

# IoT-based Real-time School Bus Monitoring System with SMS and Telegram Alerts for Improved Safety and Parental Awareness

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**Abstract**— Internet of Things-based school bus monitoring system is put in place to follow a bus's travel from any location at a given moment. The current generation needs more and more knowledge, and technology is advancing daily. In order to meet the need for information transmission while using current technology, we have devised a novel design for an Internet of Things (IoT) based smart bus monitoring system that would send SMS and photo alerts to the Telegram app. These days, bus monitoring systems are crucial, particularly for students who arrive late at the bus stop. Since students are unaware of the bus's precise location and time, we want to use the Internet of Things to deploy a smart bus monitoring system for convenient transportation. This novel technology, commonly referred to as Bus. This paper proposes an IoT-based Real-time School Bus Monitoring System designed to enhance safety and parental awareness. The system utilizes IoT sensors installed in school buses to track their real-time location, and various environmental parameters such as GPS location. Data collected from these sensors are transmitted wirelessly to a centralized server for processing and analysis. In case of any deviation from predefined safety parameters or route deviations, the system generates instant alerts via Short Message Service (SMS). Parents and school authorities can thus monitor the school bus's status in real-time, ensuring the safety of students during transit. The system aims to mitigate risks associated with school bus transportation, enhance parental peace of mind, and facilitate prompt intervention in case of emergencies.

**Keywords**— Internet of Things (IoT), School Bus Monitoring System, Real-time Tracking, Safety, Parental Awareness, SMS Alerts, Telegram Photo Alerts

## I. INTRODUCTION

In present time due to increase in number of road accident cases, parents always worry about their children's security. This project recommends solution which assists parents to track their children location in real time. To track the location using RFID card and to identify the identity of the children. Whenever a student enters in a bus, the RFID reader read the RFID card and update to the parents. If identification is done in the bus, and the system will identify the student and update log on a server will send notification and current location and time to the parents. Parents can see the location of bus, they will be notified when the children is getting into a bus or getting out from a bus. A smart school bus monitoring system is implemented for tracking the movement of a bus from any location for a specific time. A device is placed inside the bus that is not visible to anyone which determines the position of the bus using Global Positioning System (GPS) technology. Parents will be able to continuously monitor the moving bus on demand using the web application. This scheme uses a panic switch for the safety of the children. In case of any emergency in the bus, the status of the bus sends to the school organization as well as parents. In this project we are using ESP32CAM for sending photo alert to administrator. When the person is showing RF-ID card to reader. Then ESP32CAM will take photo and send to alert on telegram app.

## II. LITERATURE REVIEW

Many researches are carried out related to the bus tracking system in this study [1] 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. Parents will get notify through an Android application.

In this paper [2] A Real-time school bus tracking and monitoring system has been successfully developed. It has been designed to meet the needs of parents and school administrators to track school bus location and the safety of children from the moment they get into the bus until leaving the bus. The system has offered a web and SMS services, where data and information are shared with parents and school administrators in real-time. This proposed system [3] aims at increase the safety of Student during the daily transportation to and from college. RFID Reader read the RFID card that is inside the bus detects the RFID tags of the Student. It sends data and instant notify with the relevant data from the college database server with the help of internet.

This paper [8] has described the design and implementation of the school bus tracking system. A panic switch is placed inside the vehicle for the safety of the students. A smartphone application can be downloaded by the parents who will continuously show the location of the bus. The system to experimentally demonstrate its effective performance to track the school bus thereby ensuring the parents of their child's safety.

Swapnali Mohanrao Kumbhar and Sunita Sunil Shinde [4] In this paper, authors have presented a mechanism of Smartphone Enabled Advanced Vehicle Tracking System providing exact location of the vehicle by giving a one missed call. This system can help to identify the location of the vehicle at any time 24X7. System gives approximate 95% accuracy.

Khaled Mahfouz and other [5] the proposed system aims at enhancing school community safety by reducing and eliminating instances of leaving students behind in school buses by monitoring their attendance in buses. The generated route ensures that bus drivers are to reach an attended student's home location which in case of extreme errors or manipulation could indicate an instance of a student missing to which authorities can immediately react upon to ensure student's safety. The proposed approach implies the use of an android app that makes attendance related processes easy to deal with. The proposed system was implemented successfully and was further able to register attendances of students whether through fingerprint recognition or face recognition techniques and generate routes based on the attended students.

S. Malathy et.al [6] n this paper, the design and development of Sensible bus tracking system is represented. The necessities which are essential for a general sensible bus trailing system is expressed. It provides the details of accurate placement of the mobile school service vehicle to common people, students, faculty and school service corporations. The planned system makes use of both internet and mobile platforms with the help of current technologies for the application package development. The mobile application makes access easier for kids/students and their faculty, added to that, parents can simply track their kid's buses.

Hafiizh Nur M. A et.al [7] Based on the design and prototype of the system, it can be concluded that the monitoring system on the Bus Rapid Transit can work in accordance with the design. The main controller unit and the Firebase database are integrated into a monitoring application.

The information system can display the bus code, destination route, estimated bus arrival, available capacity, and the position of the bus that is moving in real-time.

III. THE SYSTEM DESCRIPTION

In this embedded system of smart school bus monitoring system we use Arduino Mega2560 that connect all the component and Arduino Mega2560 is a microcontroller of all the system. We use power supply, LCD display, RFID module, one switch button for send message to the children for bus arriving time and another switch button use for a bus damage/trouble to press the switch 2 the message send to the parents as well as admin to the school. GPS module used for the location tracking of the bus GSM used for a SMS alert.

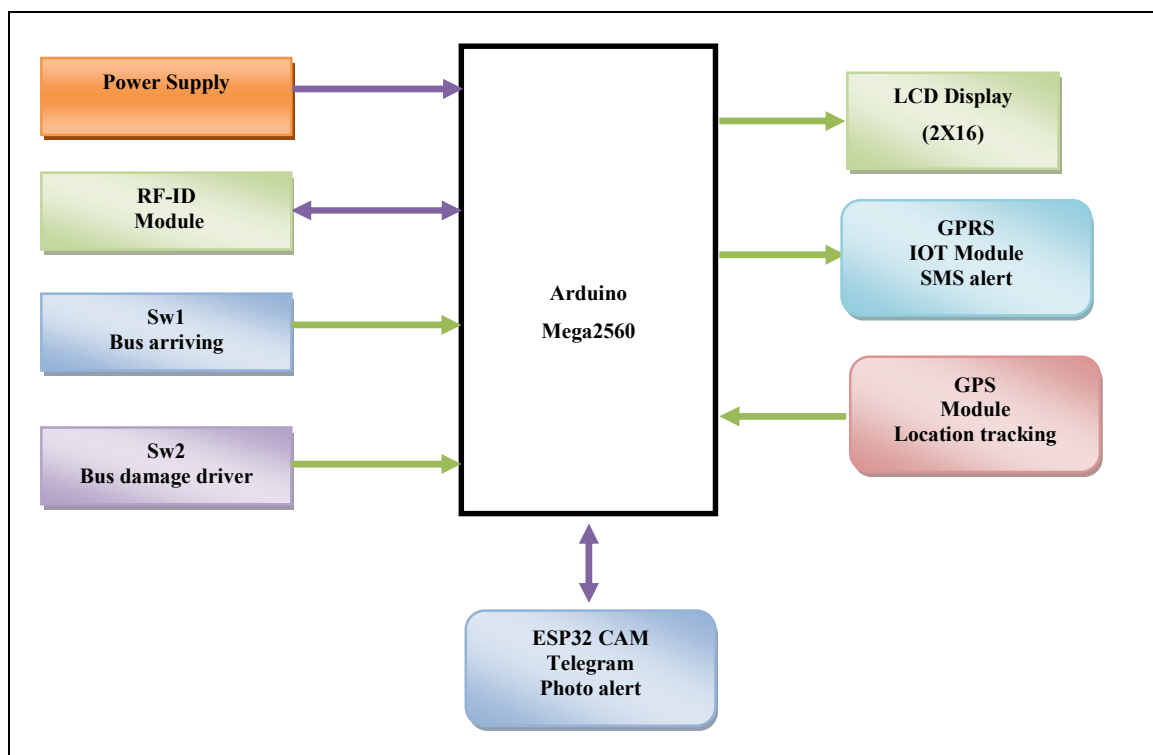


Fig. 1: Block Diagram of School Bus Tracking System Using GPS and GSM

(A) ARDUINO

Arduino an open-source physical computing platform it is a microcontroller board based on the ATmega2560. It's one of the most powerful boards in the Arduino family, offering a large number of digital and analog input/output pins, along with various other features, making it suitable for complex projects that require a lot of I/O pins or processing power. It's commonly used in robotics, automation, and other projects where a high degree of control and connectivity is needed.

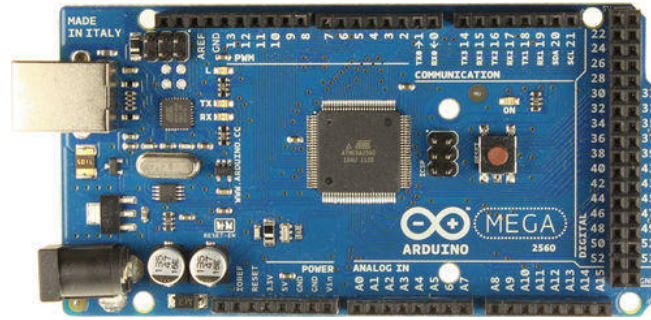


Fig. 2: Arduino 2560

## (B) ESP32-CAM

The ESP32-CAM is an Ai-Thinker's the Original ESP32 CAM Wi-Fi + Bluetooth with OV2640 Camera Module based on the ESP32 chip with the additional facility of using a camera. It is ideal for various IoT based applications. The ESP32-CAM is a very competitive small-sized camera module. It is operate independently as a minimum system.

## (C) GPS

The Global Positioning System (GPS) technology is the most significant recent advance in navigation and positioning technology.



Fig. 3: GPS Module

## (D) GSM

A GSM (Global System for Mobile Communication) is a specialized type of modem which accepts a SIM card, and it is a digital mobile network operates over a subscription to a mobile carrier service providers, just like a mobile/cellular phone.

## (E) LCD

Liquid crystal display (LCD) a type of digital display used in digital TV, monitor, watches and many portable computers. In bus monitoring system LCD used for showing latitude and longitude of the given location.



Fig. 4: LCD

(F) RFID

Radio Frequency Identification (RFID) use electromagnetic field that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object wirelessly, using radio waves.

(G) SW 1

The SW1 (switch 1) will send the notifications to the student bus arriving time and the location.

(H) SW 2

Bus in the trouble, the SW (switch 2) will send the notifications to management as well as parents in case of emergency.

#### IV. WORKING OF THE SYSTEM

The working of proposed system to track the bus, we need to find the Coordinates of the bus by using GPS module. GPS module can communicate continuously with the satellite for getting coordinates signals. Then we need to send these latitude and longitude coordinate data from GPS to our Arduino2560. And then Arduino take out the required data from received data by GPS. Before this, Arduino sends command to Wi-Fi Module for construct and attach to the router and getting the IP address. After it, Arduino initialize GPS for getting coordinates and send data them to the cloud via ESP8266 module. Later, we can see the current location of the bus at the red spot on the Google maps. Student can enter the bus scan RFID card if RFID card match then ESP32 camera capture the photo and send to the admin telegram app.

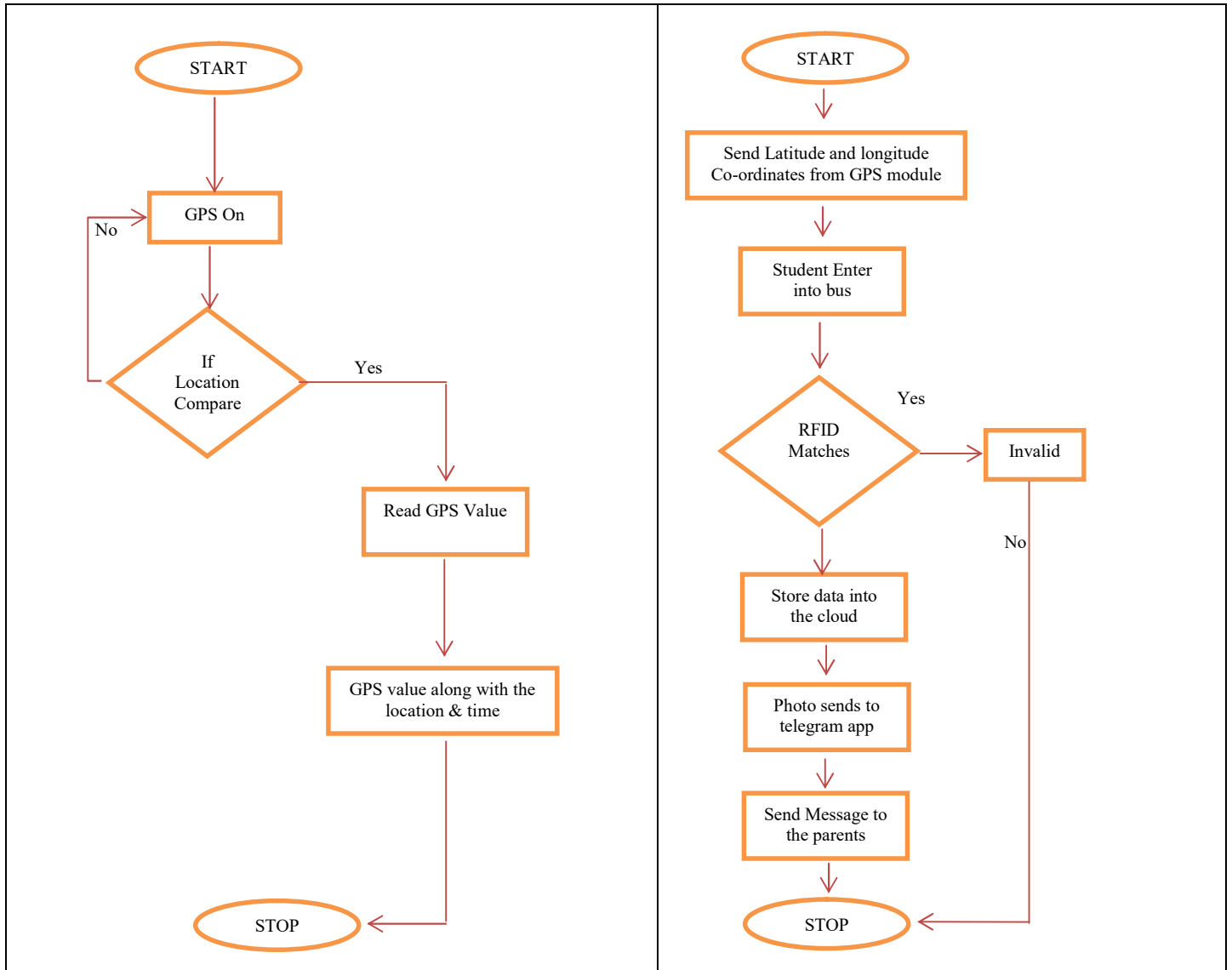


Fig. 5: Flow Chart for Location Tracking

Fig. 6: Flow Chart for student identification

V. RESULT AND DISCUSSION

This section presents the selected results of our experiments. The purpose of this analysis is show a functional prototype of proposed system. We used GPS connections, which is connected to mobile phone to buses. The GSM Module send tracking data at the web server and parents by SMS. Laptop or mobile is used to track the children/bus location on Google map.



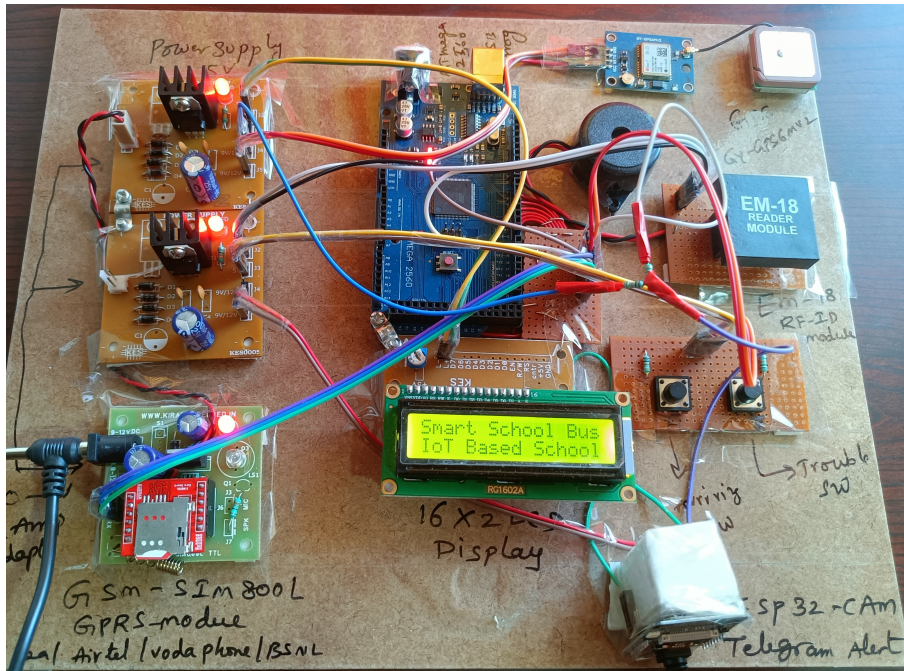


Fig. 7: Circuit Connections

The result of the proposed system consist of three parts-

- (A) SCHOOL UNIT
- (B) TELEGRAM APP PHOTO ALERT
- (C) PARENT UNIT

(A) SCHOOL UNIT

The school unit server consists of a login page, bus location page, student database record and new student update page. The code created to login page is run on XAMPP server in php MyAdmin it is a free and open source for administration tool of MySQL especially used for web hosting services in server. In login page enter valid user id and password the admin direct login to the web browser. After the login page loaded successfully it show the overall structure of the web page.

### Smart School Bus: IoT Based School Bus Monitoring System

Login

User Id:

Password:





(C) PARENT UNIT

Parents can see the location of the bus.

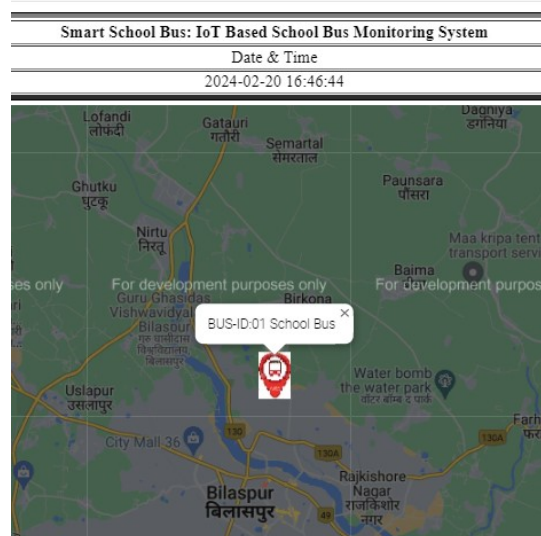
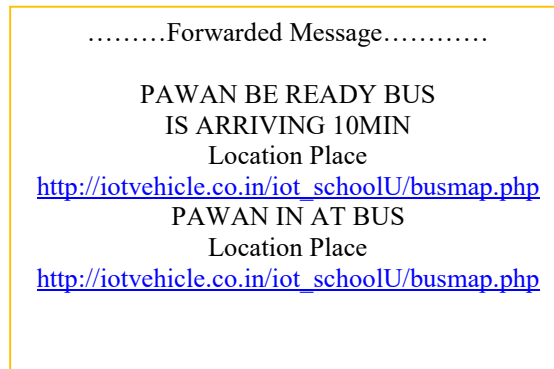


Fig. 13: Location of the bus

VI. CONCLUSIONS

In this paper, the safety of children in school buses is a major concern nowadays so having GPS based bus tracking system ensures their safety while travelling. The proposed work is designed successfully tested and implemented. . Admin will see the all buses, see the list of students on-board, add new students, and replace bus schedules and route. The system has offered a web and SMS services, where data and information are shared with parents and school administrators in real-time.

VII. FUTURE SCOPE

In the future machine learning model used which will analyze the past data and predict the required frequency of bus and bus schedule can be created. This model will help the bus management to efficiently plan the bus system to fulfill passenger’s demand. Identification of the heavy congestion routes and provides the best possible alternative routes to avoid the congestion. Looking ahead, several trends and opportunities are poised to shape the future of this field:

- Advancements in sensing technologies, communication networks, and data analytics will continue to drive innovation in IoT-based bus monitoring systems, enabling new capabilities and applications.
- Integration with emerging technologies such as artificial intelligence, machine learning,

- and edge computing holds the potential to further enhance the capabilities and efficiency of these systems.
- Collaboration between stakeholders, including transit agencies, technology providers, and policymakers, will be essential to overcome challenges and realize the full potential of IoT-based bus monitoring systems.

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