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INDOOR POSITIONING IN COLLEGE

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Abstract: GPS that is global positioning system is a very well-known and very old technology that we have been using for years. This technology has helped us from offices to our homes in our day to day lives. This technology is well efficient in detecting objects or people in our open surroundings but one drawbacks of global positioning system is that it is limited to outdoor systems. But as far as indoor systems are considered, GPS does not perform well. In this paper we will talk about a system that will work that is indoor positioning ips this can be understood as a GPS for indoor environment we will be discussing different technologies that can be used to implement it. Possible compatible technologies will be compared on various parameters such as cost, accuracy and availability of resources.

General Terms: Sensors, Wi-Fi Access point, Pattern recognition

Keywords: IPS - Indoor Positioning System, LAN - Local Area Network, GPS - Global Positioning System

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I INTRODUCTION

Global positioning system has become one of the most successful technologies. It has provided great assistance in tracking indoor environment.

Many other applications have been developed using this technology working in different fields making our life easy searching locations path finding booking cab are a few of those however for Indore environment GPS become inadequate do to presents of wall and other structure and objects in the path. Hence GPS and other satellite technologies altogether provide imprecise results due these attenuations. This is clear that imprecise or inaccurate results will give misleading results, in this case, these technologies cannot be relied upon. This is where the need of a system emerges where tracking of any object or person can be done. And here comes Indoor positioning system in picture.

As discussed, Indoor positioning system can be defined as a system that is capable of tracking or locating persons or objects in indoor environments. Indoor environments can be referred to any building such as libraries, schools, laboratories, homes or offices. This technology has a further long line of applications. This could be used in for security purposes, wayfinding applications, tracking applications, inventory management systems or surveillance purposes.

Various technologies and various devices are used for deployment of IPS. devices such as smartphones, wifi tags, antennas, cameras, etc. IPS also uses many different technologies to measure distance. There are different technologies that could be used for positioning in indoors such as Proximity-based Systems, Wi-Fi Based Systems, Ultra-Wide band Systems, Acoustic Systems, Infrared Systems, etc.

II RELATED WORK

Many surveys are already been conducted on IPS. one of those is Hightower and Borriello's, but these were one of the earliest surveys on this topic, hence these have become an outdate concept for a speedily changing field such as IPS.

However, in some of the surveys, there is no proper classification system. Unclassified or unlisted concepts do not succeed to attract readers towards itself. As the idea of these seems ambiguous and unclear. One such example of this is review by Mautz. In this review, many technologies were sequenced in a serial order, without a proper classification.

In this paper, different works are introduced, generating a conceptual understanding for mapping the IPS field. Also, some classification methods are presented in a conceptually distinguishable forms unlike reviews such as, Gu et al. [11] classified IPS systems as whether a system is network-based or non-network- based. But this criterion becomes limited when purely passive systems, such as magnetic field fingerprinting or ambient light analysis, image analysis like other technologies come into picture.

We would throw light on the point that it is difficult for a broad technology to be perfectly classified into segments under some principles. although some reviews have left some obvious areas. For instance, Liu et al.'s review [11] merely considers wireless-based positioning systems, so ignoring inertial systems, infrared, vision-related systems, sound or ultrasound, , ambient light, floor tiles, and magnetism analysis.

lastly, few of the surveys have not described the use of the technologies. For instance, Sun et al. [1] do not analyzed technologies, merely analyzed location algorithms.

III. LOCATION METHODS AND IPS

Before moving further into indoor positioning, let us understand that how outdoor positioning system works as we have described indoor positioning as a GPS system that works for interiors.

For figuring out ones position, there are two possible ways. First one is Absolute Positioning. This way is for computing precise position at a given time.As Earth is spherical, it has longitude, latitude and altitude.

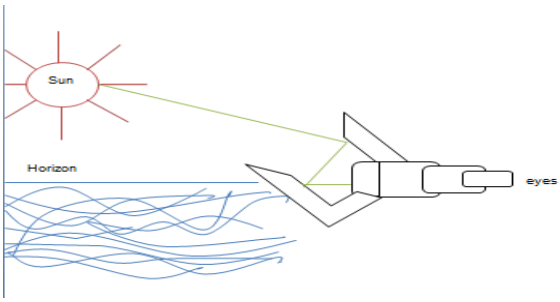

fig 1: use of a sextant to measure latitude

For years, positioning was a hectic task as it took a lot of computation and time but the results used to be imprecise and approximate. A sextant was used by navigators to measure the angle between the horizon and the sun at noon thst is latitude and a precise watch to compute the angular offset from the Greenwich meridian that is longitude. Also there were limitations that these technologies could be used only in good weather conditions and only at particular time of a day.

In the 70's a new technology was introduced for military called GPS (Global Positioning System). GPS uses a constellation of satellites to find a precise position. a total of 32 satellites are used in this. Each satellite works independently and send signals to the devices that are GPS compatible on earth. Further in 80's, this technology was introduced for civilians.

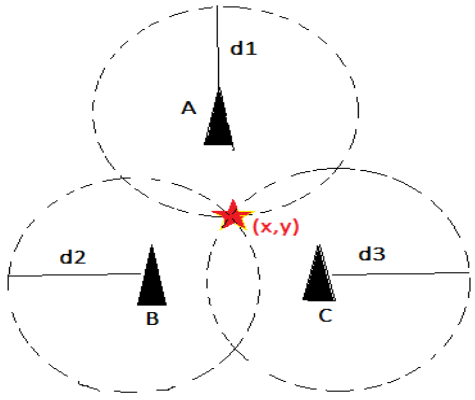

Fig 2 : Trilateration

There is an algorithm named Trilateration. This technology is most important as this technology is vastly used in approximately every position determining technology whether it is for indoor environments or for outdoor environments. This is used upon defining the distance between satellite and devices. This is used to calculate the current position. It works in a way that it allows the determination of the position from 3 known places in case of plane, and 4 known distances in case of sphere.

There is one other algorithm named Triangulation. It is also used by surveyors for determining positions but it uses angles not distances. So it should not be confused with trilateration.

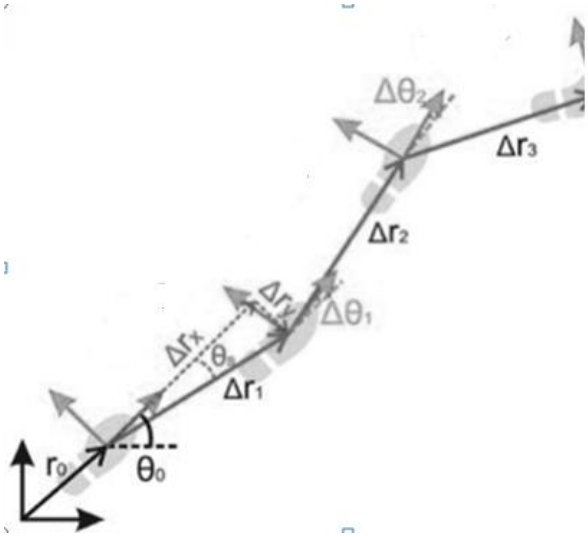

fig 3 :Dead Reckoning

The other way for determining position is Relative Positioning. It is known as Dead Reckoning in the aviation industry. IMUs are used in the situations when a continuous precise position is needed such as in moving objects for example: rockets, missiles ,ships, aircraft, spaces, cars etc. In this speed and direction is computed from the last point of departure. This technology uses an equipment called Inertial Measurement Unit (IMU).IMS uses many accelerometers and gyroscopes for calculating the covered distance.

3.1 Indoor positioning

Indoor positioning is a complicated system as common technologies that work for outdoors do not work here. GPS fails here as the waves are not able to reach the receiver devices because of the presence of hurdles in the path such as walls and roofs.

Secondly GPS fails at determining that on which floor the receiver is located in case of multistory buildings. Also no signal is received in undergrounds. these all sums up in accuracy loss in GPS system. Classical dead reckoning is also almost impossible for using in indoor environments because of the size of the inertial measurement unit (IMU). It is clear that there is

direct relation in the size of the IMU and its accuracy, the larger the IMU, the better the accuracy and vice-versa. Indoor systems include people having smart phones, that can be used as an alternative to classical IMU's that are too big to be embedded into smart phones.

Indoor positioning technologies can be categorized into the four main categories: proximity, trilateration, fingerprinting, and motion. few of these can be used independently but can also be combined to provide better accuracy.

Proximity positioning is the technology that is used on the client-side. Exception to this is Wi-Fi that has server-side detection capabilities. Here are some possible technologies:

- QR Codes / NFC tags these could be read by smartphone cameras or NFC readers. QR Code / NFC stickers are then linked to a precise position in the building.

- Bluetooth Low Energy (BLE) devices are also called beacons. A BLE sends a signal. These signals could be read when the smartphone is located in the emission area. The more beacons are used, the more is the accuracy in the position.

- Visible Light Communication (VLC) devices these are commonly known as Li-Fi. An invisible signal is sent to the smart phone camera or any receiving device through an led lamp. These led lamps have unique identity. Signals sent via this could only be read using the lamp. This is how it provides accurate position.

- Wi-Fi Access Point These can be used to locate any smartphone or any Wi-Fi aware device. Its working is same as that of for BLE devices.

- Ultrasound devices These are generally deployed on top of audio systems in buildings such as stores or shopping malls. Its working is also as BLE and Wi-Fi proximity positioning.

Trilateration positioning uses computed distances between various signal emitters and a receiver to calculate position of the receiver. Distances are determined by RSSI and ToF algorithms.

RSSI stands for Relative Received Signal Strength Indication. This algorithm calculates distance based on the attenuation of radio waves. here, the accuracy is poor because of roofs, objects or people.

Time of Flight or ToF is an algorithm that is based on the concept of the difference of time. It calculates the time difference between the emission and return of the signal. On the basis of this difference, distance is calculated. This provides accuracy but at higher cost due to the use of dedicated chipsets. Here are technologies using trilateration:

- Bluetooth Low Energy (BLE) and Ultrasounds, These use trilateration based position determination. It is used to compute distance on the client-side using RSSI.

- Wi-Fi can be used both on the client side as well as on the server side. However, server side is more accurate. But this type of services is available only on premium Wi-Fi equipment e.g. Cisco CMX, Cisco Meraki. Distances are calculated using RSSI.

- Ultra-Wide Band This used TOF and provide accurate positions. But this hs drawbacks such lack of standardization that results in no smartphone available and high cost.

Fingerprinting positioning is the technology that can either be used alone or could be coupled with other technologies for better accuracy. It uses an assumption that there is a unique signal for every position. But it only works when in motion, and second, it requires stable signals over time. This is list of technologies that can be coupled with fingerprinting:

- Bluetooth Low Energy (BLE) fingerprinting works good because it can be performed on the client-side and because BLE signals are stable over time.

- Wi-Fi fingerprinting works, but it can't be used on iOS devices because of Apple's limitations. hence it is only used for android smartphones.

- Magnetic field fingerprinting appears to work okay but it proves unstable over time due to multiple factors.

- Photo fingerprinting is based on the analysis of the image of the building interior. It does not prove stable overtime except the case when the fingerprinting is coming from high-resolution permanent cameras that are able to frequently refresh records.

Motion positioning has the same principle for working in indoor as well as for outdoor except the technology. As we have discussed that it is impossible to use IMU's so smartphones are used to detect moments via sensors of the smartphones such as compass, accelerometers, barometers, pedometers. Algorithms are used such as such as Kalman filters which process the data coming from sensors to calculate relative movement. But this technology provides poor accuracy resulting from small size sensors and cumulative errors. Hence motion positioning fingerprinting cannot be used as a stand-alone technology.

4. Conclusions

Indoor positioning is a broad and complicated matter. It cannot be implemented using any one technology unlike the outdoor positioning. However, sensor fusion can be relied that use combination of technologies in order to provide best accuracy.

Trilateration can be used to obtain an absolute position, or coupled with Fingerprinting . Motion positioning could be used to move the blue dot until they have enough radio signal variation to compute another absolute position. Proximity positioning is a basic technology to have both a low-cost and a low-tech way of getting a position. This can be used in projects that do not need really high accuracy. Wi-Fi access points can also be used both Indoor Positioning and for providing internet access and so Li-Fi lamps .

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