

# GNL: GeoFencing Based Smart Outdoor Navigation and Localization

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**Abstract:** Navigation is a technique used by humans to construct a plan to help them travel within a place using instruments or maps. Navigation in the modern age is done using various electronic systems which provide a real-time map of the place and the step-by-step directions to the desired destination. The technology widely used today is GPS i.e. Global Positioning System. Outdoor navigation using Google maps, here maps or safari is a common go-to for the users but the problem is the map provided by these companies just has an overview of the place and not the detailed information. The GNL approach which authors have used in this paper focuses on the navigation and localization of the gated environment so that the person living and visiting the area will get familiar with the area and understand the area very well. The web app that authors have designed can be used for the College Campus, Fairs, open museums, etc. Comparative analysis of the web app-based approach is done with an existing one. The Presented approach will not only help you in navigation but also provide you with information about the POI (Point of Interests) of those visiting places. The Geofence mechanism will help users to navigate and get information about the area. The aim is to give the user the maximum information about the place with secured transfer of information and better localization. The authors have tested the approach on the real testbed in the gated society and it provides good results for what it promises.

**Keywords:** Smart Tour, Outdoor Navigation, Geofencing, localization

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## I. INTRODUCTION

Geo-fencing (geo-fencing) is a function in software program that make use of the global positioning device (GPS) or radio frequency identification (RFID) to outlines geographical boundaries. Geo-fence apps and in equipment display when objects enter or exit a hooked up geo-fenced place and give signals or notifications for a device. These indicators can be in structure of textual content messages, email notifications, telephone calls or other modes of communication.

Geonotification performs a very essential role in geo-fencing. Generally geo-fencing refers to the notion in which the user defines the boundaries genuinely over a geographical area, and as soon as the transition is detected over a boundary the notification is sent. In [13] authors described that the development in navigation tools has become a source of planning reliable routes. In [14] authors describes the development in the Global Positioning System and data collection from numerous mobiles had brought a satisfying development in the Outdoor navigation system.

GPS System is widely used in various different devices like Mobile, Car, Bike, Ship, etc. The only drawback is the accuracy of the GPS, so the internet is also used to locate and get the more precise location of the device. In [20] authors describe outdoor navigation is a boon for humankind, but the rise of buildings and structures had also brought the importance of Indoor navigation.

In [2] authors also stated that indoor navigation depends on Bluetooth and Wi-Fi transmitters and receivers.

The restaurant enquiry is instance of pull type. Location-based offerings (LBS), additionally regarded as vicinity services, cellular location-based service.

The web application will be very useful for people for easy navigation in unfamiliar surroundings. The authors also tried to ease the navigation and give the best experience using the Object detection method. The Web app that the authors have proposed can be used on any campus, fairs, or museum. With the use of a web app, the user not only navigates but also gets to know the surrounding and understand the place. Here it becomes easy for users to keep track of their traveling and the places visited. Visually

impaired users can also use a navigation system application developed which is based on the GPS system. The paper is about the approach which is based on IoT in Smart Navigation. The approach introduced a web application form where the user can navigate the Gated environment easily and can save time. Various application scenarios will help the new students/visitors to explore the Campus freely without taking help from others and if they are lost somewhere our application will help them to bring them to the right path/direction again. This smart navigation system guides outdoor navigation by using geofencing that would help them to navigate better.

## II. LITERATURE REVIEW

In [1] authors explained about the problem which requires managing and operating an NFC-enabled mobile device. Due to advancements in technology that brought NFC technologies in most of today's phones, but still, there are some phones which don't have this feature. This technology does not give exact information about your location at every point, it guides you through the locations and gives you the instructions for the same. In [2] the authors have written about the method of Wi-Fi RSSI fingerprint localization. WiFi-based indoor localization is attractive, but expensive and efforts are needed to make it simple. The Challenge they faced was, the mathematical technique used for calculating the position of a receiver from signals received from several transmitters is the triangulation method. In [3] author states the disadvantages of signal in indoor environment. The Challenges where the System does not have message sending protocols for Points of interest. The system will crash if the MQTT broker hosted by Raspberry Pi 3B+ crashes. There is no offline mode to this if the internet connection goes off.

In [4] authors states about the problem statement which is focused on creating and working on geofences. The author has given complete details about the location-based service, what is geofencing and how geofencing works. The gaps and challenges in [4] are Creating Geo-fences, matching user coordinates to the geofence coordinates, and Sending geo-notification. In [5] author states Problem is focused on creating a system where the notification will be generated to both the admin and user as per requirement and live data(positioning). The authors tried to develop a general-purpose notification service. This development also helps us understand better about proximity detection systems. For providing this service they have used a Notification Processor, Intelligent Notification System which comes as a part of the commercial version of IBM's WebSphere family. The gaps and challenges are stated by authors in [5] the Personalization of notifications, this will require some interface to notify. It is important to give the users the wanted satisfaction with the minimal level of annoyance.

In [6] the authors state the Problem which is focused on the next-generation of Geofencing on the mobile application. In [7] the improvised RSSI-based Trilateration technique for indoor positioning is given by authors. In [8]

the authors have written about a system for tracking mobile devices and locating them inside a building's perimeter. In [9] authors suggest about developing and designing an indoor positioning monitoring application device with the best possible features. Due to signal loss within the interaction with building walls, the signal is lost indoors, GPS is not recommended. In [10] authors analyzes the various algorithms for finding the position of objects and for navigating in an indoor environment using the shortest path. Smart cities, robots, and visually disabled people are all in need of indoor navigation systems. Although the G-P-S are commonly used for navigating to a variety of software, the signals cannot be absorbed by building walls, and GPS can't be used for indoor nav systems. As a result, alternative navigation approaches such as Wi-Fi, sensors, and Bluetooth must be used.

In [11] authors presents a two-dimensional (2D)/three-dimensional (3D) simultaneous localization and mapping (SLAM) algorithm for ordinary indoor environments that use directional features. In [12] authors state a Real-Time Object Detection with YOLO has been introduced. The authors tried to implement the YOLO algorithm in this paper and tried to increase its accuracy to detect multiple objects in an image. This method gives us various advantages over different object detection methods like CNN. In [13] the authors proposed a new approach for object detection based on Convolution Neural Networks and LSTM. The Gaps and Challenges faced are Uncommon in navigation which leads to the formulation of problem statement Is there any scheme to incorporate the feature of Navigation, localization based on the Geo Fencing and also incorporation Image based Object detection and learning about the environment. In this paper the authors has come out with solution it contains the following sections Section2 which discusses work related to Localization and navigation techniques by different authors. Section3 briefly describes the comparative analysis of scheme suggested by authors with the existing one stated by authors in the related work Section 4 provides the Geofencing Based navigation approach and its real testbed results and application scenario which fulfill the gaps and challenges stated in the problem statement above. Section 5 provides the conclusion and also suggests the future scope of the present work.

## III. COMPARISON TABLE:

Sr. No	Approach	Localiza tion	Naviga tion	Visual Feed Knowledge	Web based
1	In [16] the author states, spatial analysis-based Navigation.	Yes	No	No	No
2	In [17] Authors states about Augmented reality based approach for navigation is defined.	No	Yes	Yes	No
3	In [10] authors	Yes	No	No	Yes

	states about the LBS based on geofencing.				
4	In [17] the author states, General purposes services application which is using location based approach.	Yes	No	No	Yes
5	In [6] author states, Location based Infrastructure-assisted Services.	Yes	Yes	NO	Yes
6	In [19] author states about the application of flying robots using Vision based approach.	Yes	No	Yes	No
7	In [18] the author states about campus guided tour based on robust localization algorithms.	NO	Yes	Yes	No
8	Our approach of Outdoor navigation, we are using geofencing and html geolocation to get user exact location and also help in Navigation. We also have option to take photo and get information, so that user can get information of the area he wants to know about.	Yes	Yes	Yes	Yes

IV. GNL NAVIGATION AND RESULTS

GNL: Geofencing-based navigation and Localization scheme is defined. Using this scheme authors have designed a web app that is divided into three major parts:

1. Explore: It helps other users to know the (Point of Interest) POI's in the locality and display it on the dashboard so as to get information about the area directly without actually visiting the place.
2. Navigate: The user wants to navigate from one place to another. The navigation app section will help the user to go

from his location to the desired location in the gated environment.

3. Geo-Fencing: When the person is exploring the surrounding area the geo-fence will help him to get the information about the exact surroundings. The information will be popped up on the screen as soon the users enter the geo fence area.

4. The feature of Object Detection (using YOLO Algorithm)—using which users can click the photo of the surrounding while navigating and the scheme presented by authors will give them the information about the place (photo). This feature makes our application a complete solution for the Navigation System.

The geo-fence mechanism triggers an action when a device enters a set location. The geofencing mechanism will help users to understand the location well. The virtual fencing will be done in the gated environment for which the author states the GNL scheme-based web app is designed. Now as the person enters the geo-fence the popup of the person will be displayed so that the user can understand the Point of Interest. The pictorial representation will make sure the person that the right information of the right place is displaced to him.

The user is also given a choice where a user can upload a picture to get the information about the surrounding. This will make the application more convenient, as the user now can also get information of the area. Web app demonstrated by authors helps users to know their surroundings; it makes users remember the place too.

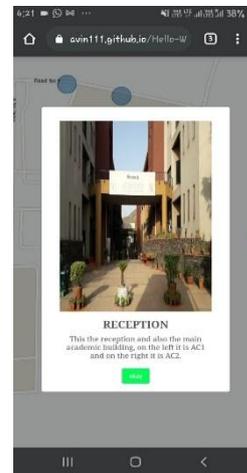


Fig 1. Shows the Pop-up as the user enters the geo-fence

All three components help users to get to know the place well and understand the surrounding accordingly.

Results Evaluation:

Step 1: After Entering the gated society, the user has to scan a QR code which will redirect the user to authors Web App login page



Fig. 2. The QR code for our website.

*Step II :* The user needs to log in using their credential ID and fill up details to register as a visitor in the gated society.

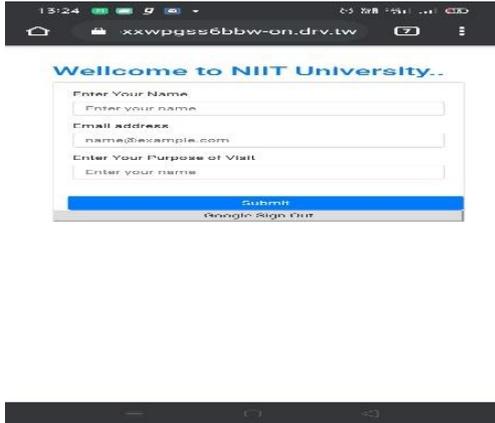


Fig. 3. The registration page of the website.

*Step III:* After registration, the user battery status of the mobile device is checked. If the user phone battery is below 45%, then the user is suggested to do the virtual tour. If the battery is more than the user is directed to the selection page.



Fig. 4. The battery status page of the web app.

*Step IV :* On the selection page user is given two options, Virtual and Interactive Tour. If the user takes a virtual tour, the user will be shown videos of the gated area. If the user chooses interactive, then the user will be redirected to the Home Page of the Web app.



Fig. 5. The selection page of the web app.

*Step V:* The homepage of the web app has 3 options, which are already mentioned below. The user needs to select as per his need.



Fig. 6. The Homepage of Web-app.

*Step VI:* The user clicks on Explore Menu then the user will be shown the surrounding area and the interesting point of interest in the gated society. Users can check out all the places without actually visiting the place and get the desired information.

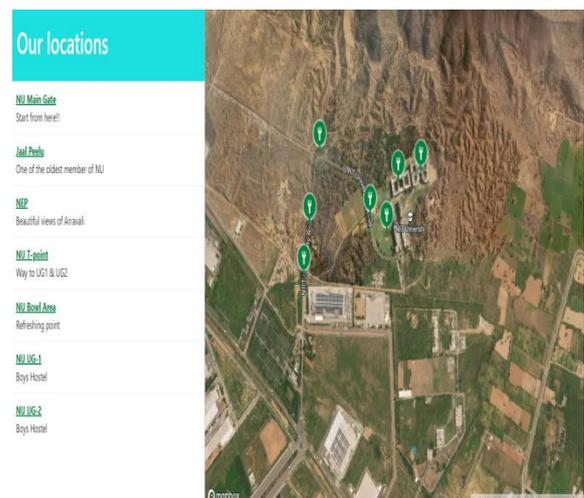


Fig. 7. Explore Page of Web-app.

*Step VII :* Before clicking on NavigateMenu the user has to turn on the GPS for accurate tracking. Users can select the destination, and the roadmap will be displayed on the screen.

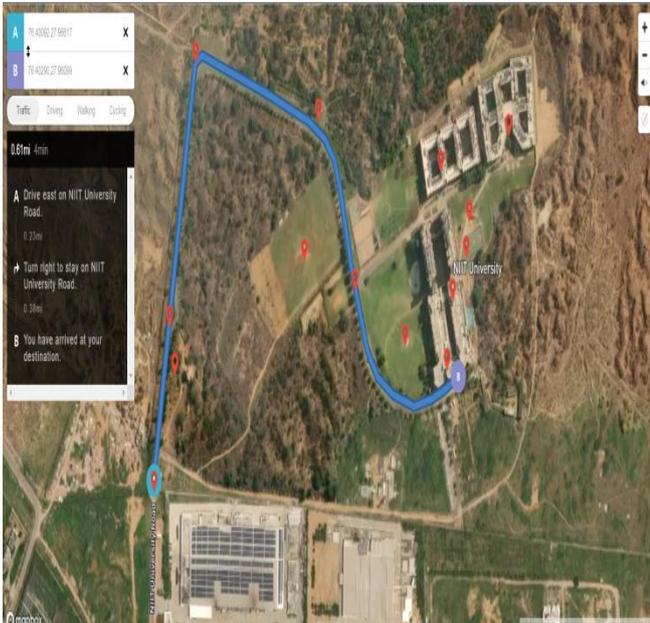


Fig. 8. The navigation map of web-app.

*Step VIII:* If the user clicks on Geofence Menu then the user roams freely around the geofenced area and while exploring new areas, the pop-up will be displayed on the screen as the user arrives at a POI or geo-fence location. The information about the location will be displayed with the picture.

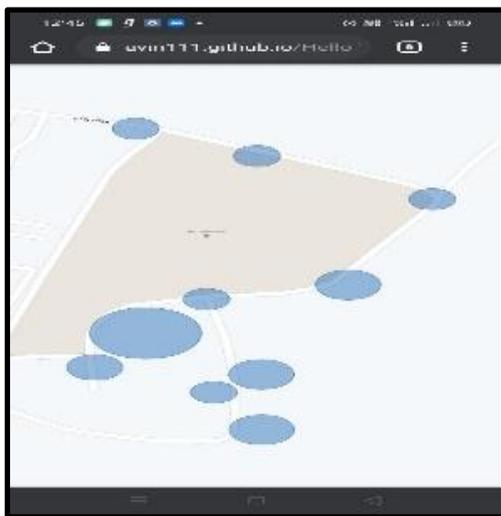


Fig. 9. The Geofencing based map of web-app.

*Step IX:* The click-a-photo feature will help the user to get information about the monument, place, or thing that you have clicked a photo. As the user clicks the photo, the information regarding the object which the user had clicked the photo will be displayed. If the user sees a mountain range, and he wants to know more about it then, the user only has to click a photo of the mountain range and then upload it. As the photo is uploaded, it is sent to the database to check with every sample set of photos. If the sample matches a certain dataset, the information about the place is displayed on the web app.

## V. CONCLUSION & FUTURE WORK:

Outdoor navigation and localization are huge tasks for today. With the help of GNSS based scheme, a web app-based smart tour for a gated environment was successfully made and also tested on the real Test bed. The authors scheme brings in the right way to know more about the environment in a gated society or environment. It helps users to understand their surroundings. This will help the visitors and the residents with navigation and localization. Indoor navigation is another big step in the process of integrating into our Web app as, the GPS does not work indoors, so alternative techniques like BLE beacon geofencing will be implemented in the future. The integration of indoor as well as outdoor navigation will make it a good feature for future work.

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