PROPOSAL OF PROTOCOL BASED VEHICLE TRACKING SYSTEM USING ESP32

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Abstract— With the advancement in the field of IoT, the average cost of vehicle tracking systems is getting lower. Currently, there are many ways to implement the vehicle tracking systems with different available technologies such as GSM based vehicle tracking, central serverless architecture, lowcost microcontroller or XBee based systems along with some security mechanisms. Due to the diversity in the ways of vehicle tracking systems being implemented, it is hard to choose a suitable technology to address multiple issues as each has its own advantages based on the application, a centralized framework is required which modularizes the functionalities based on the operation. This paper proposes a protocol-based vehicle tracking system that addresses all the concerns related to the diversity in vehicle tracking systems and facilitates in choosing functionalities based on the requirement.

Keywords— IoT; ESP32; Vehicle Tracking; GPS; Internet of Things; Wi-Fi;

I. INTRODUCTION

Logistics is one of the fastest-growing segments in the industry. With the increase in the population, the number of cargo vehicles used in the movement of goods and commodities is rapidly increasing. The vehicle tracking system plays a vital role in improving the performance in the transportation services and overall user experience. Hence a systematic approach is required to improve the vehicle tracking services.

Recent developments in the field of IoT have given rise to new ways of enhancing vehicle tracking services in the logistics sector. ESP32, which is a series of the low-cost, low-power system on a chip microcontroller with integrated Wi-Fi is used to monitor the parameters such as vehicle location coordinates (latitude and longitude), fuel indicator levels, temperature and humidity levels of the enclosed containers while sharing the parameter data to the central cloud for analysis and tracking.

This paper focusses on the proposal of new framework and implementation of IoT in vehicle tracking systems. We have used ESP32 microcontroller to collect the input from DHT11 sensor (temperature + humidity) and GPS sensor (latitude + longitude) data and share the data to the thingspeak server connected through the vehicle onboard internet connection, for further analysis and control. The controller, along with sensors is fitted inside the vehicle. We have proposed a layer-based design in our application which focusses on modularized approach in vehicle tracking systems.

II. LITERATURE SURVEY

P.Jyothi et al., [1] proposes the design and implementation of real time vehicle monitoring, tracking and controlling system using GPS/GSM SIM900A module. The frequent SMS messages update the location of the vehicle in this system. In case of vehicle theft, the owner will be able to track the vehicle current location and receives alert messages. The messages are also sent to the concerned person in case of exceeding vehicle speed limit.

S Mohanasundaram et al., [2] proposed vehicle theft tracking, detecting and locking system using openCV. Face detection technology is used in order to unlock the vehicle and to overcome the vehicle theft using mobile application. This system secures vehicle from theft as well as allowing users to view the theft details and saves the data in USB drive.

Ibraheem Kasim Ibraheem et al., [3] have proposed the design and implementation of a low-cost secure vehicle tracking system. The paper uses XBee wireless technology to provide the low-cost and high-level security. The tracking module consists of a microcontroller (Arduino) platform, an XBee, and a GPS for navigation purposes. The monitoring station receives the location data of the tracked vehicle and displaying them securely on Google earth.

Tareq et al., [4] have proposed the anti-theft vehicle tracking and regaining system with Automatic Police Notifying Using Haversine Formula. The Haversine Formula is used to calculate geographic distance on earth between two coordinates. In case of vehicle theft, the device will automatically reach to the nearest police station and tracks the vehicle movement.

Fatima et al., [5] have proposed an economic tracking scheme for GPS-GSM Based moving object tracking system. An Economic tracking scheme is proposed for GPS-GSM based tracking systems with both time and distance quantization. The moving device checks its moved distance with respect to the last sent position SMS at regular time instants, every T second. Only if the moved distance is greater than a given threshold, then a position update SMS is sent to the server.

Chunlong Ma et al., [6] uses an ARM-Linux platform for vehicle tracking. The vehicle is mounted with s5pv210 central microprocessor. GPRS network is used to transfer the positioning information between the monitoring center and

the vehicle-mounted terminal in real time to achieve real-time positioning and tracking of the vehicle. GPRS and embedded technology gives a good quality in vehicle monitoring management and security protection.

Emir et al.,[7] have proposed on improving performance of Vehicle Routing Algorithms using GPS Data. Using Vehicle Routing Problem (VRP), Traveling Salesman Problem (TSP) and GPS tracking analyze their routes and improve input data needed for the algorithm for the vehicle routing problem.

Fatima et al.,[8] have proposed cost minimization of GPS-GSM Based Vehicle Tracking System. The GPS-GSM based system is designed and implemented to economically track vehicles moving over wide geographical areas. A scheme is proposed to reduce the number and cost of the used SMS messages. Performance evaluation under hypothetical and practical test cases showed the capability of the proposed system to achieve significant cost reduction.

Elamin et al., [9] have proposed the design of vehicle tracking system using GPS. The interaction between the user and the car is designed to be via Short Message System "SMS". As well as in case of theft or scope of work departure, the user has the capability of turning car engine off remotely.

III. METHODOLOGY

A. Proposed Layer Based Design approach:

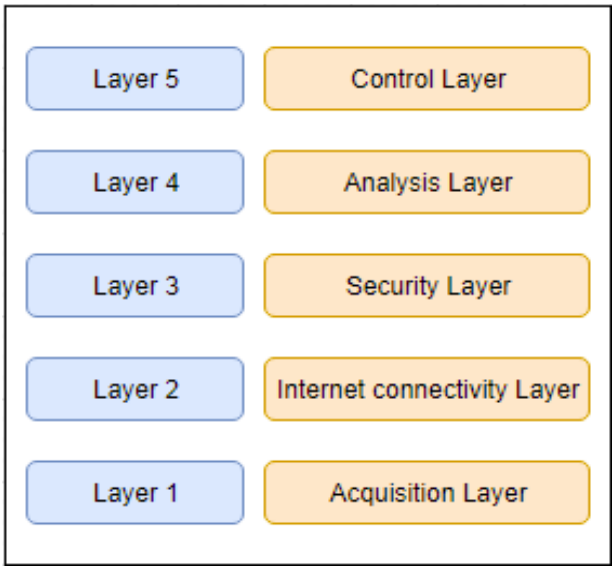
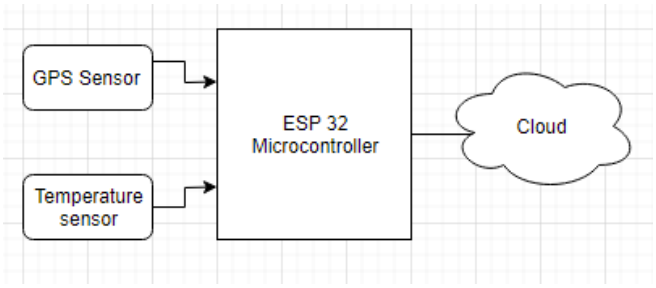


Figure 1.0

Figure 1.0 represents the proposed layer-based design approach for the IOT based implementation of vehicle tracking system. The proposed layered based design consists of sensor data acquisition layer, internet connectivity layer, security layer, parameter analysis layer and control layer. Each proposed layer performs the layer specific modularized operation that is explained as follows.

Sensor Data Acquision Layer:



The sensor data acquisition layer performs gathering the geographical location of the vehicle using sensor. In this layer, the onboard ESP32 controller gets the input from sensors which monitor the temperature, humidity of container and track the vehicle location co-ordinates. The controller reads the analog sensor inputs and send the data to the cloud. Here we have used thingspeak as the cloud service for proposing the model. The ESP32 is powered on board power supply or by battery supply.

Sensor Acquisition layer contains task of reading sensor data, hardware connection design and setup.

Internet Connectivity Layer:

In the internet connectivity layer, the data from ESP32 microcontroller is sent to the thingspeak cloud using MQTT protocol which is designed for lightweight messages that uses subscribe operations to exchange data between clients and server. To implement this, the ESP32 controller is configured to connect to internet through onboard Wi-Fi. The Wi-Fi login credentials and thingspeak server details are provided to the ESP32 controller via mobile application. On connection with the internet, the sensor values are updated to the respective channels configured in the thingspeak server.

Thingspeak is an IOT platform which offers capabilities of real time data collection, visualizing the collected data in the form of graphs or charts and it also provides the ability to create plugins and apps for collaborating with web services.

The internet layer includes server login, establishing the internet connection and provides an interface for user to monitor the sensor data.

Security Layer:

The security layer is proposed in order to provide confidentiality, integrity and end-to-end authentication. To achieve this, proper security mechanism needs to be adapted. The built-in hardware accelerator in ESP32 enables secure code storage and securely connecting to the Internet with TLS (SSL). The thingspeak server has inbuilt API keys to read and write data to a private channel. API keys are auto generated.

The security layer is implemented to provide encryption, AAA secure policy. We can adapt different security mechanisms depending on our application requirements.

Parameter Analysis Layer:

Parameter analysis layer consists of proper analysis mechanisms in order to read and interpret the sensor data acquired through the ESP32 microcontroller which includes average vehicle speed and estimated time to reach the destination. The data can be visualized using google maps.

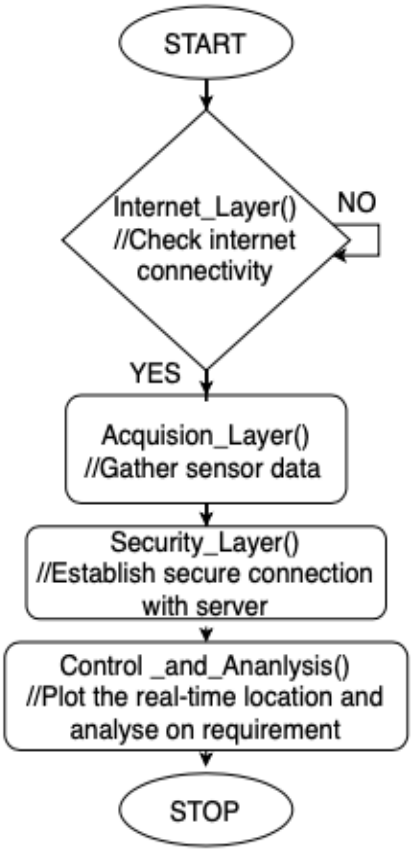
The real-time sensor data stored in the thingspesk server can be analyzed using inbuilt MATLAB tools. The average values stored in the cloud can be exported to csv/xls file and can be used for further analysis using machine learning or deep learning algorithms.

Control Layer:

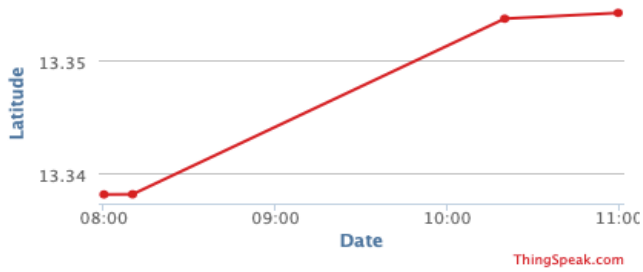
We have proposed control layer in order to control the container temperature if required. Alarm and signaling systems in case of vehicle theft or low fuel levels.

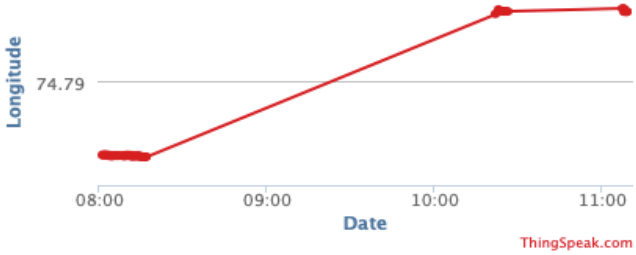
B. Software development for ESP32

The program flow consists of continuous GPS and other sensor data acquisition from the input ADC pins on onboard controller, getting the credentials from the browser or mobile application to acquire the SSID and password of the onboard Wi-Fi network and establishing the internet connection with the thingspeak server hosted in the internet. On successful connection establishment, the sensor data is forwarded the thingspeak server using MQTT protocol.



RESULTS





CONCLUSION

The objective of this paper was to propose a layer-based framework for monitoring and live tracking of the vehicles. The paper uses modular approach to classify the tasks based on the operation. The approach can be very helpful in choosing a suitable functionality of technology for each layer depending on the application.

FUTURE SCOPE

This project can be further enhanced by using machine learning techniques or deep learning techniques which can be implemented using the sensor values obtained from thingspeak cloud to maintain ambient container temperature of the logistics vehicles. The clear classification of specific tasks in live tracking enables easy modularization and plug and play of functionalities based on requirement.

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