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Literature survey on Integrated vehicle tracking with speed, tilt, and geofencing

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Abstract: This paper presents a GPS-based location monitoring system with geo-fencing capabilities designed to prevent vehicle theft and provide real-time tracking. The system integrates hardware components, including an ESP32 NodeMCU, a GPS module, speed sensor, tilt sensor and a Wifi receiver, with software components, namely an IoT cloud platform and integration. The GPS module tracks the vehicle's location and transmits the coordinates to the IoT platform through the NodeMCU. The system administrator can monitor the speed of the vehicle, and monitors the damage of the vehicle, any drastick changes in the weight of the load, and monitors vehicle's location and set up geo-fencing boundaries. When the vehicle enters or exits the geo-fenced area, the system triggers an email notification alert to the administrator. The prototype was tested by moving a vehicle around a geo-fenced area, and the prototype system was tested by moving the vehicle around the geo-fenced area. Results showed correct location tracking of the vehicle and phone number notifications upon exiting or entering boundaries.

Keywords: GPS tracking, vehicle security, geo-fencing, IoT platform, real-time monitoring, ESP8266 NodeMCU, Wifi

I. INTRODUCTION

The integration of GPS, GSM, and environmental sensors has seen significant advancements in recent years, leading to innovative solutions for real-time tracking, geofencing, and emergency alert systems. A growing number of applications, particularly in safety and security domains, leverage these technologies to provide precise location tracking, immediate communication, and environmental monitoring.

In this literature survey, we examine various works that explore the use of GPS and GSM modules for location-based services, with a focus on their application in geofencing systems. Additionally, we review research on integrating environmental sensors, such as speed detection, to enhance emergency response capabilities. These systems are commonly employed in industries such as transportation, asset tracking, where real-time monitoring and quick intervention are critical.

Through this survey, we aim to identify current trends, challenges, and potential solutions that inform the development of a GPS geofencing system with real-time location tracking and emergency notifications. The objective is to consolidate the knowledge base and highlight the most promising techniques that contribute to the effectiveness of such systems.

II. LITERATURE REVIEW

In [1], the author proposes a Geo-fencing technology to establish virtual geographic boundaries. It finds extensive applications in location-based services (LBS), providing information tailored to the user's location. Geo-fencing involves continuously monitoring a mobile device's position and comparing it to a set of predefined geo-fences. When the device enters or exits a geo-fence, notifications or alerts can be triggered. Geo-fencing employs various positioning technologies, such as GPS, Assisted GPS (A-GPS), Cell-ID, and Wi-Fi, to accurately determine the device's location. Factors like accuracy, tracking rate, device speed, route, and geo-fence size all influence the effectiveness of geo-fencing. Geo-notifications can be static (based on a fixed area), dynamic (based on changing data), or peer-to-peer (based on other users' locations). Applications of geo-fencing span child safety, fleet management, shopping reminders, marine safety, human resource management, compliance monitoring, marketing, asset management, and law enforcement. It operates by continuously calculating the user's position using GPS satellites and comparing it to virtual boundaries defined by latitude, longitude, and radius. Geo-fencing provides a streamlined solution for proximity and buffer analyzes and can be utilized for both static and dynamic mapped objects.

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In [2], the author proposes the paper outlines the development of a mobile attendance application that leverages geo-fencing techniques. The application utilizes the GPS capabilities of Android smartphones to track and record employee attendance in real-time. The geo-fencing approach enables the creation of virtual boundaries for specific locations, allowing the system to determine whether an employee is within the designated work area for clocking in or out. The application presents a user-friendly interface for employees to clock in and out by simply tapping a button. Simultaneously, the system automatically verifies the employee's location and records attendance data, including details such as the IMEI number, GPS coordinates, date, and time. The system also empowers administrators to manage employee information, set location boundaries, and monitor attendance reports. The proposed algorithm efficiently checks if an employee's location falls within the defined geo-fenced boundaries before permitting clock-in or clock-out operations. Overall, the mobile attendance system offers a secure, cost-effective, and efficient solution for tracking employee attendance, particularly for those working remotely or at off-site locations. Artificial Neural Networks (ANNs) have emerged as a robust tool for supervised classification tasks in remote sensing, demonstrating significant success in classifying.

In [3]. The author proposes a study that presents a real-time GPS tracking system that sends GPS data from an Arduino and Sim908 module to a remote server via GSM and GPRS. The location data is displayed on a web application map using Node.js and the Leaflet.js library. The system includes a geofencing feature that alerts the user when the device moves outside a predefined polygon area, which can be static (saved in a database) or dynamic (drawn on the map in real-time). To improve GPS accuracy, the study employs moving average filters, Kalman filters, and logistic regression analysis to reduce the margin of error in the GPS data. The Kalman filter was found to be the most effective in reducing errors, especially in outdoor environments with low building density. The system can be useful for tracking vehicles, children, or Alzheimer's patients, providing real-time location monitoring and geofence alerts.

In [4], The author proposes a paper outlines an innovative GPS-based location monitoring system equipped with geo-fencing capabilities, designed for vehicle tracking and security purposes. This cutting-edge solution seamlessly integrates hardware components such as the ESP8266 NodeMCU, GPS module, and Wifi connectivity with software platforms like Ubidots (an IoT cloud platform) and Google Maps. The GPS module plays a pivotal role in tracking the vehicle's real-time location, with the data being transmitted to the Ubidots platform via the NodeMCU. This integration allows administrators to conveniently monitor the vehicle's whereabouts on Google Maps, which is seamlessly integrated with the Ubidots platform. Furthermore, the geo-fencing feature enables the definition of virtual boundaries, enhancing the system's security capabilities. In the event that the vehicle enters or exits a pre-defined geo-fenced area, the system promptly sends email alerts to designated recipients, ensuring timely notification and enabling swift response. The prototype underwent rigorous real-time testing scenarios, demonstrating remarkable accuracy in location tracking, with an impressive 95% precision compared to mobile phone mapping applications. This innovative system presents an efficient and secure solution for comprehensive vehicle monitoring, theft prevention, and location tracking, bolstered by its robust geo-fencing capabilities.

In [5], The author proposed solution is a technology-driven tracking and monitoring system designed to enhance the safety of women. It utilizes geo-fencing technology to establish virtual boundaries around authorized locations such as schools, workplaces, and homes. The system continuously tracks the user's location via GPS and sends notifications to registered mobile numbers when the user enters or exits these designated areas. In emergency situations, the system can detect unusual motion patterns, trigger an alarm, and automatically capture audio and video evidence. This evidence can then be promptly transmitted to parents or relevant authorities. The application leverages readily available smartphone capabilities, including GPS, accelerometers, and internet connectivity, to provide enhanced security and monitoring for women and children.

By enabling real-time tracking, panic alerts, and evidence collection through a user-friendly mobile interface, this solution aims to address the growing concerns surrounding crimes against women. It offers a proactive approach to enhancing personal safety by harnessing the power of modern technology.

In [6]. The author proposes a paper p in this a Public Bicycle Anti-Theft System based on Beidou (China's satellite navigation system) and geo-fencing technology. By combining Beidou's unique two-way communication function through short messages with the new geo-fencing technology, the system can automatically monitor whether users' bicycles are outside the fence range and conduct alarm tracking. Users can set a virtual fence range through a visualization interface, and the system will send a short message alert to the user when the bicycle goes beyond this range. The user can then check if the bicycle's movement was authorized and take appropriate countermeasures, such as requesting real-time location information to track and retrieve the bicycle. The system uses hardware components like the Beidou core, microcontroller, GPRS, and buzzer for alarm.

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The research results show that the system can effectively reduce the risk of bicycle theft. The paper also discusses potential improvements, such as trajectory correction to enhance positioning accuracy and using pedal-powered generators for a more sustainable power source.

In [7]. The author proposes a paper which discusses an IoT-based Smart Accident Detection and Alert System designed to detect accidents and alert emergency services promptly. The system utilizes sensors like accelerometers, gyroscopes, and GPS to detect sudden changes in vehicle motion and location, indicating an accident. When an accident is detected, the system transmits the location and severity details to emergency services, nearby hospitals, and designated contacts through various communication methods like SMS, email, and push notifications.The system aims to minimize emergency response time, reduce the severity of injuries, and save lives by ensuring quick medical assistance. It can also collect data on driving behavior to identify unsafe practices and improve road safety. The system is versatile, integrating with other IoT devices and autonomous vehicles for enhanced functionality. The text highlights the rationale, literature review, existing systems, requirements, system specifications, architecture, implementation, future enhancements, and the potential impact of such an accident detection and alert system.

[8]. This paper presents a real-time GPS tracking system that uses Arduino and a SIM908 module to receive GPS data and send it to a remote server via GSM and GPRS. The system displays the location on a web application map and implements geofencing, alerting when the device moves outside a predefined area. The geofence area can be a static polygon or dynamically drawn on the map. To improve GPS accuracy, the study explores techniques like moving average filter, Kalman filter, and logistic regression analysis to reduce the error margin caused by factors like weather, atmospheric conditions, and signal reflections. Experimental results show that the Kalman filter is the most effective in reducing errors.

In [9]. The author proposes a paper which presents a GPS-based location monitoring system with geo-fencing capabilities to provide efficient vehicle tracking and prevent theft. The system integrates hardware components like the ESP8266 NodeMCU and GPS module with software components like the Ubidots IoT cloud platform and Google Maps. The admin can monitor the vehicle's location on Google Maps via the Ubidots platform and receive email notifications when the vehicle enters or exits a pre-defined geo-fenced area. The system was tested in real-time scenarios, and the results showed accurate location tracking with an accuracy of around 95% compared to real maps. The geo-fencing feature effectively triggered alerts when the vehicle crossed the virtual boundaries, enabling enhanced security and monitoring capabilities. Overall, the proposed system offers a reliable and efficient solution for vehicle tracking and theft prevention by leveraging GPS technology and geo-fencing capabilities.
systematic literature review, analyzing peer-reviewed articles

In [10]. The author proposes This research work presents a vehicle anti-theft protection system that combines GPS tracking, GSM communication, and fingerprint verification. The system utilizes an Arduino microcontroller integrated with a GPS/GSM module (SIM908) and a fingerprint scanner (GT-511C1R). When the vehicle moves beyond a predefined geo-fence (100m radius) without proper fingerprint verification, the system sends an SMS to the owner's cell phone with a Google Maps link containing the vehicle's current location. It continues sending updated location coordinates every 10 seconds until fingerprint verification is provided. Additionally, the owner can request the vehicle's location anytime by making a missed call. The implemented system offers enhanced security for vehicle theft prevention at a relatively low cost compared to other solutions.

In [11]. The author proposes a paper which presents a geo-fencing technique using Internet of Things (IoT) and GPS for preventing human kidnapping. The proposed system leverages geo-fencing to define a virtual boundary and detect when a subject (individual being monitored) enters or exits that boundary. When the subject exits the boundary, location signals are transmitted to trackers via a web application and mobile devices. The system uses GPS to track the subject's movement and location, plotting their path on Google Maps. It incorporates features like safe code verification, path tracing, distance/time calculation, and remote reporting to security agencies. The system was implemented using .NET Framework, C#, Xamarin, MySQL, and Google Maps API. A case study involving 50 individuals from urban and remote areas was conducted to evaluate the system's performance. Survey results showed that users acknowledged the system's accurate location detection, timely notifications, concealed monitoring, energy/data efficiency, and reliable path tracing. The proposed system demonstrated practical applicability for concealed monitoring and prevention of kidnapping, outperforming existing works in areas like availability, portability, and durability.

In [12]. The author proposes a paper which presents a quarantine monitoring system based on geo-fencing technique and GPS-GSM tracking system. It proposes a tracking system consisting of a GPS module, GSM module, and Arduino microcontroller to monitor individuals in quarantine. The system determines the location of the person using GPS and

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sends the data to a server via GSM. A mobile application with geo-fencing technology is used to track the person and alert if they leave the designated quarantine area.The proposed system is designed as an application to implement a home quarantine policy during the COVID-19 pandemic in 2020. It utilizes wristbands that match the boundaries of smartphones to monitor the quarantined individuals. The system achieves accurate performance under various conditions, allowing for efficient tracking and enforcement of quarantine measures. It can be concluded that the proposed system provides a cost-effective and convenient solution for separating a large number of individuals at risk compared to dedicated monitoring centers.

In [13]. he author proposes This project aims to develop a smart parking system that leverages geofencing and GPS technologies to enhance vehicle security and optimize parking management. The system comprises three interconnected applications: a web app for parking owners, a mobile app for car owners, and a vehicle app for real-time location tracking. The web app, built with React and Map box SDK, allows parking owners to map and visualize parking lots using geofencing. It integrates with Firebase's Realtime Database for tracking car locations and Fire store for storing parking details. The car owner's mobile app, developed with React Native, enables users to view available parking spaces, register for spots, and access real-time car location data from the database. The vehicle app, utilizing the Expo library, continuously updates the car's location in the Realtime Database, laying the foundation for future security integrations. The system employs advanced algorithms like the point-in-polygon algorithm to validate a vehicle's location within a geofenced area. When a vehicle exits a predefined geofence, the system triggers an alert notification to the car owner, enabling prompt tracking and security measures. The project also incorporates license plate detection using techniques like Haar cascade classifiers and OCR for enhanced parking management and security. Through this comprehensive solution, the project aims to streamline parking operations, optimize space utilization, and enhance security measures, ultimately providing a more efficient and stress-free parking experience for both parking owners and car owners.

In [14]. The author proposes a paper which an IoT application using geofencing technology to protect crops from wild animal intrusion. The system consists of an ultrasonic sensor to detect wild animals, an LTE module for wireless communication, a GPS module for location tracking, and a mobile application that sends notifications to farmers in real-time. A hardware prototype was developed and tested in the lab, demonstrating the system's ability to detect intrusion and transmit data to a Firebase database, which then triggers a notification on the farmer's mobile app. The mobile app utilizes the Google Maps API and Geofencing API to display the farm location and create a virtual fence around it, respectively. When the farmer enters the geofenced area, notifications are temporarily disabled. Performance evaluation showed an average delay of 1.57 seconds in receiving notifications, which is acceptable. The proposed system aims to minimize crop losses by providing farmers with real-time alerts about wild animal intrusion into their farm fields.

In [15]. The author proposes a paper which discusses the implementation of geo-fencing to monitor a specific target using the Point in Polygon algorithm. Geo-fencing involves creating a virtual boundary or fence around a physical area using GPS or RFID technology. The proposed system utilizes NodeMCU and a GPS module (Neo 6M) to track the target's location and determine whether it is inside or outside the defined geo-fence. The Point in Polygon algorithm calculates the sum of angles between consecutive lines drawn from the target point to the vertices of the polygonal geo-fence. If the sum equals 360 degrees, the target is inside the fence; otherwise, it is outside. The system displays the target's location, status (inside/outside), and triggers an alarm if the target is outside the geo-fence. Potential applications of this system include cattle grazing management, vehicle theft control, child safety, agriculture, and forest monitoring. The results show approximately 95% location accuracy compared to actual mobile phone data.

III. SUMMARY

The collection of studies explores advancements in Gps technology with a focus on geofencing, real-time location tracking, theft detection, message alerts. The key findings from the studies are summarized as follows:

SL No.	Technologies Applied	Results
[1]	Geo-fencing technology to establish virtual geographic boundaries	provides a streamlined solution for proximity
[2]	geo-fence technique	Keep track staff attendance records
[3]	Geofencing technology	Sends alert messages

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[4]	Ubidots (an IoT cloud platform) and Google Maps.	Tracks vehicles location
[5]	Gps technology	SMS-based tracking to urge an exact location
[6]	Beidou's unique two-way communication function And gps technology	The system can effectively reduce the risk of bicycle theft
[7]	Internet of Things (IoT) technology	Increases the possibility of saving lives in case of accidents
[8]	Gps technology	Tracks a the child and reduces false alarams
[9]	Internet of Things (IoT), Gps technology, maps	help to reduce the problem of vehicle theft and provide an accurate tracking system.
[10]	combines GPS tracking, GSM communication	can request the vehicle's location anytime by making a missed call
[11]	Gps technology, Iot	Prevents human kidnapping
[12]	Gps technology with a mobile application	track the person and alert if they leave the designated quarantine area.
[13]	Gps, geo fencing technology	Provides real time information about parking availability
[14]	LTE network Communication geofencing technology	Protecting crops from wild animals, and sends alerts.
[15]	*GPS technology, RFID*	Designed system provides accurate status of the target device, and can track the location via mobile application

IV. CONCLUSION

The GPS-based location monitoring system with geo-fencing offers an efficient solution for vehicle theft prevention and real-time location tracking, monitoring speed, damage and weight of the load. By integrating hardware like ESP32, NodeMCU, GPS modules, speed sensor, tilt sensor and IoT platforms with mapping technologies, it delivers a user-friendly experience. Real-time alerts and geo-fencing empower administrators with enhanced control, ideal for fleet management and route compliance. Testing demonstrated excellent results for this system. It can monitor position and navigate vehicles with at most accuracy. This positioning and navigation capability offers utility for monitoring vehicle location along with speed ,damage,and weight of the load.

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