

INDOOR POSITIONING SYSTEM (IPS) FOR GUIDING THE LOCATION INVENTORY GOODS IN BUILDINGS

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ABSTRACT: Now is the spatial era, where position plays a role in providing information about the existence of objects on earth. Utilization of a variety of devices requires demands on location automation that are fast and accurate. Positioning technology, known as Location-Based Services (LBS), is highly dependent on the Global Satellite System (GNSS). Now for automatic positioning also started using the Indoors Positioning System (IPS), where GNSS signals that cannot be reached inside the building can be replaced with Bluetooth and Wifi devices installed in the building. This is very important because activities in buildings are the same as benefits outside the building, such as position interests, spatial patterns, guidance or navigation, etc. for a variety of very broad interests such as smartcity, airports, hospitals, hotels, museums, parking lots, shops, exhibition and others. This research aims to utilize IPS as a means of positioning and guiding inventory objects in building space, which can be developed for various applications. Just as GPS uses satellites for reference positions, IPS also requires a number of iBeacon devices installed at a known position to communicate and determine the location of the receiving device (smartphone). Position information from the device will then be sent to the server and then mapped to the information system. Objects targeted by tracking can already be mapped using IPS based on coordinates obtained from the system, and will then be compiled as an object inventory database. Furthermore, a smartphone is used as a guide to see realtime position and then can track the goods based on coordinates in the inventory database

Keywords: Position, LBS, Indoors Positioning System, Inventory, Guide



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1. INTRODUCTION

In this era, spatial information are very important. Location has a big role in providing spatial information about the existence of objects on earth. Utilization of various devices requires accurate and fast location automation. Positioning technology known as Location Based Services (LBS) relies heavily on the Global Navigation Satellite System (GNSS) or commonly known as the Global Positioning System (GPS). While the Indoors Positioning System (IPS) technology also began to develop to overcome the weaknesses of GNSS in buildings, by utilizing communication devices installed in the room. Location Base Services (LBS) was developed rapidly in 2016, the level of growth and innovation will continue to grow, according to the Smarter Insights analysis, this is among the top 3 of the eight existing cellular technology trends. This app that exploits indoor locations precisely uses Wi-Fi technology, Li-Fi, photo and video imaging, ultrasonic flares and geo-magnetics or a combination of them [2]. The limitations of GNSS in the service of signals from satellites are then complemented by the use of Bluetooth and Wi-Fi signals that are growing

rapidly today. The advantage of Bluetooth is the ability to communicate in data, signal connections and very little energy. Although limited in range, it is a cheap and efficient system which can be developed in quantity.

Spatial information is not limited to phenomena that exist outside of (outdoor) even this phenomenon can be applied inside of room (indoor). Many daily human activities, especially in urban areas, are carried out in building, so mapping in building is also important. For example, office activities, employee movements, inventory, employee movement patterns, all of which can be evaluated with parameters such as distance, interaction, movement patterns, and so on.

The advantage of the use of this IPS are many information systems that can be developed based on spatial information. Display interface using digital devices from smartphones, tablets, notebooks, and personal computers can be used as a means of visualization and simultaneously display a variety of information that is both descriptive and spatial. The opening of this opportunity will provide a great opportunity in its development.

Future development is very necessary because the activities in the building are as important as the

various activities outside the building, such as the interests of the location, spatial patterns, guides, and so on for a variety of very broad interests such as smartcity, airports, hospitals, hotels, museums, parking lots, shops, exhibition and others. Spatial information in buildings has not yet made use of spatial location positioning, even though the existence of floor plans and maps of building and space locations have been applied in the Building Information Model (BIM). The existence of space will of course be followed by the placement of goods, such as furniture and office supplies such as printers, document folders, books and so on. Difficulties in locating and positioning spatially on these items cause their existence will also not be well documented and make it difficult to search later.

Integration between BIM and IPS makes it easier to determine position as one of the important information for placing objects in buildings that are still limited and not as popular as GNSS as a positioning system. The completeness of IPS in the building should be able to assist in various spatial information needs. Data input, process and output will certainly be facilitated with this assistance, as well as the use of GPS in positioning in the field. This can be integrated in information systems directly. Therefore we need an information system that can utilize IPS as a model of data input and visualization and users guide navigation.

Spatial-based information systems are needed in an office system. Companies, organizations, or institutions have a lot of items contained in a room / building. These items have generally been carried out an inventory. However, in reality if one day the goods are needed, there is difficulty in finding them due to the transfer of goods that are sometimes not controlled. So IPS needs to be applied in the interests of inventory of goods with the guidance information system. The purpose of this activity is to 1) Apply the Indoors Positioning System as a spatial data input system in a LBS-based building. 2) Applying information systems to inventory and guide the existence of inventory items in buildings. As well as being useful in: Providing increased inventory information of goods spatially and at the same time utilizing the guide application as navigation in the building. Also for development other benefits by utilizing the same techniques and methods as for the interests of event organizers, spatial planning and so on.

2. METHOD

Spatial data is data that can describe the facts in the field [5]. Spatial data contains information about the locations of objects on earth. This relates to technological developments in obtaining data, collecting, and processing spatial data. Geographic

information systems are tools that can be used to process existing spatial data. Spatial web-based GIS or WebGIS can be used for digital mapping and integrated with the internet to communicate in a digital map format that can be accessed by all people. Web-GIS can perform analysis and query functions related to geographic information systems through the internet network. MapServer is an open source application that can be used free of charge for creating Web-GIS. One example of MapServer conducted in this study is the use of the Mapwize application to build a spatial map database of a building.

Pseudolite (pseudo satellite) technique is used to determine the position or location of an object with radio wave technology. pseudolite utilizes radio frequency signals with a high accuracy in real-time based on the Doppler effect and the Multi-triangulation method. If the distance of an object is known from other objects around it, its position can be determined based on the multi-triangulation method. This technique has been developed by utilizing radio signals and placement of references (satellites or other media) that have been known to get the position of new objects that can capture signals from the reference station (Figure 1.). GNSS and IPS use the same principle to obtain a position from a receiver that can catch these references [3].

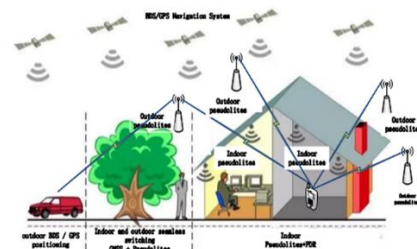


Fig 1. Indoors Positioning Systems (IPS) Used Pseudolite Technique

Smartphones have become a central part of everyday life, phone calls are now the smallest part of functional use (only about 5 percent). Cellular phone and tablet manufacturers continue to add the ability to expand the functionality and value of mobile devices. One that was developed from this cellular device is LBS. LBS is a system grafted into a smart device to get better position information on earth. Many analysts have identified precise indoor location sensing as one of the trends and capabilities of the second top cellular technology. Knowing an individual's location within a few meters is a major factor in sending highly relevant contextual information and services, such as the example of sending in-store promotional messages to smartphone applications, known as proximity marketing.

Previously known as Global Positioning System (GPS) which is a technology for determining location on the surface of the earth using satellite navigation. GPS uses several / many satellites to improve the accuracy of determining the absolute location of an object of study on the surface of the earth. Please note that if the GPS only has few satellite, the accuracy of the data points displayed are not too accurate when compared with the use of more satellites. The use of satellites on GPS has a minimum of four satellites to determine the position of X, Y, and Z of an object of study. Global Positioning System (GPS) can help humans to recognize the location where he is and help in analyzing a problem in a spatial context, however the use of satellites only reaches outside the building (outdoor). IPS is also called fake GPS, in principle the same as the GPS principle but uses a different device by utilizing the signals transmitter [1].

Indoors Positioning System (IPS) is the determination of the location / position of an object in the room [4]. The use of IPS is slightly different from the principle of using GNSS which uses satellite. Use of IPS can use Wi-Fi or use Bluetooth. GNSS and IPS integration in general are interrelated but indirectly. IPS requires a description of the room that will be used as the object of study, while the sketch of the room uses a reference point obtained from GPS coordinates. IPS requires Bluetooth Low Energy (BLE) to be able to determine the location of an object in the room [6]. BLE is a device for transmitting and receiving Bluetooth signals that can be used to find out the signal locations of a device connected to the BLE. BLE will receive signals emitted by the device and processed into location information from the signal transmitter. Later a database can be built containing the locations of the Bluetooth signal transmitter devices and further analysis can be done. The analysis can vary, such as determining the hotspot of visitors at an exhibition, determining the location of goods in a building, also monitoring employees in a company [2] [7].

Position perspectives can be divided into two types: Proximity and Position, IPS can determine these two things by answering the choice of questions (1) What are you near?, and (2) Where are you exactly? [2]. In knowing these two things which can later be developed into an information system, the approach taken technically can be illustrated in the following illustration (Figure 2).

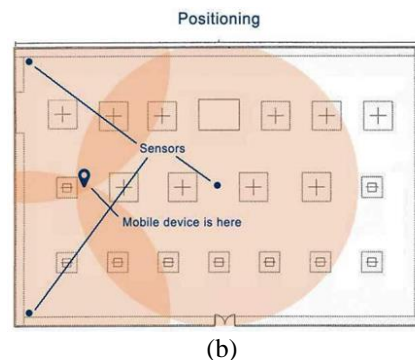
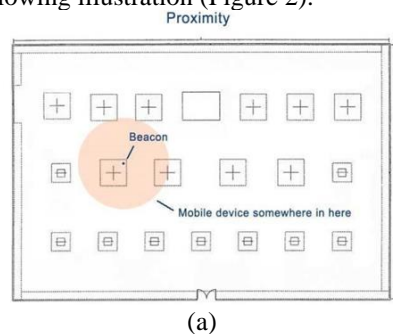


Fig. 1. Position perspectives can be divided into two types: (a) Proximity and (b) Position

Spatial data combined with the capabilities of IPS, WebGIS and Smartphones can provide an information system automatically about the existence of an item and is applied in a search path to get it (Villarrubia et al. 2019). This kind of application will certainly be useful in the efficiency of the placement and arrangement of objects in a room or building.

The tools and materials needed for this activity are: 1) A number of Bluetooth Low Energy (BLE) used in buildings, 2) Smart Devices (Tablets/ Smartphones) that are used to run mapwize applications and are integrated with the use of Bluetooth. 3) Personal Computer (PC) for creating a database of space to be mapped and used for spatial information systems, 4) Distometers, laser distance meters, 5) detailed floor plan pictures and converted in digital to Mapwize applications. Software used include 1) ArcGIS 10.2 Pro for the digitization process and map making 2) Mapwize application, this application is used to map the room by using iBeacon.

Stages of activities include: 1) Installation of Devices, Installation of tools and materials by attaching or placing Bluetooth Low Energy (BLE) in a spread manner with range between devices as much as the range of Bluetooth used. Installation by placing the tool in a certain place or by attaching it to the wall using adhesive tape. How to install it by systematically placing Beacons in a safe location and spread evenly (disperse), such as corners of the room with a measured distance adjusted to the ability of the Beacon signal. 2) Drop room/floor plans for inventory of goods location then input into the Mapwize application. In the application, room/floor plans would be integrated with a map database that is loaded in the Mapwize application, so the coordinates of the room can be determined by dragging the location icon on the application to determine the reference coordinate points. 3) placing Inventory Item (goods) to the position in the map. It aims to determine the coordinates of each item in the room. Input coordinate inventory items can be made a database and integrated with

inventory data in the office 4) Information System would present the results of an inventory of objects and display the plotting of coordinates on the interface device 5) Inventory items are then plotted into a digital database in mapwize as point of interest, then an information system is built which aims to enable users to track (wayfinding) where the inventory goods is placed. Development of information systems can show the closest route and the fastest route or distance and time needed in a building from where users go to the inventory of goods to found. 6) Evaluation and Discussion of Results, The results of the analysis were used to see how far the accuracy was generated for the inventory of goods based on the distance produced by IPS.

3. RESULTS AND DISCUSSION

Building/Floor Plans in were the primair of determining detailed references for indoors positioning. The accuracy in the technical drawing used affects the accuracy that is produced. The building is depicted on a 1: 150 print scale and converted to a PNG digital data format. This building image is a detailed background of the process of making features of point of interest location objects and polygon room areas as a feature of the information system model and the beacon position reference installed, which was built by digitizing important objects such as rooms, points of interest, and beacons, determination of item names and its location can be referenced from floor/building plans. It must be placed precisely on a base map reference like google maps or open street map as a general reference. Placement of the pictures floor plan plotted on the base map can be bound by referring to the same object from the base map. Inaccuracies in the placement of floor plans will result in a systematic decrease in accuracy. However, if there was a placement error at the position, it was possible to correct it by panning it. Beacon placement is very important to adjust to the signal settings and the placement position that is spread, Beacon is placed at a certain point of the building so that the coordinates of the position can be directly identified. Each Beacon has a unique identity integrated with the system with the specific alias name, UUID, Major, Minor and Tx Power. Automatically, each beacon would be assigned an ID to then be able to determine the position of the Multi-triangulation calculation results, such as GNSS. (Figure 3)

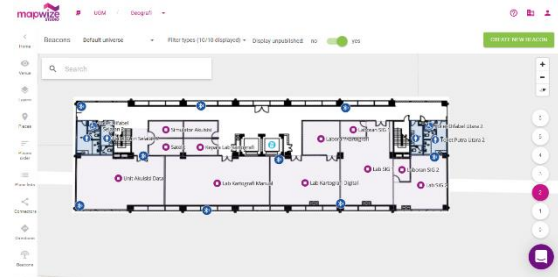


Fig. 3. Venue, Layers, Places, Connectors and Beacon input process at mapwize studio

As like as guide from mapwize application, the process includes: (1) establishing a venue, as an area determined for the building location (2) then making the stratified building layers arranged according to the building floor plan (3) each important object and polygon area is defined as a spatial feature (4) making connections between floors such as elevators, escalators or stairs (5) making networks for direction guides that can be adjusted according to the direction and node of the network. It is very important to define the model to be determined, to be modeled close to the actual conditions, such as the trajectory that is traversed by people and the determination of lanes in a large room. Here beacons will determine the position of the device in the room so that the application can direct the user to the desired location through a network of directions that have been made. By following the line that appears and the direction of the map, it will arrive at the destination location. (Figure 4 and Figure 5).

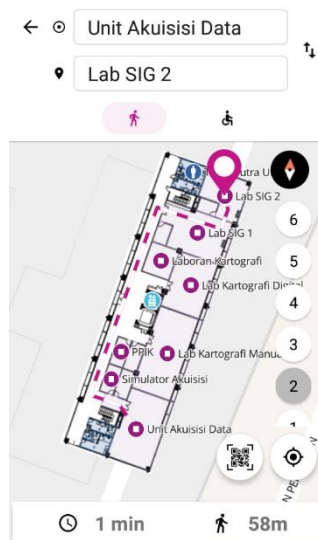


Fig 4. Navigation Guide from “Unit Akuisisi Data” to Position of “Lab SIG 2” by Android Smartphone

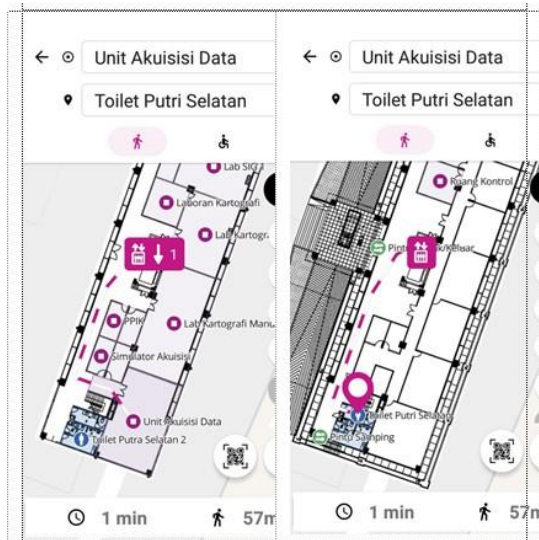


Fig 5. Navigation Guide from “Unit Akuisisi Data” to Position of “Toilet Putri Selatan” connecting by elevator from Floor 2nd to Floor 1st by Android Smartphone

4. CONCLUSIONS

First, the use of beacons as 'fake GPS' can determine the position of a device in a building, accuracy is very dependent on errors caused systematically from the LBS and non-systematic from the drop position of the building plans images and beacon plotting drop on the base map. Second, Indoor positioning wayfinding can direct the device to the location of the intended goods, by setting the location of goods as a place and the network as a direction guide.

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