International Journal of Advanced Research Methodology in Engineering & Technology,
Special Issue, March 2017, ISBN 978-1-63535-324-2

BLE Based Asset Location Identification Using IOT

J.Nadimuthu.[1] ,S.Prabhakaran[2] ,
E.Subbaiah[3] ,M.Vignesh Pandian[4] ,
Electronics and Communication Engineering ,
Kings college of Engineering,
Punalkulam,Thanjavur.
Prabhas3095@gmail.com

Mrs.P.Geethabhai ,
Assistant professor/ECE,
Kings College Of Engineering ,
Punalkulam,Thanjavur.

Abstract—During the last decades, location based services have become very popular and the developed indoor positioning systems have achieved an impressive accuracy. The problem though is that even if the only requirement is room-level localization, those systems are most of the times not cost-efficient and not easy to set-up, since they often require time-consuming calibration procedures. This paper presents a low-cost, threshold-based approach and introduces an algorithm that takes into account both the Received Signal Strength Indication (RSSI) of the Bluetooth Low Energy (BLE) beacons and the geometry of the rooms the beacons are placed in. Performance evaluation was done via measurements in an office environment composed of three rooms and in a house environment composed of six rooms. The experimental results show an improved accuracy in room detection when using the proposed algorithm, compared to when only considering the RSSI readings. This method was developed to provide context awareness to the international research project named SmartHeat. The projects aims to provide a system that efficiently heats a house, room by room, based on the habitants' habits and preferences.

Keywords—Indoor positioning, localization, Bluetooth low en-ergy, RSSI, room-level accuracy

I. Introduction

In the past two decades, there has been a continuous rise in interest in location-aware applications. After the invention of the Global Positioning System (GPS), more and more devices have included a GPS receiver and have been using this technology. Especially with the rise of the smartphones, Global Navigation Satellite System (GNSS) receivers have become available in the market at low cost, and are nowadays ubiquitous. While the GNSS is an exemplary solution for most outdoor applications, it is not suitable for indoor environments. Therefore, new technologies and systems have been invented that can be used for indoor localization.

One common category of such systems is that of the inertial ones, namely those that use an inertial measurement unit tracking technique, such as the pedestrian dead reckoning

[1]. Sound based systems also exist, using for example ul-trasound anchor beacons with known position [2]. There are also systems that use other spatially dependent environmental properties such as magnetic fields, visual object recognition and light. Last but not least, there are hybrid systems that are implementing multiple technologies [3] or that are using multinodal sensoring [4].

However, the most widespread indoor localization technique is by using radio transmissions. Methods that use radio include Wi-Fi devices that are popular and widely deployed, and Bluetooth beacons that are of low cost [5]. Those systems either estimate the distance between the transmitter and the receiver by employing path-loss models or employ location fingerprinting to infer a position. The measured radio signal quantities typically include the link quality, the time of arrival (TOA), the angle of arrival, the time difference of arrival, the signal-to-noise ratio (SNR) and the RSSI. The RSSI is the relative received signal strength in a wireless environment, in arbitrary units. RSSI is an indication of the power level being received by the antenna and therefore, the higher the RSSI number, the stronger the signal.

Our approach to indoor localization is based on the use of BLE beacons, using the RSSI value, since it is available in all standard wireless communication devices. The important feature of our approach that distinguishes it from other systems based on Bluetooth is that it does not only rely on radio signal quantities. It also takes into account the geometry of the rooms the beacons are placed in, i.e. the height and the surface area. Since the requirements of the localization system to be developed were minimal cost and setup process for the end user, we used the minimum amount of BLE beacons, that is one BLE beacon per room attached to the ceiling in the center of it, and we opted to develop a more sophisticated algorithm for room detection.

In ubiquitous computing the need for location information is critical and several context aware applications are in need of an indoor positioning system for room localization. Our motivation in developing this indoor localization system with room-level accuracy is to provide contextual information to the international research project named SmartHeat. The project aims to provide a system that efficiently heats a house, room by room, based on the habitants' habits and preferences. It will also be used to provide location information to the F2D fall detection system [6], as a way to provide the system with context awareness in order to improve its accuracy as well as the reaction time of the user's carers. The same solution, though, can be easily deployed and used for any application that requires room-level localization.

Ideally, in line of sight conditions the performance of such a system can be accurate. On the other hand, the RF signals indoors are prone to disturbances due to shadowing, fading, the multipath propagation phenomenon and device imperfections. These can lead to major errors when estimating distances based on the radio signal quantities, since the signal can significantly fluctuate. This can be confronted by not using exclusively the newest reading of the signal quantity, but by averaging a set of the latest ones [7].

The rest of this paper is organized as follows. In Section II we present some of the related work on indoor localization using Bluetooth and other technologies. Then, in Section III we present the system we designed, while the experimental evaluation of it in an office and in a house environment is included in Section IV. Finally, our conclusions are drawn in Section V.

II. Related work

Location information is essential for a wide range of ubiquitous and pervasive applications. This is the reason why the topic of determining the position of a device has been the subject of many studies. In this section, we give an overview of some existing systems and implementations that use Bluetooth as well as other technologies as a means to achieve room-level localization. All different implementations have had to balance the technologies used in terms of cost, precision, accuracy, portability, ease of installation, deployment and use.

One of the first indoor badge positioning systems is the Active Badge system [8]. Active badges were used to emit a globally unique infrared signal and were carried by people. Sensors were placed in each located place such as a room, in order to detect the signals sent by the active badges and to infer a position for each badge. Although the sensors and the badges were cheap, the sensors had to be connected to a central server and the cables raised the cost of the system, despite the room-level accuracy that it provided. The use of a central server is also not suitable for our application.

Another way of indoor localization is by using ultrasound signals. Inspired by bats that use those signals to navigate at night, several such systems have been developed. The Active Bat positioning system [9] is using tags that periodically broadcast a short pulse of ultrasound. Ceiling mounted receivers at known positions receive the aforementioned pulses. Using the TOA measuring method and trilateration, a 3D position for every tag can be calculated. Generally, the performance of the ultrasound technology is hindered by reflections and by obstacles between receivers and transmitters. Although the system has achieved an impressive accuracy in positioning, the use of a large number of receivers by the Active Bat and the interconnection between them, limit the scalability of the system.

Conversely, the Cricket indoor localization system [2] uses ultrasound emitters attached on the walls or ceilings at known positions and receivers attached to objects to be located. The system uses again TOA and the trilateration location technique to infer a location. On top of this, radio frequency (RF) signals are used for the synchronization of TOA and for proximity positioning to address fault tolerance issues. Although the system was not targeting room-level accuracy, less ultrasound emitters can be used to achieve this, leading to a proportional decrease in both cost and accuracy. The problem with this approach though, is that both the transmitters and the receiver need more power, since they have to handle both ultrasound and RF signals at the same time.

A large body of indoor localization approaches use the Wi-Fi technology, as to take advantage of the spread of wireless access points in urban areas. The RADAR system [10] uses the existing WLAN technology and employs RSSI and SNR with the triangulation localization technique. Another system named WILL [11] also uses the existing Wi-Fi infrastructure and mobile phones to localize the user indoors. On this occasion site survey is not needed and thus the deployment is easy and rapid. Although Wi-Fi positioning is one of the most popular indoor positioning techniques, most of the times the Wi-Fi access points are not deployed with the ideal geometry and density for positioning, and thus are not optimized for indoor localization.

Another wireless sensor network based indoor location estimation system uses the ZigBee communication standard for room detection [12]. It considers the behaviour of the RSSI through walls, floors and ceilings, and using a decision algorithm estimates a position. A blind node is located by using the reference nodes, that are placed one per room. The system exhibits good performance for its simplicity, although a wrong room indication often occurs when the blind node is located in the vicinity of a wall, due to the unpredictable indoor multipath effects and the potentially small path loss through the intersecting material. The boundary locations were also the biggest challenge that we faced in our approach.

The use of Bluetooth technology for positioning has been evaluated more than a decade ago [13]. Since then, the introduction of the BLE radio protocol provided even more opportunities for indoor localization. BLE beacons are flexible in the sense that they are small in size, they do not need to be plugged in and are power efficient. Either deriving a location from fingerprinting techniques [14], or ranging techniques that use path-loss models [3], researchers have focused on increasing the accuracy of the positioning. Although a room estimation can often be derived from such systems, they are usually not optimized for it. Our research has focused on developing an easy to set up BLE-based system for room localization, while keeping the cost as minimal as possible.

V.System overview

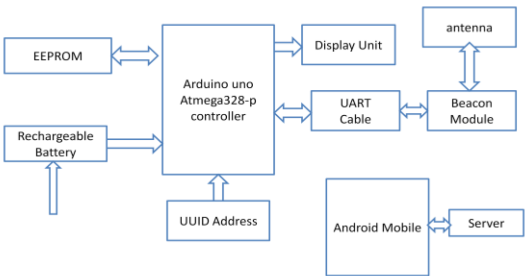
- Designing an intelligent tracking system for indoor and outdoor communication with help of Beacon Nodes.

VI.Existing System;

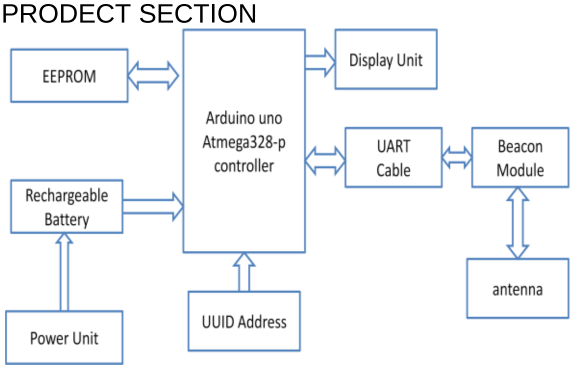
- Various cost effective location-based facilities after settling the position mechanically without extra user's exploit such as NFC (Near Field Communication) or QR (Quick Response) RFID.

- By using GPS due to Signal propagation in indoor environments is complex, affected by factors such as floor-plans and duct-work, varying transmission and reflection properties of building materials and furniture, and interference from other devices.

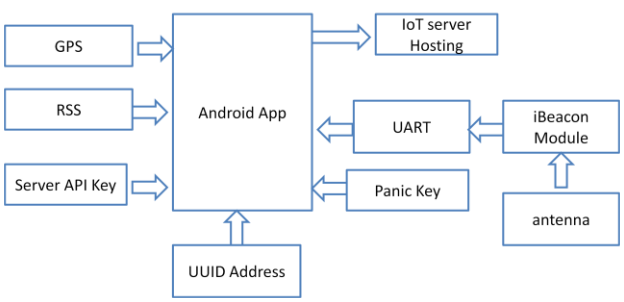
III. Block Diagram



PRODECT SECTION



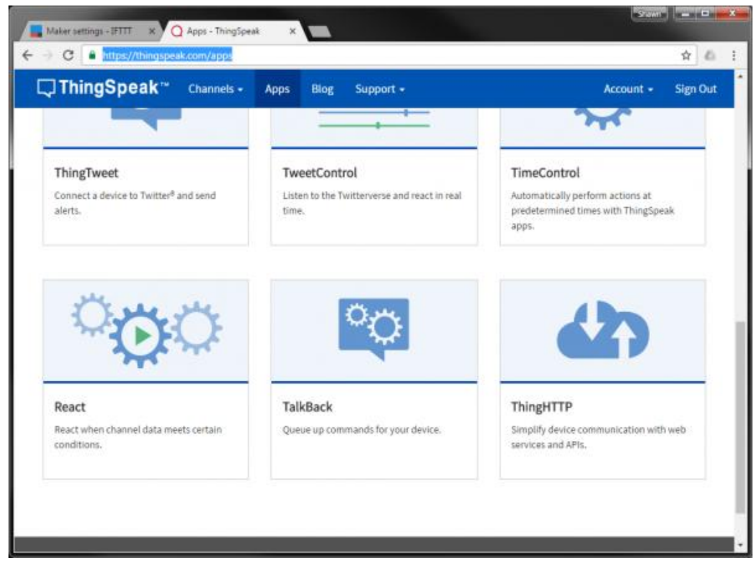
RECEIVER SECTION



IV. Proposed System

- Our project enables to find out the exact position of the product, if any person who have beacon app in their mobile crosses near the beacon.
- That mobile will act as a cloud network and send the current position to their owner who belongs to the product via IOT Cloud Server.
- Our mobile app also integrates emergency or panic switch for the use of women's safety. If the panic switch is triggered then it will send an message with current location to relevant person.
- By this we also search missing product location with in indoor environment like home or institution.

VII. Server Creation



XI. Conclusion

In this paper we have presented an easy to deploy BLE-based indoor positioning system with room-level accuracy. The system only requires the geometry of the rooms and BLE beacons attached to the ceiling in the center of every room. The presented algorithm computes two RSSI thresholds for every room, and based on them, categorizes the RSSI readings and finally estimates a room location.

We have deployed our system in two different locations, an office environment composed of three rooms and a house environment composed of six rooms. After comparing it with the no-threshold approach, we saw an improvement of room estimation accuracy, especially in the boundary locations of the rooms. These are the locations in a room that were farther away from the center of the room, than the center of a smaller adjacent one. Overall, out of the 90 points that measurements were taken, the algorithm managed to improve the localization accuracy of 13 of them, decreased the accuracy of 4 and did not affect the rest.

REFERENCES

[1] L. Fang, P. Antsaklis, L. Montestruque, M. McMickell, M. Lemmon, Y. Sun, H. Fang, I. Koutroulis, M. Haenggi, M. Xie, and X. Xie, “Design of a wireless assisted pedestrian dead reckoning system - the navmote experience,” Instrumentation and Measurement, IEEE Transactions on, vol. 54, no. 6, pp. 2342–2358, Dec 2005.

[2] N. B. Priyantha, A. Chakraborty, and H. Balakrishnan, “The cricket location-support system,” in Proceedings of the 6th Annual International Conference on Mobile Computing and Networking, ser. MobiCom ’00. New York, NY, USA: ACM, 2000, pp. 32–43. [Online]. Available: http://doi.acm.org/10.1145/345910.345917

[3] G. G. Anagnostopoulos and M. Deriaz, “Automatic switching between indoor and outdoor position providers,” in Indoor Positioning and Indoor Navigation (IPIN), 2015 International Conference on, Oct 2015, pp. 1– 6.

[4] Y. Li, P. Zhang, H. Lan, Y. Zhuang, X. Niu, and N. El-Sheimy, “A modularized real-time indoor navigation algorithm on smartphones,” in Indoor Positioning and Indoor Navigation (IPIN), 2015 International Conference on, Oct 2015, pp. 1–7.

[5] A. Bekkelien, M. Deriaz, and S. Marchand-Maillet, “Bluetooth indoor positioning,” Master’s thesis, University of Geneva, 2012.

[6] P. Kostopoulos, T. Nunes, K. Salvi, M. Deriaz, and J. Torrent, “F2d: A fall detection system tested with real data from daily life of elderly peo-ple,” in e-Health Networking, Applications and Services (Healthcom), 2015 IEEE 17th International Conference on, Oct 2015.

[7] C. Papamanthou, F. P. Preparata, and R. Tamassia, “Algorithms for location estimation based on rssi sampling,” in Algorithmic Aspects of Wireless Sensor Networks. Springer, 2008, pp. 72–86.

[8] R. Want, A. Hopper, V. Falcao,˜ and J. Gibbons, “The active badge location system,” ACM Trans. Inf. Syst., vol. 10, no. 1, pp. 91–102, Jan. 1992. [Online]. Available: http://doi.acm.org/10.1145/128756.128759

[9] A. Harter, A. Hopper, P. Steggles, A. Ward, and P. Webster, “The anatomy of a context-aware application,” in Proceedings of the 5th Annual ACM/IEEE International Conference on Mobile Computing and Networking, ser. MobiCom ’99. New York, NY, USA: ACM, 1999, pp. 59–68. [Online]. Available: http://doi.acm.org/10.1145/313451.313476

[10] P. Bahl and V. N. Padmanabhan, “Radar: an in-building rf-based user location and tracking system,” in INFOCOM 2000. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE, vol. 2, 2000, pp. 775–784 vol.2.

[11] C. Wu, Z. Yang, Y. Liu, and W. Xi, “Will: Wireless indoor localization without site survey,” Parallel and Distributed Systems, IEEE Transac-tions on, vol. 24, no. 4, pp. 839–848, April 2013.

[12] K. D’hoe, G. Ottoy, J. P. Goemaere, and L. De Strycker, “Indoor room location estimation,” Advances in electrical and computer engineering, vol. 8, no. 2, pp. 78–81, 2008.

[13] J. Hallberg, M. Nilsson, and K. Synnes, “Positioning with bluetooth,” in Telecommunications, 2003. ICT 2003. 10th International Conference on, vol. 2, Feb 2003, pp. 954–958 vol.2.

[14] R. Faragher and R. Harle, “Location fingerprinting with bluetooth low energy beacons,” IEEE Journal on Selected Areas in Communications, vol. 33, no. 11, pp. 2418–2428, Nov 2015.

[15] H. Hashemi, “The indoor radio propagation channel,” Proceedings of the IEEE, vol. 81, no. 7, pp. 943–968, Jul 1993.

[16] Bluetooth SIG, “Bluetooth core specification v4.2,” https://www.bluetooth.com/specifications/adopted-specifications, Dec 2014, [Online; accessed Feb 21, 2016].