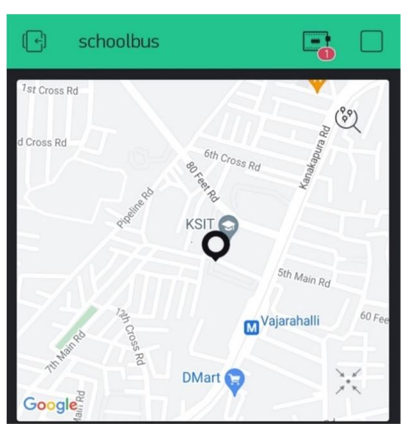
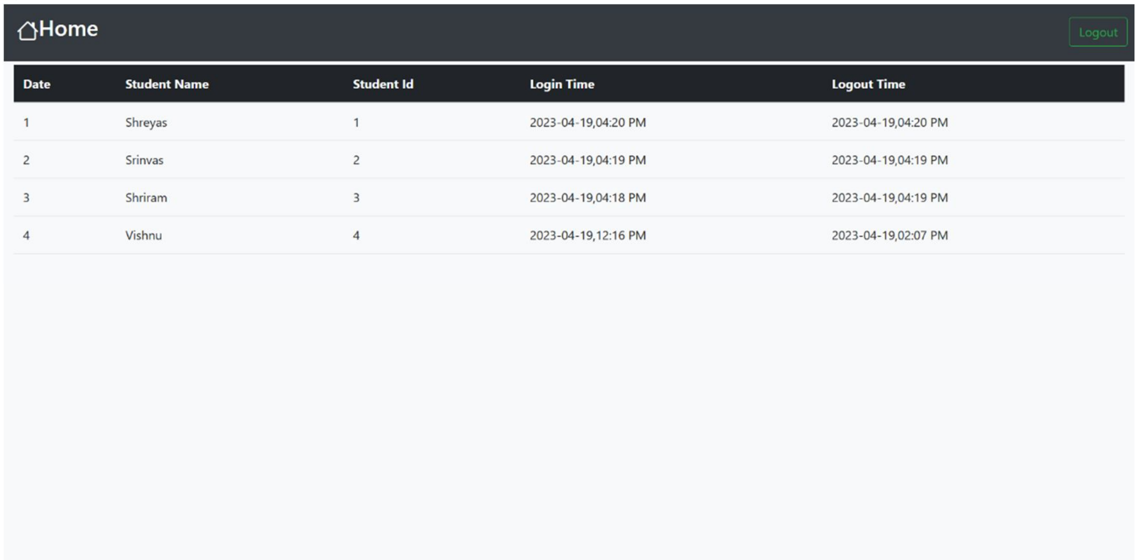


Figure 5: Location fetched using Blynk IoT



Date	Student Name	Student Id	Login Time	Logout Time
1	Shreyas	1	2023-04-19,04:20 PM	2023-04-19,04:20 PM
2	Srinvas	2	2023-04-19,04:19 PM	2023-04-19,04:19 PM
3	Shriram	3	2023-04-19,04:18 PM	2023-04-19,04:19 PM
4	Vishnu	4	2023-04-19,12:16 PM	2023-04-19,02:07 PM

Figure 5: Student database

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