Overview of common indoor positioning methods

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Abstract

In the 21st century is the era of information engineering, is an age of artificial intelligence, the rapid development of economic and social causes the people to improve production and living demands, so that the information model of frontier technologies such as artificial intelligence and indoor positioning appeared and rapid development in outdoor positioning technology is relatively mature, under the condition of indoor positioning as one of the core technology of artificial intelligence technology arises at the historic moment, and has a very rapid development momentum, it will be for the coming era of artificial intelligence play a crucial role.

Keywords

Intelligent mobile phone;sensor;radio-frequency signal;location service; indoor positioning.

1. Introduction

Rapid economic and social development, mobile phone, hand ring, new wearable Internet equipment, such as mobile devices are increasingly emerging, large and medium-sized cities of large buildings and streets, shopping malls, underground garage, warehouse, such as more and more, and according to the United States environmental protection agency's report, there are nearly 70% - 90% of their time is spent in indoor [1].Therefore, the realization of information management of buildings or projects and accurate and reliable indoor location positioning can not only bring better experience for users, but also have very important scientific significance and social value to meet the public needs such as intelligent storage, crowd monitoring, mobile health, emergency safety and human social contact.

2. Indoor positioning

Positioning technology according to the orientation of location can be divided into outdoor and indoor, outdoor positioning is based on satellite positioning technology, to map the location of the anchor point for rendering services, the technology is already relatively mature, is a kind of switch on for a quick to the intelligent mobile technology, its localization accuracy can reach the level of Amish, even has become one of the most widely used mobile set for use in.In contrast, the indoor positioning, development of smart devices, such as smart phones is rapidly in recent years, mobile sensors and different built-in positioning such as rf signal source is becoming more and more rich, however, due to the indoor environment is relatively complex, accompanied by spatial topology variable factors such as, to realize the indoor positioning is relatively accurate, reliable becomes not so easy, meet the needs of all kinds of specific environment positioning is still very challenging.

2.1 Types and status quo

Positioning is the location service of the Internet of everything, and it is one of the core technologies of artificial intelligence in the future. With the continuous improvement and development of smart phone technology, positioning information has become one of its indispensable basic information. There are a variety of location sources in smart phones, which can be divided into built-in sensors and rf signals:

built-in sensors: mainly including accelerometers, gyroscopes, magnetometers, barometers, light sensors, microphones, speakers and cameras;

radio frequency signals: mainly including WiFi, bluetooth, cellular wireless communication signals, etc.

With the exception of satellite navigation receivers, all sensors and rf signals are not set for location, but they do provide us with many indoor location sources. Today some of the world's giant male also in actively explore effective indoor positioning technology based on these positioning source, such as Google main research and development of indoor location services technology vision, apple is committed to promoting iBeacon indoor positioning technology based on low power consumption bluetooth, baidu to Finland IndoorAtlas's indoor positioning scheme based on magnetic field matching, etc. [1]

3. Sensor-based positioning

Although the accelerometer, gyroscope, light intensity sensor, camera, speaker and other built-in sensors are not set for positioning, they can be used as the built-in positioning source of rangefinder algorithm for different forms of positioning. Due to the relatively serious magnetic interference, its stability and measurement accuracy are also relatively low, so it is not enough for inertial navigation.

3.1 Magnetic field positioning technology

Magnetic field positioning technology is based on the establishment of fingerprint database with magnetic field intensity as fingerprint signal. However, this kind of matching and positioning needs to go through two processes of training and positioning.

Operability: IndoorAtlas, a navigation and positioning system based on geomagnetic field, is proposed by olu university in Finland. This method integrates magnetic field and built-in sensor, and the positioning accuracy can reach 0.1-2m [2].The current smart phones equipped with magnetometer generally, magnetic field signal is turned on for a quick, so smart phones can use magnetic positioning technology, but due to the magnetic field characteristics and closely tied to interior space distribution and environmental conditions, it is easy to be affected, so it is difficult to in the practical application of the magnetic field characteristic fingerprint library building to achieve precise positioning of the standard, and the magnetic field fingerprint database should be enriched and updated, real-time it means higher cost, so the realization of the magnetic field orientation still has considerable obstacles.

3.2 Visual positioning technology

The so-called visual positioning is to take electronic camera products as the visual point, through the establishment of image library, image matching method. Visual positioning usually uses the monocular camera on the smartphone, which mainly matches with visual positioning. It also needs to establish the image library with known location in advance, enrich and update it in real time, and then realize the positioning through field photo matching.

Maneuverability: the indoor scenes in reality are complicated and easy to change. The establishment of the photo library requires collecting a large number of photos, and extracting the significant image features of the registration point through repeated shooting and comparison, and then determining the object square coordinates of the significant image feature points in the positioning field. The advantage is that this bit can determine the posture of mobile phone shooting, more accurate; The disadvantages are that the algorithm of visual positioning technology is complex, the power consumption is high, and the updating of image library costs time and manpower, so the popularization needs further support of mobile phone technology.

3.3 Infrared positioning technology

Infrared ray belongs to electromagnetic wave, which is a kind of non-visible light, and its wavelength is 760nm-1mm, which is between microwave and visible light. The classic infrared indoor positioning system is the Active Badge scattering infrared technology system designed and developed by AT&T

Cambridge institute [1].That is, the receiving end conducts positioning by receiving a modulated and unique infrared signal transmitted by pedestrians every 10s.

Maneuverability: infrared emitter is small in size, light in weight and easy to carry, which is convenient for system installation and maintenance; However, the emission path of infrared positioning must be direct path, not too much path interference is allowed, and the operability is low. However, with the increasingly rigorous and perfect development of smart phone biometrics, indoor positioning using smart phone infrared LED will also attract more and more research attention.

3.4 LED visible light positioning technology

Visible light positioning includes two major categories: one is to locate the high frequency flicker signals that cannot be perceived by human eyes by modulating the light source, and the accuracy can reach the level of meters [3].The second is also the use of time frequency characteristics of ambient light, the establishment of fingerprint database matching method.

Maneuverability: similarly, the positioning of the former requires specific optical signal transmitting and receiving equipment and direct path, which requires high directional requirements for the optical sensor and poor anti-interference ability. The latter requires the establishment of an efficient and real-time updated fingerprint database for complex ambient light, so it is not easy to realize.

3.5 Ultrasonic positioning technology

Ultrasonic positioning technology is a method of transmitting ultrasonic wave to the object to be measured and collecting back and forth signals, and then calculating the distance through time difference.

Operability: the ultrasonic positioning system has a relatively simple structure and positioning accuracy up to centimeters [4], but the disadvantage is that currently there is no ultrasonic transmitter in smart phones, and the ultrasonic signal is easily affected by indoor environment, and the attenuation is obvious in the channel propagation process, so it is not conducive to promotion and use for the time being.

4. Location based on rf signal

Today's smart phones are relatively rich in functions, all equipped with WiFi, bluetooth, cellular wireless communication and other technologies, and the location algorithm mainly based on ranging and non-ranging two categories. Due to the relatively complex indoor space environment, the signal multipath propagation is often interfered or blocked. However, the advantages of non-ranging positioning technology based on RSSI(received signal strength response, radio frequency received signal strength) are highlighted. It has the advantages of low cost of detection equipment, simple and easy positioning method, and relatively stable measurement signal. Therefore, some RSSI-based positioning algorithms are widely adopted in indoor positioning technology.

4.1 WiFi location technology

WiFi location is an indoor location technology based on wireless local area network signals, mainly including ranging rendezvous and fingerprint matching. Ranging intersection is a method to obtain position estimation based on distance and channel attenuation model by measuring the signal strength (RSSI) of the receiver to multiple WiFi access points (AP) [5].The matching and positioning mode of fingerprint is the same as the above mentioned magnetic field and visual positioning. The fingerprint database needs to be formed through collection and training, and then the measured value and grid fingerprint are compared and matched to achieve positioning.

Maneuverability: due to the complex indoor environment and variable non-line-of-sight phenomenon, it is difficult to accurately estimate the channel attenuation model, which will affect the final positioning accuracy. Besides, the construction cost of WiFi system is high and the power is large, which is not conducive to its investment and promotion. At present, RSSI fingerprint matching WiFi positioning systems include RADAR, Ekahau, Horus, etc.[6], and their positioning accuracy is 2-5m. However, they are not mature enough to be widely used.

4.2 Bluetooth location technology

Bluetooth is a short-range rf signal based on wireless personal area network (WPAN) IEEE802.15.1 protocol [7]. Its working frequency is at 2.4ghz and the signal transmission distance is usually about 10m. With the continuous progress of technology, the new BLE4.0 protocol supports the maximum transmission distance to 100m.

Maneuverability: bluetooth positioning has the advantages of low power consumption, small size and high cost performance ratio, and has been widely used in smart phones and other electronic devices. The disadvantage is that the coverage of each base station is small, extensive installation needs a certain cost, and the stability of complex space environment is slightly poor.

4.3 Cellular positioning technology

Cellular communication positioning technology, also known as RAN (radio access network), USES 2G/3G/4G mobile signals to design positioning protocol or add positioning module in the base station for positioning [8].

Maneuverability: the biggest advantage of cellular positioning technology is that it is easy to achieve indoor and outdoor seamless positioning, the disadvantage is limited by system design, signal modulation mode, international standards and other factors, can only reach tens of meters to hundreds of meters of positioning accuracy, can not meet the needs of most indoor positioning applications. However, with the rapid development and application of 5G communication technology, this technology is expected to get further attention and improvement.

4.4 Ultra-wideband positioning technology

Ultra-wideband (UWB) positioning technology is a new positioning technology that USES anchor nodes and bridge nodes with known positions to form triangulation or "fingerprint" positioning with newly added blind nodes [9-10].It transmits data by sending and receiving extremely narrow pulses of nanoseconds or less, eliminating the need for carriers in traditional communication systems.

Maneuverability: the advantage of ultra-wideband positioning is that it has strong penetrating force, good anti-multipath effect, high security, low complexity of the GHz scale bandwidth, the application prospect is very broad; However, since new blind nodes need to be laid out in advance, and communication power consumption is high, the cost cannot meet the requirements, so temporary request is not conducive to promotion.

4.5 ZigBee indoor positioning technology

ZigBee is an emerging short-distance, low-rate wireless network technology [11-12]. It forms a network through a known position reference point and several undetermined sites, and transmits data from one node to another through radio waves in a coordinated relay, so as to realize the positioning of all nodes through calculation.

Operability: the core advantage of ZigBee indoor positioning technology lies in its low communication power consumption and high work efficiency; At the same time, however, its disadvantages are particularly obvious. Just like infrared ray and ultrasonic wave, signal transmission is greatly affected by multipath effect and environmental complexity. How to ensure the smooth and stable channel space is still the key to solve the problem.

5. Conclusion

Different from open and clear outdoor space, indoor space needs different methods due to channel quality, topological variation, signal decay and other factors. The positioning method based on the built-in sensor does not rely on infrastructure, but with the increase of service life, errors will accumulate; The shortcomings of indoor positioning method based on radio frequency signal are also obvious. The changeable path, complex environment and human flow density will interfere with the accuracy of positioning, or the error of fingerprint matching, or even directly cause matching errors. Under the premise that the respective defects of the above positioning methods have not been effectively solved, the final solution is to seek multi-source and multi-core fusion technology method

to solve the indoor positioning problem, so as to achieve wide-area universality, and even to seamlessly connect indoor and outdoor positioning.

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