

INDOOR NAVIGATION SYSTEM

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Abstract— In the modern world, localization and navigation systems are extremely important. They are often utilized in several industrial sectors as well as in day-to-day activities. Real-Time Locating Systems (RTLS) are used in the development of navigation devices to give an effective and user-friendly navigation aid. Real-Time Locating Systems (RTLS) are outdoor positioning systems and indoor positioning systems (IPSS) that can locate an object's position in a given region in real time, or very near to it. Among the numerous uses RTLSs are currently frequently employed for indoor navigation applications because of their resilience and dependability. Objects in their surroundings may be tracked both spatially and temporally thanks to real-time location systems (RTLS).

Keywords—Navigation, API (application program Interface), Satellite, Campus, Maps, GPS, RTLS.

I. INTRODUCTION

Since ancient times, people have traveled from one location to another using maps. Digital maps have been employed by navigation devices during the past ten years to determine the user's location and help with navigational instructions. Maps are increasingly used in navigation systems as more than simply a visual assistance; they also help to increase the accuracy of the navigational solutions that are found. The primary focus of the study of navigation is tracking and controlling a craft's or vehicle's movement from one area to another. Navigation can be broadly classified into four areas: space navigation, aviation navigation, maritime navigation, and land navigation. The three main concepts in navigation are latitude, longitude, and altitude.

Every day, thousands of teachers and students traverse vast, congested university and college campuses. With so many buildings, floors, and indoor and outdoor spaces, it's easy to get lost, confused, and irate on campus. This begs the question, "How can colleges and universities help staff and students get around campus and inside specific buildings?" The solution is as easy as using a campus map software! This adaptable digital tool can do much more than just navigate and provide directions; it can also be used to schedule study rooms, reserve parking spaces, take virtual tours, and much more. Since indoor mapping has so many advantages for schools and universities, we may conclude that having a great campus navigation software improves everyone's experience there!

An Indoor navigation system is a software or mobile application designed to help students, faculty, and visitors navigate around a campus. The system usually provides a map of the campus, showing the locations of buildings,

parking lots, and other facilities. It can also provide directions to specific locations, including classrooms, offices, and event venues. Indoor navigation systems can be very useful for people who are unfamiliar with a campus, as well as those who may have difficulty finding their way around. They can also help to reduce the amount of time that people spend searching for a particular location, which can improve productivity and reduce frustration.[2]

In addition to providing basic navigation functionality, some indoor navigation systems may also offer additional features, such as the ability to search for specific services or events, view real-time transportation schedules, or receive alerts about important campus news and events. Overall, an Indoor navigation system can be an essential tool for anyone who needs to get around a college or university campus quickly and efficiently.

II. WHAT IS RTLS?

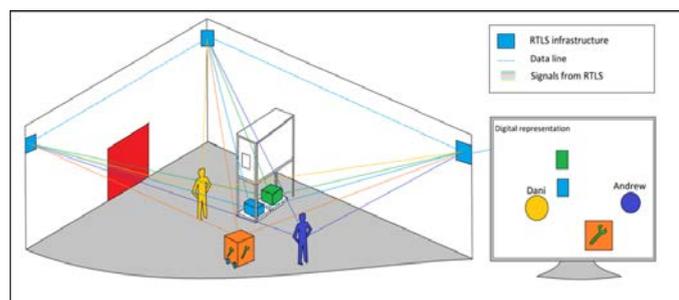
Real Time position Systems, or RTLS for short, are any systems that can precisely pinpoint the position of an object or person. RTLS is a goal that may be achieved with a number of systems for asset location and management, not a particular kind of system or technology. The time at which assets are monitored is a key component of RTLS, and depending on the application, this data may be used in a variety of ways.[1]

Certain RTLS applications, for instance, demand far more detailed visibility and require that time data be updated continuously, while other applications just need timestamps when an object passes through an area[7]. By precisely identifying, monitoring, and managing people, assets, and inventories based on location data that has been obtained, an ideal real-time location system may assist organizations in making well-informed decisions.

Many sectors utilize real-time logistical systems (RTLS) for specialized applications including high-value asset tracking and workforce tracking. Although these applications are found in the mining and industrial sectors, the healthcare sector is where they are most common.[3][4]

The project's goal is to create a mobile application that will enable users to navigate the campus with ease and display their current location. Additionally, the application will be able to augment reality by displaying hybrid road maps and 3D images of buildings to make location identification easier. Provide a helpful, educational, mobile-based indoor navigation solution for TASUED that includes all the

information needed to guarantee simple, accurate navigation and department identification. This will assist visitors and students, especially those who are new, in getting where they need to go without experiencing any difficulties.



III. DEFINITION OF TECHNICAL AND CONCEPTUAL TERMS

- **Navigation:** The process or activity of precisely determining one's position and arranging and adhering to a path is known as navigation.
- **API:** An application program interface, or API, is a collection of procedures, conventions, and development resources used in software development. While programming graphical user interface (GUI) components, APIs are used to define the protocol that software components should utilize to communicate with one another. [6]
- **Satellite:** A man-made object launched into orbit around Earth or another planet for communication or data collection.
- **Campus:** A university, college, or school's buildings and grounds are referred to as its "campus."
- **Map:** A diagrammatic depiction of a region of land or sea that displays physical characteristics such as cities, highways, and other aspects.
- **GPS:** The US Department of Defense launched a network of 24 satellites into orbit to create the Global Positioning System (GPS), a satellite-based navigation system.
- **Latitude:** Measured in degrees and minutes, latitude is the angular distance north or south of the earth's equator.
- **Longitude:** Measured in degrees and minutes, the angular separation between an east and west position with respect to the Greenwich meridian.
 - **Location:** A location is a place or a particular point in time where an event has occurred or is scheduled to occur.

IV. WHAT IS INDOOR LOCATION TRACKING AND POSITIONING?

- **Indoor tracking** finds and monitors subjects' (people and objects') movements inside buildings. Indoor tracking is made possible by indoor positioning systems, a network of electronic devices and computer software that locates objects or persons in

situations where GPS is inconsistent or downright unreliable.

- Although the phrases "indoor tracking" and "indoor positioning" are synonymous, they must be defined differently because there are numerous technologies and methods now in use to determine and deliver real-time location data.[5]
- There are different technologies that can be used for tracking and positioning indoors, even though the GPS (global positioning system) is still the most popular and commonly used technology for tracking and locating objects outside. These include technologies based on radio, optical, magnetic, and sound waves.
- While each is well-suited to handle a specific use case, radio-based UWB RTLS offers the accuracy, scalability, and dependability needed for indoor tracking—even under difficult conditions. Thus, UWB RTLS is the best choice for "Indoor GPS" right from the beginning.

V. RTLS TAGS FOR INDOOR LOCATION TRACKING

- Tags, or small electronic devices, are affixed to items that need to be tracked in a real-time location system (RTLS). The location server receives the blinks that the tags send, processes them, and uses the information to determine the tags' position. For safety purposes, RTLS tags are utilized for material flow analysis, asset tracking, vehicle tracking, and staff position tracking.
- Three distinct tags were produced by Sewio to accommodate the varying requirements of each vertical and use case. This allowed customers to select the tag that best suited their demands and budget. Sewio partners can further personalize the tags thanks to the system's design.[8][9]
- Real-time tracking and identification solutions are offered by Sewio RTLS tags, which are ideal for midrange and enterprise-sized businesses that are facing challenges in boosting their productivity. In contrast to conventional indoor tracking systems, only Sewio offers excellent precision and an extended tag battery life, allowing thousands of tags to be tracked in a single location.

VI. RTLS COVERAGE OPTIONS

The read ranges and capabilities of RTLS differ depending on the technology and configuration. For instance, because its receivers are satellites orbiting the Earth, the system with the longest read range, GNSS (GPS), can provide an item's real-time location anywhere in the world. Locating within a building or zone is possible using other technologies, such as UHF Passive RFID, which have lower read ranges. The various coverage levels that RTLS can achieve are listed below. Take note that based on the technology selected, the quantity of tags and/or receivers, and/or the positioning method selected, more granularities can be obtained with any of these coverage options. **Wide Area Coverage:** This term

often refers to employing global coordinates to locate a person or object on a worldwide scale.

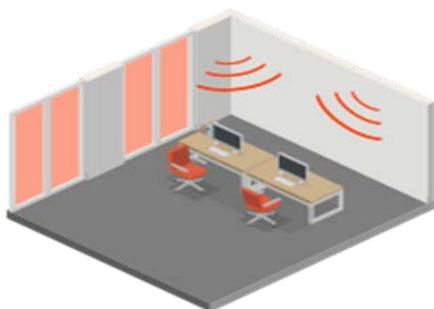
Application Example: Locating cargo containers traveling across ocean or land with valuable machinery inside.



- Local area coverage is the general term for finding something or someone inside a structure or facility that is connected to the same network.
- Example of Application: Finding an IT asset inside a business building..



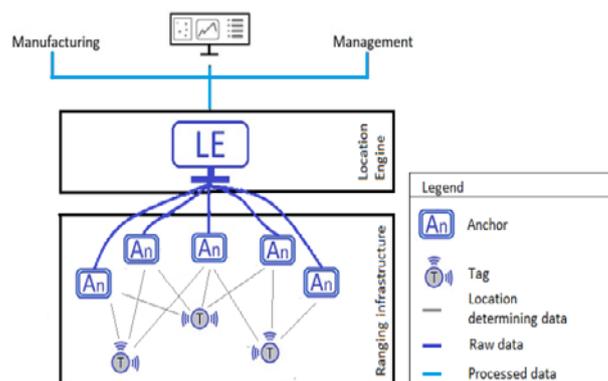
- Zone Coverage: This generally refers to placing hardware at regular intervals based on read range and read obstacles in order to locate an object or person within a designated zone (such as a room or office within a wider region).
- Finding a high-value oxygen tank within a hospital is an example of an application.[15]



VII. PROPOSED WORK OR METHODOLOGY

- An Indoor navigation system is a software application designed to help individuals navigate through a college or university campus. The following are some key concepts and methods used in a campus navigation system:[12]
- Mapping: A indoor navigation system typically uses a map of the campus to provide users with visual information on buildings, roads, walkways, and other features.
- GPS Location: The system uses GPS technology to track the location of the user and provide them with real-time directions based on their current location.

- Points of Interest (POI): A POI is a specific location on campus that a user may be interested in finding. These could include buildings, departments, parking lots, food courts, and other important locations.[13]
- Indoor Navigation: In addition to outdoor navigation, a campus navigation system may also provide indoor navigation, which involves mapping out the interior of buildings and providing turn-by-turn directions.[14]
- The application that is produced gives the user the ability to locate paths to particular spots and offers location-based information within particular campus buildings, roadways, and other facilities. With the help of this software, guests can use their mobile devices to explore the facilities on university campuses. A pedestrian navigation system at the university ought to be created, much like an automobile navigation system. tracks on campus can have segments on multiple building floors and are therefore typically three dimensional, whereas tracks calculated by car navigation systems are just two dimensional. Considering this, a new user interface that works with 3D navigation needs to be created.[16]



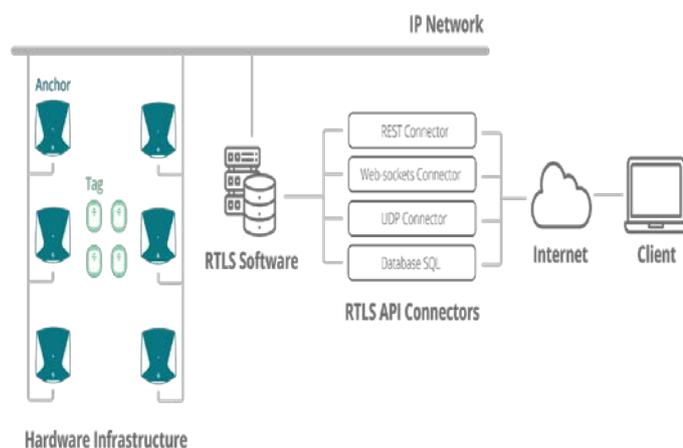
VIII. PROCESS BLOCK DIAGRAM:

Anchors are electrical devices used in real-time location systems (RTLS) that pick up UWB signals (blinks) released by UWB tags and send them to the location server for tag position calculations. There are five distinct versions of RTLS Tags, each designed to offer the ideal blend of features, sensors, and power supply choices to satisfy the requirements of a specific use case and guarantee the most return on investment.[17]

Through the API, position data on the server can be accessed via three connectors.

- REST → Delivers positional data and all available metadata. can be used to retrieve historical and static data, such as details on buildings, floor plans, tags, anchors, and other information. The only connector that can retrieve static data from the database is this one.

- **Websockets** – This technology is utilized in apps that need to get location data in real time. Only positional data can be sent by websockets. For historical data access, kindly utilize the REST connector.
- **UDP** → It is utilized in situations when Tags with extremely quick refresh times are used. Only positional data can be obtained from UDP streams. For historical data access, kindly utilize the REST connector.



IX. PROGRAMMING LANGUAGES USED

HTML & CSS: Two of the key technologies for creating Web pages are HTML (Hypertext Markup Language) and CSS (Cascading Style Sheets). The page's structure is provided by HTML, while its (visual and auditory) layout is handled by CSS across a range of devices.

JavaScript: A popular programming language for creating front-end applications is JavaScript. It can be applied to the development of interactive maps and navigation system user interfaces.

Mapping and Geolocation APIs:

Google Maps API: Google Maps API provides a comprehensive set of tools for developing location-based applications, including maps, geocoding, and routing services.

Backend services and database management are offered by Firebase, a cloud-based platform that powers backend functionality for mobile and online applications. It provides functions including cloud storage, user authentication, and real-time databases.[18]

X. OUTCOMES FROM THE SYSTEM

Indoor navigation systems are designed to help individuals navigate within large, enclosed spaces such as shopping malls, airports, hospitals, or office buildings. These systems typically provide real-time guidance, mapping, and location-based services to assist users in finding specific locations, points of interest, or the most efficient routes within the indoor environment.

The results and effectiveness of indoor navigation systems can vary based on several factors:

1. **Accuracy:** The accuracy of indoor positioning technology (such as Wi-Fi, Bluetooth, RFID, magnetic positioning, or sensor fusion) affects the precision of location tracking. Higher accuracy leads to more reliable navigation.
2. **Mapping Quality:** The quality and detail of the indoor maps significantly impact the user experience. Detailed and updated maps enhance the effectiveness of the navigation system.
3. **User Interface:** The user interface of the navigation application plays a vital role. Intuitive design, ease of use, and clear directions contribute to the system's success.
4. **Real-time Updates:** Dynamic information, including changes in the environment like closed pathways, new stores, or temporary obstructions, should be reflected in the system for accurate guidance.
5. **Integration of Services:** Some indoor navigation systems integrate additional services such as store locators, product information, or interactive features to enhance user experience.

The results of an indoor navigation system can be measured by user satisfaction, the ability to find destinations accurately, time efficiency, and adaptability to changes within the indoor environment. The success of these systems often depends on the balance and efficiency of the above factors to provide a seamless navigation experience.

XI. CONCLUSION

The Indoor Navigation System is a system that offers extremely special features and capabilities to regular users in an easy-to-use manner. The purpose of this system's introduction is to improve customer happiness and facilitate university self-tours. The system's creation has taken into account and evaluated the most common needs of university visitors and students. Users just need to learn the necessary details in order to navigate the university's premises; they are not heavily involved in the processing of data or information. Many of the visitors have experienced the usual general concerns that the program is currently addressing before this system was first created and put into place. The introduction of the Indoor Navigation System has a significant impact on the academic environment since it makes it extremely easy for visitors, lecturers, and students to find and navigate places of interest.

Indoor navigation systems have emerged as a revolutionary technology, significantly enhancing user experiences within complex and large indoor spaces. These systems have proven invaluable in various sectors such as healthcare, retail, transportation, and education, offering seamless navigation solutions to users. Through the integration of advanced

technologies such as Bluetooth, Wi-Fi, RFID, and sensors, indoor navigation systems have become increasingly accurate and efficient, allowing users to navigate intricate indoor environments with ease.

The benefits of indoor navigation systems are multifaceted. They enhance accessibility for people with disabilities, improve operational efficiency in commercial spaces, increase customer satisfaction, and optimize resource management. Moreover, these systems have paved the way for innovative applications like location-based services, asset tracking, and personalized marketing strategies.

While indoor navigation systems have made significant progress, there are still challenges to overcome, including privacy concerns, security issues, and the need for standardization in technology and data formats. As technology continues to evolve, addressing these challenges will be crucial to the widespread adoption and seamless functioning of indoor navigation systems. Looking ahead, the future of indoor navigation systems is promising.

With ongoing advancements in artificial intelligence, machine learning, and sensor technologies, these systems will likely become even more precise, cost-effective, and user-friendly. As a result, they will continue to transform the way people navigate indoor spaces, making every day experiences more convenient and efficient for everyone.

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