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EFFICIENT MODEL FOR AUTOMATED SCHOOL BUS SAFETY AND SECURITY USING IOT AND CLOUD

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Abstract - **School bus services now play an important role in transporting students from their homes to schools in every country region. Many parents rely heavily on school bus services, despite their concerns about their children's safety. As a result of this difficulty, this paper proposed an SMS-based solution to help most parents track their children's school bus movements (in/out). Parents will receive an SMS once their children have boarded the bus and arrived at their destination. Using RFID and GSM technology, the system strives to create a school bus security system. RFID is used to authenticate the student's identity to the parent's phone number and to count the number of students in the bus, whereas GSM is deployed as a platform to send SMS notifications to parents about their children's whereabouts. The microcontroller is coupled to RFID and GSM technologies, with the visual studio application deployed in AWS cloud controlling both the microcontroller and the operations. According to the system, the developed project is capable of allows both parents and school administration control and monitor a variety of aspects such as the number of children on bus, each student's details, pick-up and drop-off times, location, and attendance system. A web application allows parents to keep track of the school bus's whereabouts as well as the student's pick-up and drop-off times. In short, this prototype system could provide peace of mind to most parents who entrust their children to the school bus transportation system.**

***Keywords*—RFID Module, GSM Module, GPS Module, AWS Cloud, Visual Studio Application.**

I. INTRODUCTION

The Internet of Things (IoT) is a concept that connects all of your devices to the internet and allows users to interact with one another. Devices and objects with built-in sensors are connected to an Internet of things platform, which combines data from various devices and applies analytics to share the most useful information with apps customized to individual needs. Machines can communicate with one other without human interference, resulting in faster and more timely production.The Internet of Things (IoT) was first most valuable to business and manufacturing, where its use is frequently referred to as machine-to-machine (M2M), but the focus is now on populating our homes and offices with smart gadgets, making it relevant to practically everyone.Parents are usually concerned about their children's safety and agitated by the growing number of incidents that occur on a daily basis. With all those unpleasant feelings bottled up, they can't help but wait till evening to learn about their child's well-being. Thus, not only in terms of a child's safety, but also in terms of a parent's well-being and the school's responsibility, tracking school buses is significant.

The proposed system provides a cost-effective and efficient solution to these issues. With the use of real-time monitoring, this system can track the current location of students, as well as pick-up and drop-off hours. With the support of real-time monitoring, parents and school administration, as well as other essential help, can rapidly reach out to children's aid in an emergency.This system describes a low-cost school bus display that tracks many characteristics such as the number of children on bus, adherence to the route and schedule, location, speed, and other information needed by the school and parents. The Global System for Mobile Communication (GSM) module and radio frequency identification system (RFID) have been integrated in this system to enable a tracking mechanism, with an RFID tag placed in the student id card. Via SIM-300 GSM module technology, a notification SMS will be delivered to the identified parents' mobile phone number after the RFID reader has been scanned. The GPS module is implemented in a satellite navigation bus tracking system.

The notification system aids in ensuring individual ward safety as well as reducing time wastage while students wait for delayed buses. This system uses real-time monitoring to enable students self-address their concerns. All of these actions are controlled by the microcontroller and managed by a web application deployed on AWS cloud service, which both parents and schools may use to obtain time records, location data, and real-time SMS service to the authorized parents' mobile phone numbers.

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II. OBJECTIVES

This project aims to overcome a problem that may lead to tragic situations and, as a result, an increase in kidnapping and other criminal actions involving school students. Parents may need to contact the bus driver to confirm that their children have arrived at home or school. As a result, the proposed system integrates a passive card approach that is integrated inside the student ID card to track students'attendance. Similarly, parents are notified of their children's arrival and departure times from the school bus.

III. LITERATURE SURVEY

A Sai Aishwarya.Et.al [1] developed "IOT Based Smart School Bus Monitoring and Notification System" (2020) In this paper, they used SQLyog and Visual Studio to build a website and a mobile application that will allow parents and schools to track the bus location as well as monitor children using the fingerprint sensor and GPS module controlled by the NodeMCU microcontroller. The fundamental idea behind this existing system is that using a website and application made by them, both parents and admins can keep track of their children and monitor the bus.

Nada Abdul Al-Balushi.Et.al [2] implemented "Transport Safety Mechanism of School Children Using IOT based Smart System" (2020) The IoT smart transportation system for a children's school is presented in this research study. The system includes IR sensors to determine the number of students, an RFID card and reader to read student data and keep track of attendance, and a MQ3 sensor to detect alcohol and assure the driver's safety. It also includes a smartphone application for receiving notifications and messages, as well as the time student boarded the school bus and exited the bus. You can also use the most recent coordinates to track the bus using Google Maps. This system uses Things Speak a public cloud developed for IOT.

Dr. M. V. Vyawahare.Et.al [3] implemented "IOT Based School Bus Monitoring and Security System" (2019) In this system A vehicle monitoring system is used to track a bus's travel from any location at any particular time. The proposed system utilizes a technique that integrates a smartphone app with a microcontroller. The devices used in this system are NodeMCU Mega, RFID reader, GSM module and MQ3 sensor to monitor, track and send notification alerts to parents and school. This system uses Blynk application to monitor and run the application.

Palvi Shelke.Et.al [4] wrote "Smart Tracking System for School Buses for Ensuring Child Security using IoT Implications and GPS Technology" (2019) This result recommends an android-based solution that allows parents to monitor their children's location in real time via IoT applications. GPS technology can be utilized to track the child's whereabouts, and a biometric identification system is included into the system to identify the child's existence. Additionally, if the driver or bus worker has consumed alcohol or over speed the sensors implemented in the bus will notify the school authorities.

Tun Mohamad Aqil Mohamad Fadzir.Et.al [5] gave "Development of School Bus Security System Based on RFID and GSM Technologies for Klang Valley Area" (2018) The goal of the project is to develop a school bus security system that uses RFID and GSM technology to monitor and manage students as they go from school to home and back. Things Speak, a public cloud service for IoT applications, will store the students' data and also the bus's location. The location of the children's travel will be sent to the parents and the school via SMS on their mobile phones.

Judy Thyparampil Raj.Et.al [6] contributed "IoT Based Smart School Bus Monitoring and Notification System" (2017) The proposed system includes real-time information regarding numerous vehicle aspects such as location, route, speed, passenger list, driver adherence to schedule, and much more. The system makes use of the Firebase Cloud messaging service, and Blynk app also allows parents to be alerted when their children get off or on the bus. They deploy RFID and GPS technologies in this system, and use an ESP8266 microcontroller to connect them to a remote server using Wi-Fi.

IV. PROPOSED SYSTEM

This research developed a system concept for adopting a safety mechanism for school bus transportation in which attendance is recorded and parents are notified via SMS. The RFID technology has been used to create a system that counts every student's arrival and exit by detecting the unique identification information. When a student touches his or her RFID tag to the RFID reader, the system displays all of the students' names on the LCD screen module. Due to the availability of GSM module technology, most parents can receive SMS notifications while their children board or exit the school bus.A microcontroller, the Arduino Uno board, has been used to control the working mechanism between the components. The parents can even see the location of the school bus via the GPS module integrated in the school bus safety mechanism. All the operations of the microcontroller and the time logs and student's information is stored in the web application deployed on AWS cloud service. The visual studio applicationcontrols the entire Arduino microcontroller and perform all the task via cloud.

The below**figure 1** illustrates the working of the proposed system, there are three modules implemented in the system the student module, parent module and the school module. Each student has a unique RFID tag integrated in their id card. The RFID read is been implemented in the entry and exit of the school bus.

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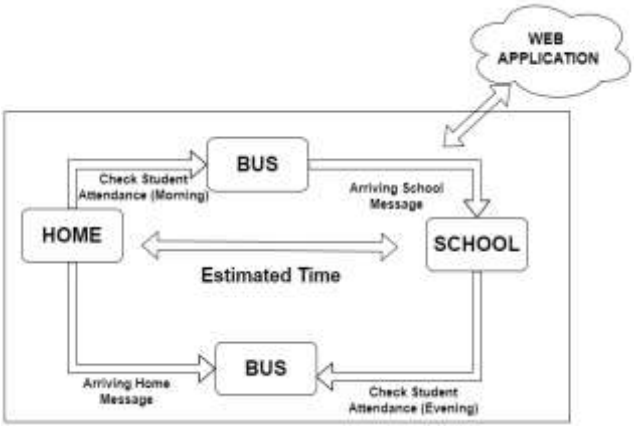

Figure.1 Shows the architecture of the proposed system

A. Hardware Components

Arduino Uno: The Arduino Uno has been used as the main circuit to control the system's input and output, as shown in Figure. It also operates as a central processing unit (CPU) for coordinating the actions of other components. Furthermore, in comparison to other microcontrollers such as ATMEL and PIC, the circuitry board is simple to programme and reprogram. This physical board contains 2Kbytes of SRAM and 32Kbytes of Flash memory technology. In the below **figure 2**shows the figure of Arduino Uno.

Figure.2 Arduino Uno

GSM Module: The SIM-800L GSM module, as depicted in Figure, is a communications device that allows the user to send and receive messages. It functions similarly to a mobile phone network by inserting the SIM card into a provided slot. Furthermore, the existence of a GSM modem within the module allows it to work via a wireless network. This idea was utilised to create a digital wireless metre. However, before it can work with the Arduino Uno microcontroller, this GSM module must first initialise its signal coverage. For this module to transmit a notification message, the operational voltage should be between 3.7V and 4.2V.The below **figure 3**depicts the GSM Module.

Figure.3 GSM Module

RFID Reader Module: As shown in Figure, the RC-522 RFID module is a device that can transfer or read data over a short range. This RFID scanner module can read RFID tags from a range of 0 to 10mm. Likewise, the RC-522 RFID tag has a unique ID number that can be read by an RFID reader. The 13.56MHZ electromagnetic field is used to communicate between the RFID reader and the tag. Halal Kit identification has been proposed previously using the same frequency. In order to interpret the tag's inquiry signal and provide a response to the microcontroller, this RFID RC-522 reader requires 3.3V from an Arduino Uno board. In the below **figure 4**represent the RFID Reader Module.

Figure.4 RFID Reader Module

GPS Module: GPS is a satellite-based module that receives a specific location. When you're outside, GPS is a useful tool for locating a location. The GPS module can use many GPS satellites. The satellite's location will be communicated to a computer through Bluetooth. To retrieve the satellite's location, we'll use the U-blox NEO-6M Module. In this case, we'll utilise the same Bluetooth module, the HC-06. A computer will listen to a robot's GPS data. Latitude and longitude coordinates are the GPS data that is transmitted. In the below **figure 5**illustrates the figure of GPS Module.

Figure.5 GPS Module

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LCD Display: A 16x2 Liquid Crystal Display (LCD) is utilised to display a student's status information when on or off the school bus, as seen in Figure.The below **figure 6** shows the LCD Display.

Figure.6 LCD Display

Smart Phone: Smart phones are used to receive messages from the school bus system regarding their children's in and exit logs. Also, we use our smartphones to track the location of the school bus. The below **figure 7** shows the Smart phone.

Figure.7 Smart phone/Mobile phone

Battery: To run and perform all of the actions in the system efficiently, the batteries or any type of power supply, such as a power bank, is necessary. The below **figure 8**depicts the Battery supply/Power supply.

Figure.8 Battery supply / Power Supply

B. Software Components

Arduino IDE: The Arduino IDE (Integrated Development Environment) is a software application that assists programmers in writing code. There are numerous toolbar and menu options for sketching the required system's codes. This software enables the newly sketched programme to be uploaded to the Arduino board. The below **figure 9**exhibits the logo of Arduino IDE.

Figure.9 Arduino IDE

Visual Studio: This is the best all-in-one IDE for.NET and C++ developers on Windows. It includes a variety of tools and features to assist you in improving and elevating your software development process at every stage. Working on projects of any size or complexity is easier with a 64-bit IDE. You can alter code across several files using a new Razor editor. Fix difficulties by visualising async processes and using automatic analysers.You can construct cross-platform mobile and desktop apps with.NET MAUI. Blazor is a responsive Web UI framework written in C#. You may write, debug, and test.NET and C++ apps in Linux environments. Hot reloading can be used in.NET and C++ programmes. You can edit running ASP.NET pages in the web designer view. AI-assisted code completion to collaborate in real time, use pooled coding sessions. The below **figure 10**illustrate the logo of visual studio.

Figure.10 Visual Studio

MS SQL Server: Microsoft SQL Server is a relational database management system (RDBMS) that was created by

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the company. This solution is designed to perform the basic task of storing and extracting data as needed by other applications. It can be used on the same computer or on a networked computer. It's also a relational database management system (RDBMS). It is platform-specific. It is both a graphical user interface (GUI) and command-based software. It supports the IBM-developed SQL (SEQUEL) language, which is a non-procedural, database-independent, and particular instance language.The below **figure 11** shows the logo of MS SQL Server.

Figure.11 MS SQL Server

AWS: Amazon Web Services, Inc. (AWS) is an Amazon company that offers required basis cloud computing platforms and APIs to consumers, businesses, and governments. These web services for cloud computing include a variety of basic abstract technical infrastructure and distributed computing building blocks and services. The below **figure 12**exhibits the logo of AWS.

Figure.12 Logo of AWS

V. WORKING SYSTEM

The design method is implemented using different student identity cards that were all unique. First, a 9V power adapter must be connected to the system. The 9V power adapter's purpose is to ensure that the system can properly activate the SIM-800L GSM module. Before the system to operate, the GSM module must be activated. After the system is turned on, the LCD panel shows instructions for scanning the RFID tag, which include a real-time clock.

The output that is presented on the LCD screen module as well as on the mobile phones of the parents. During the morning session, the school bus driver picks up students from their homes. The program read the initial period to notify parents whether or not their children have attended or were missing from school. The LCD module's output was used to check students' overall attendance during the morning session.The design system model analyzed the students' total attendance and sent a bulk notification message based on the timeframe provided.When the students swipe their cards on the RFID reader, a notification message will be sent to their parents. providing a real-time notification confirming that the children have arrived at the school. Similarly, affords real notifications to parents that their children have boarded the school bus at noon, as well as a real-time message indicating that their children have arrived home.

All the devices such as RFID Reader, GSM Module and GPS Module is been connected to the Arduino Microcontroller. The operations such as Real time notifications to the registered parent mobile number, recording each student time logs and the location of the school bus is managed by a visual studio web application deployed on AWS Cloud. So that the parents as well as the school management can access the information and get the data from anywhere. This system will in turn help the school and parents to maintain the safety of their children while travelling from home to school or vice versa.

The below **figure 13**illustrates the flowchart of the proposed system to check the attendance of student during morning and evening session.

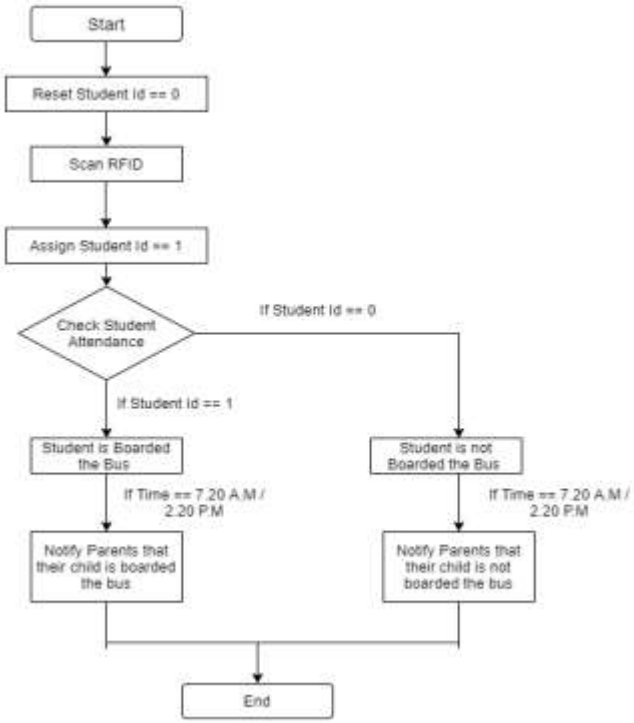

Figure.13 Attendance Checker Flowchart

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Initially the RFID reader will be assigned to 0(absent) in the morning as the student enters the school bus and scans his/her ID card through the RFID reader, the RFID reader checks the student in the database if the student is been registered it displays their registered name on the LCD display and the specify student is assigned as 1(present) and the parents is been notified. After the bus reaches the school and RFID is again reset to 0.

As in the evening timing the student again scans their ID card the same process is been repeated if the student is been registered it assigns to 1(present) and SMS notification will be sent to the parents. All the time logs of the students of entering and exiting the school bus will be recorded in the cloud database along with the student's name and other details which can be accessed by parents as well as the school authorities as for attendance and safety of the students.

The below**figure 14** shows the flowchart of the proposed system sending a real time message to the parents registered mobile number after reaching or starting from the prescribed location.

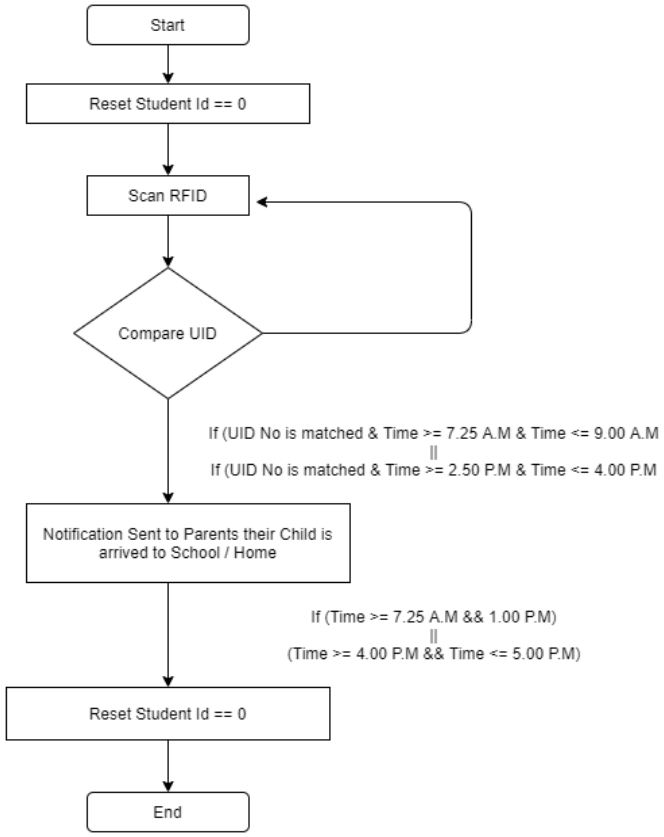

Figure.14 Real-Time Notification Flowchart

Initially the whole system will be set to zero as the student enters the bus in the morning he/she scans their ID card through RFID reader the student information is been checked in the database along with the time log and via the GSM module a notification is been sent to the registered parent mobile number stating your child is boarded the school bus. After reaching the school while exiting the school bus the SMS is again sent to the parent's mobile number as your child is reached the school safely.

As in the evening time the system is initialized to zero, as when the student boards the school bus scan his ID card and the student data is been checked and a real time SMS is been sent to the parent registered number as your child is left the school and after reaching the prescribed home location of the student the SMS is been sent to the parent stating the child is reached home safely. After the whole process is done the system checks the student data logs and the time logs and sends real time SMS for the absent students. This is the workflow of the real time notification sending to the parent mobile number along with the location.

VI. METHODOLOGY

Step 1: Connecting all the devices such as GPS module, GSM module, LCD, RFID reader to Arduino Microcontroller through jumper wires.
Step 2: Assigning a unique UID to each RFID card
Step3: Installing ESP8266 sketch data upload tool in Arduino IDE.
Step 4: If the RFID id number matches the registered student number in the database,then the application marks the attendance of the student.
Step 5: After the attendance, the GSM modules sends the SMS to the registered parent mobile number.
Step 6: The GPS module gathers the coordinates from the google map and location is sent to parent's mobile number.
Step4: Develop a visual studio web application using .net language and MS SQL server for the database.
Step5: Uploading the web application into AWS cloud.
Step6: Testing / Subscribing the model.
Step7: Event / Data Logging.

VII. RESULTS

The School Bus Safety and security is developed using IOT devices such as RFID reader to read the unique number registered to each RFID card, GSM module to send SMS to the registered parent's mobile number along with location using GPS module about the status of their children reaching school or home, AnLCD device to display all the notification. All these devices are been connected to and controlled by Arduino esp8266 microcontroller.

A web application is developed using .net framework in visual studio where each parent can get the daily status of their children. A MS SQL server is used as a database where all the time logs is been recorded of the registered students inside the bus. The project is been deployed in AWS (Amazon web services) a cloud platformwhere the school management as well as the registered parents can access the application from anywhere using any internet connectivity.

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The working of this system is as the student board the bus from their home or school he/she scans their respective RFID card across the RFID reader. The database is been checked and the registered student attendance is been marked in the database, a SMS along with location is been sent to the registered parent's mobile number. All the notification will display on the LCD devices.

Figure.15 Scan the RFID card to RFID reader

The above **figure 15** shows the notification in the initial phrase asking the student to punch the RFID card present in each student ID card across the RFID reader to perform all the functions such as attendance and SMS to the parent's mobile number.

Figure.16 Student Boarding the bus notification

The above **figure 16** shows the notification after the student boarded the bus after scanning the RFID card.

Figure.17 Sending GPS and SMS Notification

The above **figure 17** shows the notification displaying on the LCD stating the GPS and SMS sending to the registered parent mobile number about their children boarding and reaching the home using the GPS and GSM modules.
A web application is been developed using .net framework using visual studio and MS SQL server to track and record the call and time logs about students. The school management and parents can access the application from anywhere as it is also be deployed in AWS cloud services.

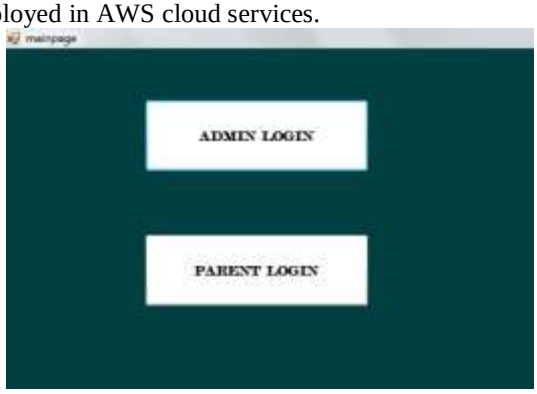

Figure.18 Main page of the web application

The above **figure 18** shows the main page of the web application where the school management and registered parent can login and get the details of respective students.

Figure.19 Admin Home Page

The above **figure 19** shows that admin or the school management can access and manage the student registration, parent registration and also track and manage the students logs.

Figure.20 Student Registration Page

The above **figure 20** shows the registration page of student where the school management should assign the unique tag id, name and mail id of the respective student.

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Figure.21 Student Database Page

The above **figure 21** shows database of both parents and students where all the time logs of the respective students is been tracked and recorded in the database.
The project is also deployed in AWS cloudwhere the web application can be access by the school management and parents to check the whereabouts of their respective children. The system is mainly developed for reducing the illegitimate activities of school going children so that parents have a free mind. This system is cost and time efficient completely automated using IOT devices.

VIII. CONCLUSION

A school bus security system based on RFID and GSM technologies is proposed and implemented using this system. RFID technology could be used to track students as they onboard and exit school buses. The message is sent immediately to the parent's phone as soon as their children have successfully left or arrived at their destination, giving them peace of mind.An additional feature of the attendance checker is that it will notify parents if their children are not on board (missing). The proposed project is improved by using the Global Positioning System (GPS) as the school bus's location tracker.

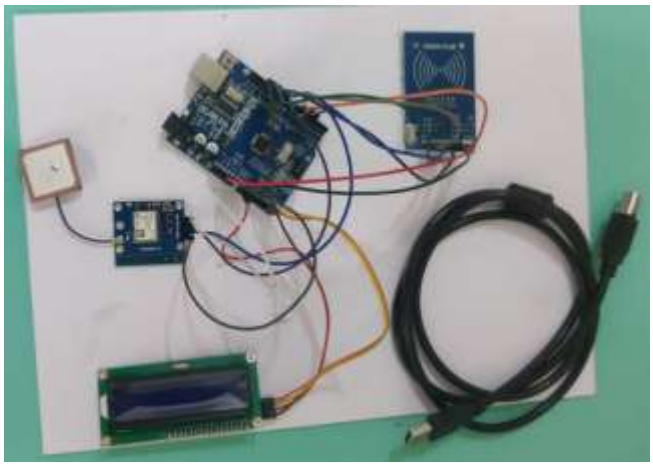

Figure.22 Final Project Implementation

The above **figure 22**shows the final project implemented where all the IOT devices such has the GSM module, GPS module, RFID card reader and the LCD display device is been connected to the Arduino NodeMCU ESP8266 using jumper wires. This system been connected to a power source such as a battery or power bank in order to function in small scale.
To keep the system running efficiently, devices like the RFID module, GSM module, and GPS module are connected to the Arduino microcontroller through a power source. In addition to assisting the school and parents, the web application developed using visual studio is been deployed in AWS Cloud manages this system, which allows them to access time logs, bus location, and messaging service to the registered parent mobile number. The main goal of this proposed system is to provide students safety and security when going to school and returning home from school, in order to prevent kidnappings of school-aged children.

IX. FUTURE ENHANCEMENT

In terms of size and convenience, a wristband incorporating coil-on-chip technology may be preferable than using a student identification card. Even biometric fingerprint scanners are effective in tracking students, and in addition to the bus's location, school authorities can provide a route map to the destination, which will aid working parents in picking up their children on the way. Our proposed System is efficient for a working model of school bus which will avoid abduction of the children and to maintain or record the daily attendance of the students.

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