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A Review on State of the Art Facilities to Implement Indoor Navigation

Shaswat*, Prof. Sneha M**, Ajey Nadhadhur Jagannathan***
*(Computer Science Engineering, R.V. College of Engineering, Bengaluru
Email: shaswat.cs17@rvce.edu.in)
** (Computer Science Engineering ,R.V. College of Engineering, Bengaluru ,
Email: sneham@rvce.edu.in
*** (Assistant Manager, Bosch Limited, Bengaluru
Email: AjeyNadhadhur.Jagannathan@in.bosch.com)

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Abstract:

In today's world GPS (Global Positioning System) is the most common digital infrastructure that provides the facility of navigation to an average person but it has it's own limitations. The infrastructure scope is only limited to the outdoor positioning and navigation system. To tackle the above problem indoor navigation infrastructure needs to be developed. Indoor navigation could be a vital component in user's daily life due to the vast scope of real life applications. The idea behind this paper is to review the different state-of-the-art technology stack ways to implement the idea of indoor navigation. The paper gives an overview of new infrastructure ideas that could potentially be helpful to develop and scale the idea of indoor navigation.

Keywords **—Indoor navigation, Wifi, Bluetooth low energy, UWB, infrared, GPS, Beacon**

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I. INTRODUCTION

Indoor navigation basically means providing the facility of navigation in an environment where the navigation couldn't be achieved with the standard GPS navigation systems. The examples include parking lots, shopping malls, Hospitals, Apartment complexes, Business hubs etc. The idea behind this is to create a local infrastructure specific to the vicinities of a locality.

The problem that arose because of GPS navigation is the lack of a satellite flag due to which it will not function properly indoors. Furthermore, obtaining position data in indoor situations is particularly challenging due to a variety of factors, including errors caused by multi-path and Non-Line-of-Sight (NLoS) conditions, the proximity of moving individuals, which affects the indoor proliferation channel, the thickness of obstructions, which causes high weakening and flag dissipation, and the demand for greater exactness and precision.[2]

Many techniques were proposed to tackle this problem. Fhelelboom discovered that a wireless local area network (WLAN) may be used to place items in any interior environment.[5] In addition, Pedersen presented a reduced scale positioning technique that may be used to place and monitoritems in an interior environment. This paper discusses the state-of-the-art techniques to implement the idea of indoor navigation.

II. LITERATURE REVIEW

Magnetic Field Aided Indoor Navigation

In this study, magnetic field intensity data and aKalman filter are used to help inertial navigation systems in an indoor setting. Many existing helping technologies, such as aiding with the Global Positioning System, do not perform effectively in an interior environment. The method proposed in this study employs a maximum-likelihood approach to estimate location using magnetic field intensity data from a three-axis magnetometer. A Kalman filter is used to integrate the location measurements with a motion model. A mix of simulated and actual measurements are used to test the magnetic field navigation method. A magnetic field intensity map of the whole test environment is used to conduct these tests. The results of these tests demonstrate that the position assisting algorithm can generate position estimates from actual data that are within 1 metre of the genuine trajectory for the vast majority of them. In a laboratory hallway environment, 3 metres distant from the real trajectory. A leader-follower scenario is used to further investigate the possibilities of the location assisting algorithm. In this situation, the follower estimates its present position and attempts to follow the leader's route using magnetic field strength data obtained by the leader. The findings demonstrate that tracking is achievable and that the leader's measurement range has a significant influence on the outcome.[1]

Proximity based indoor navigation system

Here the idea is to use the concept of Bluetooth Low Energy. Fixing of Beacons in the parking lot. The idea is to divide the indoor area in 2-Dimensional Coordinate system and then fixing the beacons in that plane.Scanning the beacon and receiving the RSSI from it. Smoothening of RSSI captured should be done by creating a signal smoothening algorithm to prevent any abnormalities caused by parameters such as reflection, interference, atmosphere, etc. To smooth the data, a filtering machine learning algorithm is utilised. RSSI signals are used to measure distance. The calibration RSSI value mentioned in the Beacon protocol may be used to calculate the distance between a Beacon and the user. The intensity of the signal generated by the Beacon at one metre is used to calibrate this figure.Using distances from different beacons, trilateration is used to compute the location of a device. It calculates the location of an item using the known distance from at least three fixed locations (three nearby beacons can be specified). Trilateration determines the location by determining the place where a sequence of circles cross.To make a multi-floor visualisation with the shortest path finding algorithm.

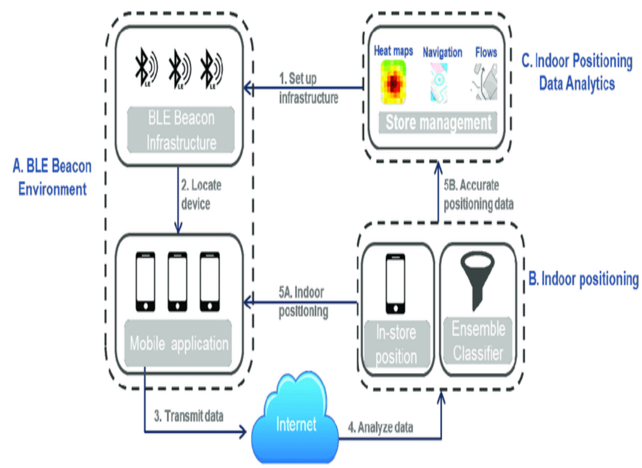

Fig. 1 A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

Infrared based indoor navigation system

This study proposes a novel indoor locating system based on infrared light incidence angle measurement. Though numerous studies on indoor location systems utilising a vision sensor or an ultrasonic sensor have been conducted, they offer both advantages and limitations. This innovative approach uses the incidence angle of infrared light to reduce the drawbacks they have. Three infrared emitters are set in known places in a novel positioning system. The angle variations between the two emitters are measured using an incidence angle sensor. Angle discrepancies are used to determine a location.

Here the positioning system is based on a similar principle to that of GPS. The pseudo-ranges, or distances between satellites, are measured by GPS. It also calculates the position of each satellite using measured pseudo-ranges and position information, as illustrated in Figure. 2. Furthermore, because to clock bias, true GPS requires one mOTe satellite to establish position. Here, process is to compute the location using the observed angle differences and position information for each emitter. Figure 3 depicts the new positioning system.GPS is challenging to install because it employs electromagnetic waves to measure pseudomages.

All satellites must be synced, and the receiver must be able to count extremely minor time discrepancies in order to be useful. Furthermore, GPS is unavailable indoors.Indoor satellites are required for absolute position measuring systems. Electromagnetic waves, on the other hand, are too rapid to be used indoors or in confined area.Ultrasonic waves, rather than electromagnetic waves, are one alternative technique.Because ultrasonic waves are far slower than electromagnetic waves, they are ideal for interior locating systems. As a result, ultrasonic sensors have been used to conduct research on an indoor locating system.

The most significant issue with an ultrasonic system is interference between ultrasonic emitters. Because of interferences, ultrasonic emitters release waves in turns rather than all at once.[3]Another approach is proposed to address all of the issues stated above. Instead of using travel durations to determine distances, we utilise incidence angles of light diffused by each emitter. Infrared light is utilised for emission because it is invisible, widely used, and distinct from visible light. Optical and electrical filters can be used to reject noise and disruptions from the sun and interior lights. This new location mechanism is also completely decoupled from all emitters. To put it another way, the number of users is unrestricted.[3]

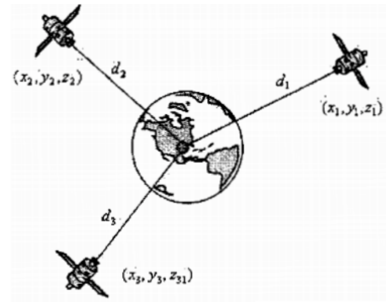

Fig. 1 A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

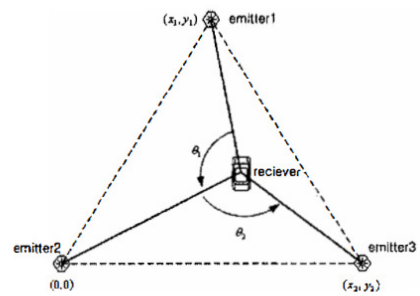

Fig. 1 A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

Wifi based indoor navigation

A WiFi-based system is made up of WiFi transmitter tags. These tags deliver basic packets to a building's WiFi access points. The timing and strength of the reading are calculated and reported by the indoor navigation sensors. Algorithms can determine a user's location in this way.

In this study they apply different methods like time of arrival(ToA) , angle of arrival (AoA), Hybrid ToA/AoA elc to a WiFi system with an access point (AP) with several antennae as local anchors, because WiFi technology is extensively used in interior situations. Mobile platforms having WiFi capabilities, such as smartphones and tablets, might be used as positioning devices. When there is just one WiFi AP, they use a hybrid AoA/ToA method to figure out where the target is. When there are two or more nearby WiFi APs, we used

AoA to get a more accurate position. Even if the number of adjacent anchors is restricted, this architecture can provide precise positioning service.

Round-trip time (RTT) technique was used in the system to calculate distance without the need for time synchronisation between transmitters and receivers. The transmitter delivers the message to the receiver and records the transmit timestamp in the standard RTT measurement method. The RTT may then be determined by subtracting the time between sending and receiving the message from the interval between sending and receiving the message. Here the device transmits several messages to the WiFi AP in our system,and the AoA is calculated using the channel estimation approach. Any pair of antennas can determine the AoA. When there are more than two antennas, the AoA can be calculated jointly for improved performance. The localisation of device was done with the help of distance and angle of arrival obtained from the above techniques.

Optical indoor positioning system

Optical Indoor Positioning is a type of fixed indoor positioning in which a framework is installed in the building and a client-supplied camera is used.CLIPS (Camera and Laser based Indoor Positioning System) was proposed by Tilch . This framework combines the two breakthroughs in indoor object positioning. For placing items, the camera functions similarly to a cell phone. The laser device is mounted on the roof, and laser pillars are located on the roof. The camera follows the laser shafts and adjusts its position in relation to the laser bars. Inside an indoor environment, optical indoor positioning is more commonly used for robot selflocalization. A comparison of the 3D coordinates of the laser-spots, which were redundantly computed by the CLIPS system itself through spatial intersection, and an independent survey utilising a total-station was used to conduct an initial system evaluation. The residuals of an affine transformation were used to make the comparison.[2]

Ultra Wide-Band Based solution

In this study Ultra Wide-Band technology is discussed. Ultra Wide-band (UWB) is a radio technology for short-range, high-bandwidth communication that uses Time of Flight (TOF) measurements and multilateration techniques for distance calculation, localization, and tracking. A radio wave signal is delivered from a tag module to an anchor module and back, and the time it takes to complete the journey is measured (TWR, two way ranging). Simply divide the time of flight measured from the anchor by the speed of radio waves (c = 299792458 m/s) to get the distance between the two

antennas used in the triangulation procedure. The utilisation of a wide frequency bandwidth (>500 MHz) allows for excellent temporal and range precision. In reality, a wave travels over 30 cm in a single millisecond. In the case of UWB, the attainable range resolution may be estimated by rr c / 2b where c is the speed of the wave front and b the bandwidth. Here the technique of positioning is to estimate the position using basic geometry. It is feasible to determine the position by measuring the distance between a number of anchors with known positions. It is feasible to know that the unknown point will be in a circle of that radius around the anchor by measuring a given distance. When measuring distance using three anchors, the intersection of the three circles determines the position. Trilateration (or multilateration if more than three anchors are employed) is the name given to this approach.[15]

III. CONCLUSIONS

This paper reviews the current state-of-the-art methods to implement indoor positioning and navigation system in a local environment. The paper discussed the challenges that might arise when designing an indoor positioning system, discussed several solutions that have been offered to overcome these challenges, and identified a potential area of use and enhancement within indoor positioning systems. Indoor positioning, as we viewed it, is a huge area with a lot of applications and improvements to be made. Explorations within indoor positioning, as said before in this research, may be progressively useful when transmitted for individuals on foot placement because the accuracy isn't as accurate as it is in established interior positioning. The scope of this infrastructure is not limited to the vicinities of this paper. This specific infrastructure could be a vital addition to the current navigation system.

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