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A Comprehensive Survey on Indoor Positioning System and Its Evaluation

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Abstract: ***Locating people in the indoor locations have gained great interest in this decade, and so positioning systems have been widely evaluated for accuracy. Major reasons for positioning people are guide them to a certain place, locating them and assisting organizations and companies with their assets management. Many techniques and mechanisms were presented to resolve the people positioning problem and to enhance the accuracy of the existing systems. In the current scenario, one of the many existing wireless protocols or standards such as RFID, Bluetooth or Wi-Fi or Infrared is chosen the working protocol for indoor positioning. In recent days, many indoor positioning systems (IPSs) have been developed to make location information of people or devices available for processing. With location information available for users, users can make efficient use of applications which depend on locations for providing efficient services. Personal Area networks (PANs) are designed to meet the users' location based needs and interconnects users' handheld devices embedded with various standards or communication methods in various places to form one entity of network. Location-aware services are required to be developed in PANs to offer adaptive and flexible personal services and thereby improve the quality of lives. This paper gives a evaluative survey of various IPSs, including both, the research-oriented solutions as well as commercial products. Comprehensive performance comparisons including accuracy, security etc. are addressed.***

Keywords: Indoor Positioning Systems, Communication Standards, Personal Networks, Location Techniques

1. Introduction

The problem of locating a user is a fundamental problem in many research areas. In outdoor environments, the Global Positioning System (GPS) can provide good location estimates. However, the GPS solution cannot be used in indoor environments. In this kind of environment (which is typically called GPS denied environment) the GPS signal is very poor because of the lack of line of sight between satellites and the receiver. Due to the large number of applications that can benefit from a location service in indoor environments, indoor location systems have been an important research topic in recent years. Because of the advances in wireless technologies and the consequent proliferation of wireless devices in indoor buildings, the use of radio frequency signals to perform localization has become an interesting and promising technique to build better location systems [1].

The primary progress in indoor location sensing systems has been made during the last ten years. Therefore, both the research and commercial products in this area are new, and many people in academia and industry are currently involved in the research and development of these systems. This survey paper aims to provide the reader with a comprehensive review of the wireless location sensing systems for indoor applications. When possible, the paper compares the related techniques and systems. The authors hope that this paper will act as a guide for researchers, users, and developers of these systems, and help them identify the potential research problems and future products in this emerging area. Pedersen [2] proposed a micro positioning strategy that should be implemented within the indoor environment in order to position and track objects. He stated that this strategy would work as a replacement for the GPS positioning system. In addition, Fhelelboom [2] found that a wireless local area network (WLAN) can be used within any indoor environment to position objects. In this paper, we review the different positioning environments, the different systems applied for each environment and the algorithms used within each system. We specify three scenarios for positioning people and objects within an indoor environment. Each of these scenarios has its own challenges, which researchers tried in the past to mitigate by proposing several solutions over the last ten years. We have organized the paper as follows. In the next section, section II, we point out some preliminary technical information regarding indoor positioning techniques. In section III, we point out some problems and challenges of the systems. In the next section, section IV, there is number of technologies or systems for indoor localization. Finally in section V, there is conclusion and future scenario.

Several types of wireless technologies are used for indoor location. Currently there are many indoor positioning techniques, such as infrared ray (IR) techniques, wireless Bluetooth techniques, radio frequency identification (RFID) techniques, ultrasound techniques, ultra-wideband (UWB) Techniques, WLAN, ultrasonic system and cellular based techniques. The following will be introduced one by one.

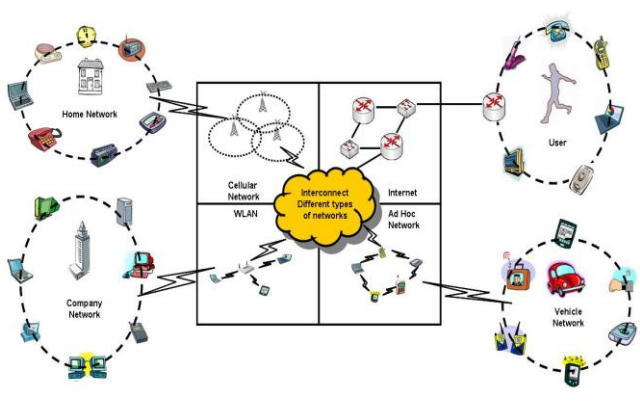

Figure 1: General architecture of local positioning [9]

2. Literature Survey

Many positioning systems have been developed over the years for indoor location estimations. We introduce a variety of IPSs in this section. The location technology and technique used in each IPS are addressed to give a scientific overview of the system. Since the evaluation of these IPSs is focusing on the need of users in PNs. Thus we can know the advantages and limitations of these IPSs from the view of users in PNs.

A. RFID

RFID is a means of storing and retrieving data through electromagnetic transmission to an RF compatible integrated circuit and is now being seen as a means of enhancing data handling processes [12]. An RFID system has several basic components, including a number of RFID readers, RFID tags, and the communication between them. The RFID reader is able to read the data emitted from RFID tags. RFID readers and tags use a defined RF and protocol to transmit and receive data. RFID tags are categorized as either passive or active. Passive RFID tags operate without a battery. They are mainly used to replace the traditional barcode technology and are much lighter, smaller in volume, and less expensive than active tags. They reflect the RF signal transmitted to them from a reader and add information by modulating the reflected signal. However, their ranges are very limited. The typical reading range is 1–2 m, and the cost of the readers is relatively high. Active RFID tags are small transceivers, which can actively transmit their ID (or other additional data) in reply to an interrogation. Frequency ranges used are similar to the passive RFID case except the low-frequency and high-frequency ranges. The advantages of active RFID are with the smaller antennae and in the much longer range (can be tens of meters). Active tags are ideally suited for the identification of high-unit-value products moving through a harsh assembly process.

B. Fast Bluetooth (IEEE 802.15)

Numerous individuals now store extensive amounts of individual and corporate information on tablets or home PCs.

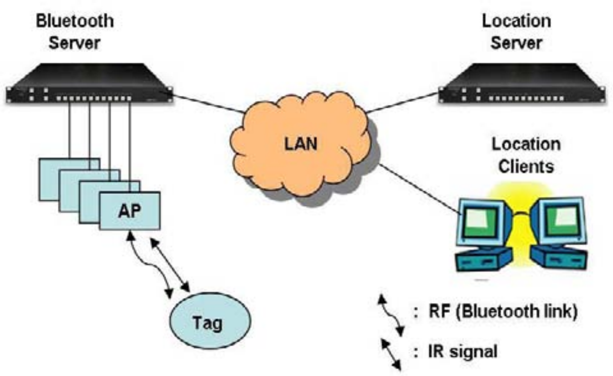

Figure 2: The System Architecture of Topaz IPS [9]

These frequently have poor or discontinuous network, and are helpless against burglary or equipment disappointment. Ordinary reinforcement arrangements are not appropriate to this environment, and reinforcement administrations are every now and again deficient. This paper depicts a calculation which exploits the information which is basic between clients to build the pace of reinforcements, and diminish the capacity necessities.

This calculation bolsters customer end per-client encryption which is essential for classified individual information. It likewise underpins a one of a kind element which permits prompt location of normal sub trees, dodging the need to question the reinforcement framework for each document. We portray a model usage of this calculation for Apple OS X, and present an investigation of the potential viability, utilizing genuine information acquired from an arrangement of ordinary clients. At last, we talk about the utilization of this model in conjunction with remote distributed storage, and present an investigation of the commonplace cost reserve funds [2].

C. WLAN (802.11)

This midrange wireless local area network (WLAN) standard, operating in the 2.4-GHz Industrial, Scientific and Medical (ISM) band, has become very popular in public hotspots and enterprise locations during the last few years. With a typical gross bit rate of 11, 54, or 108 Mbps and a range of 50–100 m, IEEE 802.11 is currently the dominant local wireless networking standard. It is, therefore, appealing to use an existing WLAN infrastructure for indoor location as well, by adding a location server. The accuracy of typical WLAN positioning systems using RSS is approximately 3 to 30 m, with an update rate in the range of few seconds.

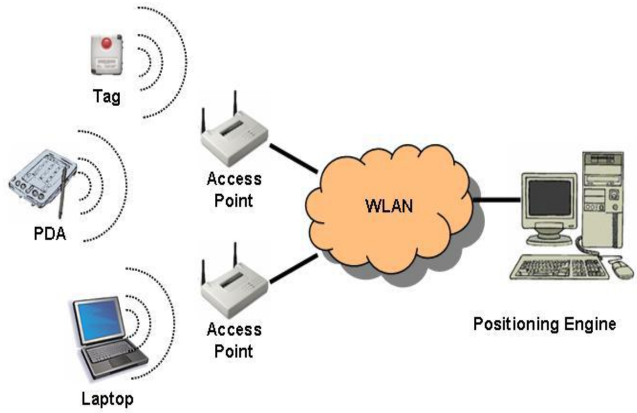

Figure 3: Ekahau Locating system using WLAN [9]

D. UWB –Ultra Wide Bands

UWB is a new communication technology and has great differences with traditional communication technologies. It does not require the use of traditional communication system in the carrier, but by sending and receiving a nanosecond or less of the extremely narrow nanosecond pulses to transmit data, which has the magnitude of the bandwidth. UWB can be used for precise indoor positioning, for example, found the location of the battlefield soldiers, robot motion tracking. UWB systems compared with traditional narrowband systems has many advantages, such as the penetrating power, low power consumption, resistance to multi-path effects, high security, low complexity, and highly accurate positioning and so on. Therefore, UWB technology can be applied to indoor stationary or moving objects and people location tracking and navigation, and can provide very accurate positioning accuracy.

F. Cellular-Based

A number of systems have used global system of mobile/code division multiple access (GSM/CDMA) mobile cellular network to estimate the location of outdoor mobile clients. However, the accuracy of the method using cell-ID or enhanced observed time difference (E-OTD) is generally low (in the range of 50–200 m), depending on the cell size. Generally speaking, the accuracy is higher in densely covered areas (e.g., urban places) and much lower in rural environments [13]. Indoor positioning based on mobile cellular network is possible if the building is covered by several base stations or one base station with strong RSS received by indoor mobile clients. Otsasen et al. presented a GSM-based indoor localization system in [14]. Their key idea that makes accurate GSM-based indoor localization possible is the use of wide signal-strength fingerprints. The wide fingerprint includes the six strongest GSM cells and readings of up to 29 additional GSM channels, most of which are strong enough to be detected but too weak to be used for efficient communication.

E. Ultrasonic Positioning

Ultrasonic positioning technology has one-way law and reflective distance ranging method, which ultrasonic transmitter and receiver echoes generated by the measured object, according to echo the time difference with the launch wave under test to calculate the distance. Ultrasonic ranging mainly takes reflective distance method by triangulation positioning algorithm to determine the location of objects. The higher the overall accuracy of ultrasonic positioning, simple structure, but the ultrasound by the multi-path effects and nonline -sowing great influence, and needs a lot of the underlying Hardware infrastructure investment, the cost is too high.

F. IR Based Positioning

The principle of infrared positioning is that infrared IR modulated infrared ray emission is identified by the optical sensor installed in the indoor positioning receiver. Although the infrared has a simple structure, low cost and relatively high accuracy indoor etc., because light cannot pass through obstacles, it makes the only line of sight infrared ray communication. The two main disadvantages of the indoor positioning are Short sight lines and Transmission distance.

3. Problems and Challenges

Here we can reason that our proposed framework information DE duplication of record is done approves way and safely. . In this we have additionally proposed new duplication check system which produce the token for the private document. The information client needs to present the benefit alongside the united key as a proof of possession. We have settled more basic piece of the cloud information stockpiling which is just endured by diverse systems. Proposed routines guarantee the information duplication safely.

A. Accuracy

Accuracy of a positioning system is the closest calculated position that can be achieved to a target object. Different systems provide different accuracies. For example, RADAR systems provide an accuracy of 2-3 meters [8]. Where, a cricket system which uses ultrasonic signals has an accuracy of 2 cm [9]. However, the accuracy is still a very challenging area of research for many researchers in this field.

B. Range of Coverage

Each positioning system works in a different range. The most effective systems are the ones that cover the widest range. Ranges of existing systems go from 5 meters to 50 meters. Providing a system that has coverage of more than 60 meters is a challenge by itself.

C. Security

The security aspect of indoor positioning systems has not been a major concern in most of the undertaken research in this area. However, it is an important factor in positioning within Personal Network (PN) [10] which users use to position objects and people in their home. An example of a secure wireless indoor positioning system is the Beep system [11].

4. Conclusion

This paper surveys the current indoor positioning techniques and systems. Different performance measurement criteria are discussed and several tradeoffs among them are observed. For example, the one between complexity and accuracy/precision needs careful consideration when we choose positioning systems and techniques for different applications environments such as warehousing, robotics, or emergency. Usually, location fingerprinting scheme is better for open areas while Active RFID is suitable for dense environments. In terms of scalability and availability, these positioning techniques and systems have their own important characteristics when applied in real environments. The choice of technique and technology significantly affects the granularity and accuracy of the location information.

From this survey, we can see that each medium used in position estimations has its limitations. None of the technologies can satisfy the system requirements of performance and cost. Instead of using a single medium to estimate the locations of the targets, combining some positioning technologies can improve the quality of positioning services. For example, the SVG system combines the advantages of WLAN and UWB based positioning technologies, where WLAN technology can provide positioning services covering large area and UWB can give highly accurate position estimated in some small required areas.

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