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GEO Fencing System Using Machine Learning

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ABSTRAC T

Geofencing, also known as geo-fencing, is an excellent feature found in software programs that makes use of Global Positioning System (GPS) or radio frequency identification (RFID) to establish geographical boundaries. Essentially, a geofence is a virtual barrier. It employs GPS, Wi-Fi, and cellular data to precisely monitor the location of the user's device. Real-time location tracking is used to ensure prompt detection of boundary crossings. It enables users to set geographical boundaries (geo-fences) on a map interface. It supports various shapes for geo-fences, including circular, rectangular, and custom polygonal areas. This project explores the integration of machine learning with geo-fencing technology to create more intelligent, adaptive location-based systems. Traditional geo-fencing relies on fixed boundaries and manual triggers, while this approach uses machine learning to analyze location data, predict behaviors, and automatically adjust geo-fences in real-time.

KEYWORDS: Accurate Tracking, Boundary Detection, Interactive map, Machine learning, Magnetic field.

1. INTRODUCTION

The location-based services (LBS) have recently undergone a massive shift in popularity. While the first generation of LBS has not attracted much attention in recent years. Information about the geographical location of a mobile device is used in various fields, including computer software and physical security. Most current technologies focus on pinpointing the user's exact location using the Global Positioning System (GPS) outdoors. Another approach to location-aware computing is to focus on the user's presence within a virtual perimeter of a specific geographical area, complementing the first approach known as Geo-fencing, which has numerous benefits. Geo-fencing denotes a virtually enclosed geographical area and has been utilized for tasks such as controlling equipment theft, tracking, and automatic house arrest monitoring systems, as per almomani (2011). Location-based services, including geo-spatial networking, have introduced new ideas and use cases through social networks. Additionally, various techniques are being researched to enhance the robustness and security of such systems, with a focus on developing a geofencing system for theft control, house arrest, and event management using Android phones.

Geo-fencing using machine learning is a modern approach that combines geographical boundaries with intelligent systems to create automated, context-aware solutions. A geo-fence is a virtual perimeter for a real-world geographic area, which could be a radius around a location or a defined boundary such as a city, building, or campus In this project, machine learning is applied to enhance the functionality of geo-fencing by making decisions based on patterns, predicting movements, and responding to dynamic changes. Traditional geo-fencing systems rely on predefined coordinates and rules, but with machine learning, the system can adapt to user behavior, optimize boundary precision, and manage real-time inputs. For instance, machine learning can improve how geo-fences are triggered by learning the typical movement patterns of people or objects, reducing false alarms, and increasing accuracy. This is particularly useful for applications in security, logistics, marketing, or any context that requires location-based intelligence. By leveraging data from GPS, Wi-Fi, Bluetooth, or cellular networks, the system can intelligently classify zones, detect anomalies, and automatically adjust to changes, offering smarter and more responsive location-based services.

The project "Geo-fencing using Machine Learning" focuses on improving traditional geo-fencing systems by incorporating machine learning techniques. Geo-fencing allows the creation of virtual boundaries around a physical location, triggering specific actions when devices cross these boundaries. By using machine learning, the system can adapt to user behavior, predict movements, and fine-tune the geo-fences in real-time, resulting in greater accuracy and responsiveness. This enhanced approach is particularly useful for applications in areas such as security, logistics, and location-based marketing.

3.LITERATURE SURVEY:

OnTrack: development and feasibility of a smartphone app designed to predict and prevent dietary lapses. Translational Behavioral Medicine [1]. Open-source smartphone app and tools for measuring, quantifying, and visualizing technology use [2]. A simple location-tracking app for psychological research. Behavior Research Methods [3]. Using geofences to collect survey data: Lessons learned from the IAB-SMART study. Survey Methods [4]. Geofencing technology has become increasingly popular, allowing businesses and organizations to target specific audiences based on their specific location. Geofencing use cases extend beyond marketing and advertising, with applications in sectors such as logistics, security, agriculture, and so much more [5,6]. Data Quality Issues: Geolocation sensor data may have missing data and measurement quality issues (Bähr et al., 2020) [7]. Behavioral Interventions: Geofencing can predict and prevent dietary lapses through smartphone apps (Forman et al., 2019) [8]. In a follow-up project was developed to avoid getting lost while travelling. There is another study in the form of a system that prevents intruders from entering [9]. There are also studies developed on Arduino. [10] In the study where Telit-gl865 device and GPS click device were used, the only tracking system was developed. In another study developed with Sim900 device, [11] geofencing features were added. This application operates based on the mobile user's location in relation to other users. For instance, a person might receive notifications about nearby friends on social media apps such as Facebook, Instagram, or Foursquare, as suggested by Sachin W. Rahate [12]. In fleet management, when a truck driver deviates from their route, the dispatcher receives an alert. This is implemented in fleet management using Geo-Fencing [13]. "Support Vector Machine" (SVM) is a supervised machine learning algorithm that processes data for classification or regression challenges in geo-fencing applications for disaster and college applications. It is also utilized in classification problems when a user enters a location, after which the application algorithm operates, as explained by Ithipan Methasate [14]. A simple method to draw a 100-foot radius circle on Google maps is specified using APIs during mobile app development. This Geo-fence then triggers a response when an authorized device enters or exits that area, as determined by the administrator or developer, as proposed by Ankita Sakore [15]. The geographical region defined by a circle within a specified radius around a point on Earth is known as the geographic region area. Each time a user of the application crosses the boundary of the region, the system generates an event, as proposed by Komal Wagh [16]

4.METHODOLOGY:

Gather location-based data from GPS, Wi-Fi, or other sensors, along with behavioral data like movement patterns. Clean and organize the data to ensure accuracy and remove noise. Use machine learning algorithms (e.g., classification, clustering) to learn patterns, predict behaviors, and define dynamic boundaries. Integrate the trained model into the geo-fencing system to trigger actions based on real-time location inputs. Continuously monitor and improve the model based on performance, reducing false triggers and optimizing accuracy.

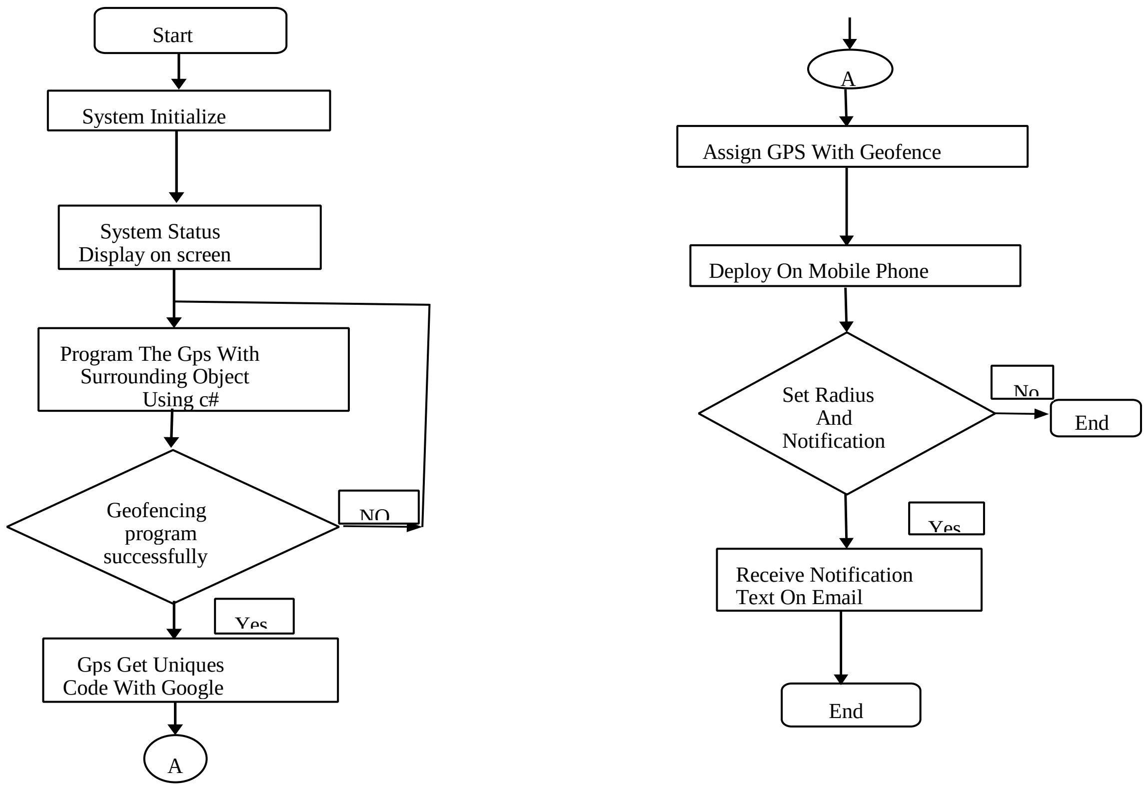

Figure 1. System Architecture Geo Fencing

Explanation:

1. Start

The process begins with the initial step of starting the system.

2. System Initialize

The system initialization involves setting up necessary hardware and software components required for the geofencing operation. This could include starting services, loading configurations, and preparing the environment for further actions.

3. System Status Display on Screen

Once the system is initialized, its status is displayed on the screen. This may include details about the current state of the system, any errors encountered, or confirmations that all components are functioning correctly.

4. Program the GPS with Surrounding Object Using C

In this step, the GPS device is programmed using the C programming language. The programming involves configuring the GPS to recognize surrounding objects and establishing geofencing parameters. This setup allows the system to detect when an object enters or exits a defined area.

5. Geofencing Program Successfully?

After programming the GPS, the system checks if the geofencing setup was successful:

No: If the geofencing program was not successful, the process terminates, and troubleshooting may be required.

Yes: If the geofencing program was successful, the process proceeds to the next step.

6. GPS Gets Unique Code with Google

The GPS device is assigned a unique identifier code using Google services. This unique code helps in distinguishing between different geofences and ensures accurate tracking and management of multiple geofences.

7. A (Connector to Right Path)

The successful setup leads to a transition (denoted by "A") to the next phase, which involves deploying the geofencing system on mobile devices.

Right Path: Assign GPS with Geofence to Notification

1. Assign GPS with Geofence

The GPS device, now equipped with a unique code and geofencing capabilities, is assigned a specific geofence. This involves defining the virtual boundaries within which the GPS will monitor and detect movements.

2. Deploy on Mobile Phone

The geofencing setup is then deployed on a mobile phone. This deployment includes installing necessary applications, configuring settings, and ensuring the mobile device is ready to receive geofencing data and alerts.

3. Set Radius and Notification

The user sets the radius for the geofence, determining the size of the monitored area. Notifications are also configured in this step to alert the user when the geofence boundaries are crossed:

No: If the radius and notifications are not set, the process terminates.

Yes: If the radius and notifications are set, the system proceeds to the next step.

4. Receive Notification Text on Email

The system is configured to send notification texts to the user's email address. These notifications alert the user when the geofence boundaries are crossed, providing realtime updates on movements within the defined area.

5. End

The process successfully completes with the geofencing system fully operational. Notifications are set up, and the system is ready to monitor the geofence and send alerts as configured.

4.1.Existing System

1.Overview:

Current Technology: The existing systems for geo-fencing often involve GPS and location-based services integrated with mobile applications. These systems can track users' location and trigger specific actions based on pre-defined geographical boundaries.

Platforms: Geo-fencing is commonly used in mobile apps on iOS and Android platforms.

Functionality: Typical features include location tracking, alerts/notifications when entering or exiting defined zones, and integration with maps for visual representation.

Accuracy: Ensuring accurate location tracking and boundary detection can be challenging.

Battery Consumption: Continuous location tracking can significantly drain the battery.

Privacy Concerns: Handling location data requires stringent privacy and security measures.

2.Feasibility Study

Operational Feasibility:

User Interaction: The system should be intuitive and user-friendly. Users should easily set up and modify geo-fences and receive notifications.

Integration: The geo-fencing feature must seamlessly integrate with existing app functionalities, such as notifications and user profiles.

Support: Adequate support should be available to handle operational issues and user queries related to geo-fencing.

Technical Feasibility:

Technology Stack: Using React Native with libraries like react-native-background-geolocation or react-native-geofencing can facilitate the implementation of geo-fencing. These libraries offer features for location tracking and geo-fencing.

GPS Accuracy: Ensure that the app can handle various GPS accuracies depending on the use case (e.g., street-level vs. building-level accuracy).

Background Services: Implement background services to handle geo-fencing when the app is not in use, while being mindful of battery consumption.

Platform Compatibility: The solution should be compatible with both iOS and Android platforms, considering their respective geo-fencing APIs and limitations.

Economic Feasibility:

Development Costs: Include the cost of development, testing, and deployment. Costs will vary based on the complexity of the geo-fencing features and the need for custom development.

Maintenance Costs: Ongoing costs related to app maintenance, updates, and support.

Return on Investment (ROI): Assess potential benefits, such as increased user engagement and retention, improved user experience, and any monetization opportunities from geo-fencing features.

3. Summary

Objective: Implement a geo-fencing feature to enhance user engagement by providing location-based notifications and services.

Approach: Utilize React Native libraries to integrate geo-fencing capabilities, ensure cross-platform compatibility, and address operational, technical, and economic considerations.

Challenges: Address issues related to accuracy, battery consumption, privacy, and integration with existing systems.

Prototype Development: Create a prototype to test the geo-fencing functionality and gather user feedback.

Testing: Conduct thorough testing on both iOS and Android platforms to ensure reliability and performance.

Deployment: Prepare for deployment and monitor the system's performance to make necessary adjustments based on user feedback and operational data.

4.2 Algorithms And Defination:

a. Haversine Algorithm:

The Haversine formula is used to calculate the shortest distance between two points on the surface of a sphere, based on their latitude and longitude coordinates. It assumes the Earth is a sphere and computes the great-circle distance between two points, making it ideal for determining if a location (such as a GPS coordinate) falls within a circular geo-fenced area. The formula accounts for the curvature of the Earth, providing more accurate distance measurements over longer ranges compared to simple planar geometry.

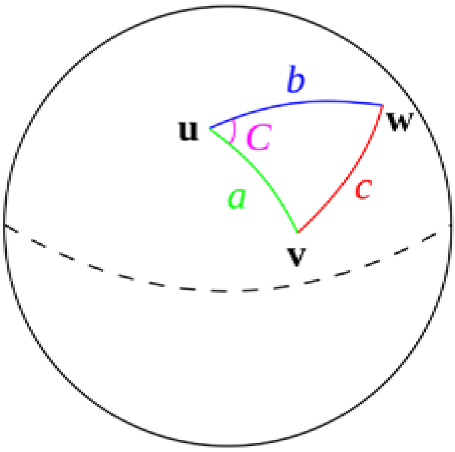

Figure.2 Haversine Algorithm Formula

cos (c) = cos (a− b) + sin (a) sin (b) cos (C) In spherical units, a "triangle" on the surface of a sphere is defined as the large circle connecting the three points u, v, and w on the sphere. If the lengths of the three sides are (from u to v), b (from u to w), and c (from v to w), and the opposite point of view c is C .

5.RESULTS:

The results of a geo-fencing project using machine learning typically show improved accuracy and efficiency compared to traditional methods. The machine learning model can dynamically adjust geo-fence boundaries, reducing false positives and enhancing responsiveness to real-time location data. It can also predict movements, improving decision-making for location-based actions. Overall, the system becomes more adaptive, reliable, and scalable, offering better performance in areas like security, marketing, and resource management.

5.1Objective:

Let's create a simple and safe Geo-fencing that uses find the admin location. This system makes it easy to sign in with a mobile number of using passwords. It's all about making things safer and more convenient.Components used are as follows:

User Registration:

Information Collected:

Name

Mobile Number Password

5.2Login Process:

First here user will fill the registered mobile number and the here password will b e required then the login process will done and next will go to the fencing location are of admin.

SCREENSHOT

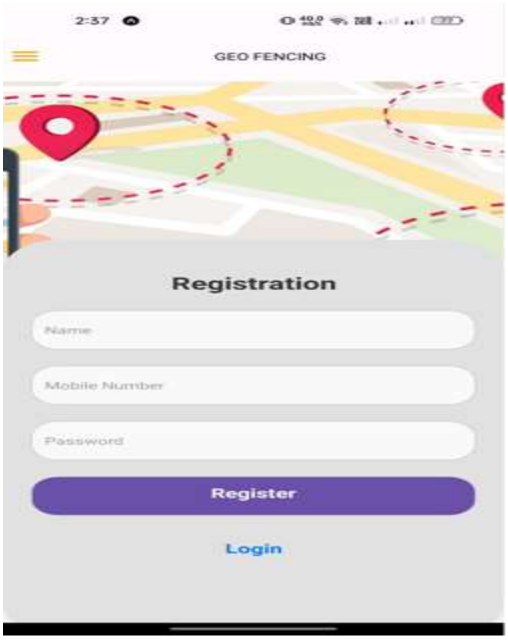

Fig.3. Registration

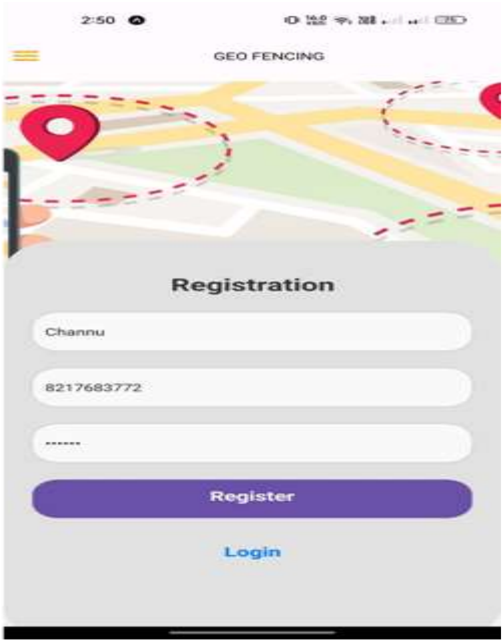

Fig.4. Registration process

Explanation:

In the shwon above (Figure 3), the user will initiate the registration process since the admin does not possess the login credentials. Therefore, the user will complete the registration using a username and mobile number. Following this, the admin will establish their password for security reasons after the registration is completed. In the subsequent step (Figure 4). the admin will provide comprehensive details for the registration, including admin name, admin mobile number,

and password setup, thus finalizing the registration process.

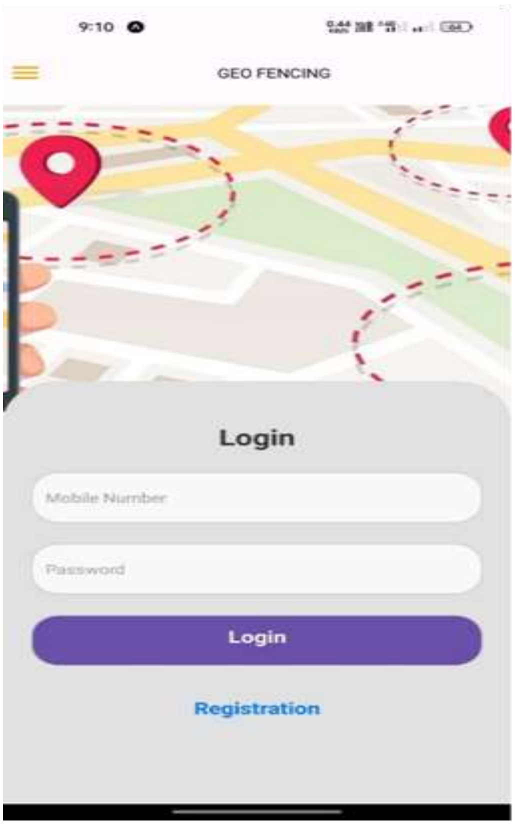

Figure.5. Login process

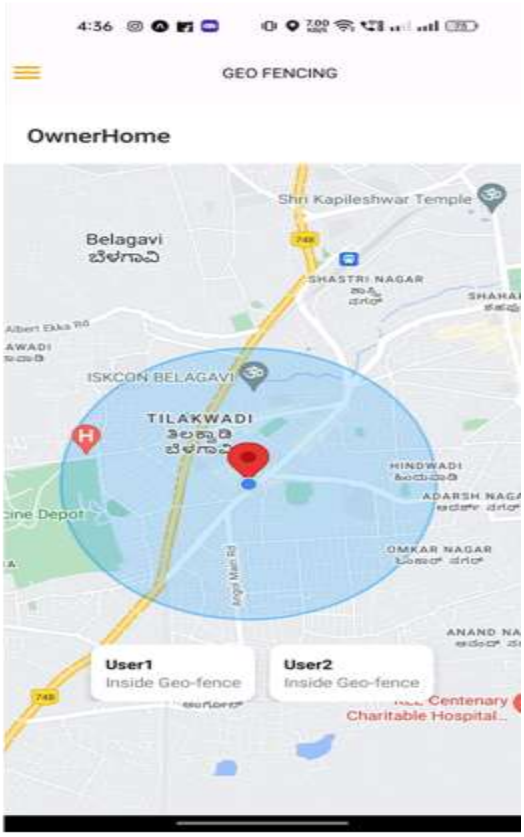

Figure.6. Fencing Area

Explanation:

In the shown above (Figure 5), once the registration process is completed, the login page will be displayed. The admin will login using the registered mobile number. After logging in, the admin may be directed to the fencing area, which represents the admin's location. In the final output of the project (Figure 6), the admin's live location is displayed. When a user logs in, the admin receives information about the users. Upon user login, the admin is notified whether the user is inside or outside the Geo-fence.

6.CONCLUSION

Geo-fencing has been successfully implemented by integrating its capabilities into the React Native app to monitor user locations in relation to predefined areas. The app has been configured to respond to user movements into or out of geo-fenced zones by triggering actions such as sending push notifications or updating application data The app's functionality has been improved by providing location-based services, thereby increasing relevance and engagement for users. It's important to note that geo-fencing can significantly consume battery power due to constant location tracking. High accuracy in location detection and geo-fencing boundaries is being ensured We are also focused on managing user privacy and ensuring data protection while utilizing location data. The integration of geo-fencing capabilities into the React Native app has enabled the monitoring of user locations in relation to predefined areas. The app has been programmed to initiate actions such as sending push notifications or updating application data when users enter or leave geo-fenced zones. By offering location-based services, the app's functionality has been enhanced to increase relevance and user engagement. It's crucial to consider that continuous location tracking for geo-fencing purposes can have a significant impact on battery life. We are ensuring high accuracy in location detection and geo-fencing boundaries. Our focus also includes safeguarding user privacy and data protection when utilizing location data.

FUTURE WORK:

Future developments for a geo-fencing project using machine learning could involve exploring more advanced algorithms to improve prediction accuracy and adaptability. This could include incorporating deep learning for better handling of complex patterns in large-scale data. Additionally, integrating real-time data from more diverse sources, such as IoT devices or 5G networks, can enhance precision. Another area for future development is improving the system's ability to handle dynamic environments, such as changing geographical conditions or new user behaviors, making the system more flexible and autonomous in various applications.

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