Comparative Analysis of Indoor Positioning System using Bluetooth and Wi-Fi

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Abstract

An indoor positioning system (IPS) is defined as the network of devices which is widely used to wirelessly locate objects under the same roof using radio waves, acoustic signals, magnetic fields and other sensory information grasped by mobile devices. Reliable indoor positioning is a base for emerging indoor location based services. Bluetooth - Indoor Positioning System is said to be the intersection of Indoor Positioning Systems and Bluetooth Technology. Similarly, Wi-Fi Indoor Positioning System is the intersection of Indoor Positioning Systems and Wi-Fi Technology. This paper presents a comparative analysis of Wi-Fi and Bluetooth using IPS.

Keywords: Indoor Positioning System, Bluetooth, and Wi-Fi

I. INTRODUCTION

An indoor positioning system (IPS) is dependent on the nearby anchors i.e. nodes with a known position, they either provide environment context or actively locate tags for devices to sense. The localized nature of an IPS results in design fragmentation which has systems that makes use of various radios, optical or even acoustic technologies[2][5].

Since GPS does not work on indoors, Wi-Fi and Bluetooth are good alternatives for indoor positioning and indoor navigation. Indoor navigation uses Wi-Fi and senses when it has to replace GPS in buildings. This paper uses Bluetooth and Wi-Fi and aims at providing the comparative analysis of Indoor positioning system [5].

- Bluetooth - A wireless technology standard to exchange the data overshot distances (via ISM band from 2400-2480 MHZ in short-wavelength radio transmissions) from mobile and fixed devices. It creates personal area networks for high level security.
- Wi-Fi - Any wireless local network product which is based on the IEEE 802.11 standards. The merit of Wi-Fi over Bluetooth is that it essentially needs no infrastructure effort to track applications if the indoor area is covered through Wi-Fi signal.

The merits of using a wireless solution in industrial applications are as follows:
1) Higher mobility and greater possibility to move devices and eventually connect to tablets or smart phones freely without constraining to cables,
2) Elimination of costly transmission media and its maintenance like the swivels, flexible cables and by-passing long distances areas where cables could not be practically fit
3) For quick and easy installation process,
4) For higher flexibility if a need arises to modify an existing installation
5) To increase the personnel safety by maintaining distance between devices during maintenance and configuration
6) To simplify integration of devices inside the network.

II. LITERATURE SURVEY

Bluetooth is said to provide a reliable solution to the interior location [3]. Another working group is called for local positioning which was set up to develop a Bluetooth description. The type and format of information not only allows the Bluetooth device to exchange the location information, but also the co-ordinates of the algorithm [5]. Anyhow, it takes enough time before the group with personal data, since the author is presently engaged in a project to grasp the performance of local Bluetooth positioning.

Many research & tests for the usage of Wi-Fi communication for indoor navigation has been done in the long past through optimized and advanced versions of algorithms [7]. Through dense network of access points and by RSSI measurements over the Wi-Fi signals one can determine the distance of user’s device using individual access points, and finally applying the trilateration technique for precise position determination. This gives a clear picture in estimating the mobile device’s location in indoor setting.

There is a growing organization for research work mainly concerned with indoor positioning, primarily driven by the desire to personalize or augment the users experience in a contextual range. Currently, one of the promising works has mentioned the fact that despite the excessive use of smart phones and technology infrastructures which has the potential to provide precise positioning is it reliable with respect to positioning? It’s still an on-going research question.
III. RELATED WORK

Among the different existing proposals for indoor positioning, Wi-Fi and Bluetooth are two widely used wireless technologies. We briefly review Wi-Fi based and Bluetooth based indoor positioning.

A. Wi-Fi Based Indoor Positioning

Wi-Fi refers to a wireless technology that stands for Wireless Fidelity which allows devices to communicate over a wireless signal. IEEE standard 802.11 also known as Wi-Fi; uses the centralized router devices for sharing Wi-Fi signal with the inclusion of other additional standards such as 802.11a, 802.11b, 802.11g and 802.11n. Wi-Fi supports additional features: Power management (802.11h) and Security mechanisms (802.11) include WPA/WPA2/WEP. For the transfer of data with high speed over short distances, waves are been used by the Wi-Fi networking technology.

Like Ethernet and token ring siblings (fig 1), Wi-Fi is designed for use in limited geographical areas such as home, office buildings, campuses, by allowing local area networks (LANs) to process without wiring and cables.

For many modern devices such as tablets, computers, laptops and mobiles the wireless broadband internet access is provided by Wi-Fi with authentication. With the functionalities of Wi-Fi, high data transfer rate can be accessed by broadband internet connection (fig 2). The major attractive feature of Wi-Fi is that it provides broadband connection for wireless communication within a specific geographic space.

B. Bluetooth Based Indoor Positioning

Bluetooth technology is beneficial when information needs to be transferred between many devices that are nearby and when the speed is not the issue, such as printers, modems, smart phones and telephones. It is most suitable for the applications which specifically uses lower-bandwidth for transfer of data within précised geographical boundary, such as transferring audio information with telephones i.e., with a Bluetooth headset or with hand-held systems for (transferring files) for byte-data or mice and keyboard. In order to enable positioning the deployment of Bluetooth hotspots in indoor space was practiced.
Since Bluetooth hotspots relatively cover limited space, the proximity analysis is been employed by the Bluetooth based indoor positioning systems for position estimation. Specifically, the locations deployed by Bluetooth hotspots are tracked as reference positions. These reference positions are returned as the user’s position estimates when a Bluetooth-enabled device of the user enters a specific hotspot’s range, the hotspot of the device identified (or vice versa).

It is even possible to utilize the range of detection of a Bluetooth hotspot to nearly approximate a user’s present position. In this case, (fig 3) when the multiple Bluetooth hotspots are detected paralellly at a location, intersection of all the hotspot detection ranges or band can be used to approximate the user’s location. However, these techniques are most complex in nature as they might return erratic regions as location estimates; this even involves expensive geometrical calculations.

For application in industry, wireless technology has to be compatible when the environment is noisy. Bluetooth utilizes the features of Adaptive Frequency Hopping (AFH) and Forward Error Correction (FEC) to operate. It gives a universal short range wireless capability. It operates within the 2.4 GHz frequency band and devices within 10m from each other can share data upto 720Kbps of its capacity. Before making the connection between the devices, this technology or system which is an authenticated one sends the acknowledgement from receiver to transmitter.

![Bluetooth connection](image)

**IV. BLUETOOTH V/S WI-FI**

**A. Formulation**

The invention of Bluetooth technology has been credited to Ericsson in the year 1994 which then launched it as an alternative to wireless communication to RS232.

Though Wi-Fi had researches since mid 80s, it was officially launched in 1997. A separate committee for the development of Wi-Fi was then set in the year 1990 head by, Mr. Victor Hayes – The Father of Wi-Fi.

**B. Standards of IEEE**

Bluetooth which was initially defined under IEEE 802.15.1 standard is now taken care under a special interest group (SIG).

Wi-Fi, which was defined under 802.11.x series of protocols and is presently maintained under the same protocol. Various companies have founded a Wi-Fi alliance, which tests and authorizes gadgets to be compatible with Wi-Fi.

**C. Frequency**

Wi-Fi based networks work at 2.4, 3.6 and 5GHz. Whereas Bluetooth works at 2.4GHz frequency.

**D. Range**

Bluetooth based wireless connection has a maximum range of 30m whereas for Wi-Fi it can extend almost upto 100m. In Wi-Fi, the range is dependent on the versions of its Wi-Fi protocol applied and addition of antennas in communication system. While no such range concerns or extra antennae are so much known in case of Bluetooth.

**E. Connection of Devices**

In Bluetooth, upto 8 devices can be connected to one another. Whilst in the case of Wi-Fi, the number of maximum connections depends on Wi-Fi router. The routers can simultaneously accommodate one to several communicating devices.
F. Security

In Bluetooth, the earlier versions were encryption and till date Bluetooth security is limited to key matching. Whilst in Wi-Fi, the standards of security have been inclusively provided with new versions. Wi-Fi Protected Access (WPA) and Wireless Equivalent Privacy (WEP) are the most used security accesses in Wi-Fi.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Wi-Fi</th>
<th>Bluetooth</th>
</tr>
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<tbody>
<tr>
<td>Cost</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Authority of specifications</td>
<td>IEEE, WACA</td>
<td>Bluetooth SIG</td>
</tr>
<tr>
<td>Security</td>
<td>More secure</td>
<td>Less secure</td>
</tr>
<tr>
<td>Development year</td>
<td>1991</td>
<td>1994</td>
</tr>
<tr>
<td>Latency</td>
<td>150 ms</td>
<td>200 ms</td>
</tr>
<tr>
<td>Bit-rate</td>
<td>600 ms</td>
<td>2.1 ms</td>
</tr>
<tr>
<td>Typical link length</td>
<td>100 m</td>
<td>10 m</td>
</tr>
<tr>
<td>Power consumption</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Latency</td>
<td>150 ms</td>
<td>200 ms</td>
</tr>
<tr>
<td>Wired technology analogy</td>
<td>Ethernet</td>
<td>USB</td>
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<tr>
<td>Hardware requirement</td>
<td>Wireless access points, Wireless adaptors on all devices of the networks</td>
<td>Bluetooth Adaptor on all the devices</td>
</tr>
</tbody>
</table>

Wi-Fi security strategies are:
- Block your Service Set Identifier (SSID) from being broadcast.
- SSID that allows identifying the service network: it is a 32 bytes character string of a variable size.
- SSID is used in order to guarantee the authentication and the identification between an AP and a client.
- Wireless beacon so PCs can easily find the access point. Change the default network name in the access point.
- Change the default access point password.
  - Center the access point in the middle of the building, house or any other place.

G. Power Consumption

Can work at longer distances and capable of being loaded with high quality security protocols? This makes Wi-Fi a power consuming protocol when compared to Bluetooth.

V. CONCLUSION

To summarize, it can be said that amongst the two Indoor Positioning System, Wi-Fi outmaneuvres the other i.e. the Bluetooth system through its capability and compatibility in different work environment. Overall, Wi-Fi uses better protocols and algorithms to deliver better performance i.e. from its location determination of a mobile user to the Quality of output. And also the security provided by Wi-Fi is more compared to Bluetooth, for this Wi-Fi uses WPA (Wi-Fi Protected Access) and WEP security protocols. Follow-up work will concentrate on the further analysis and system improvement of the models and on the integration with other protocols to deliver better quality signals to smart phones.

REFERENCES


