IEEE.org   IEEE *Xplore*   IEEE SA   IEEE Spectrum   More Sites   SUBSCRIBE

SUBSCRIBE   Cart   Create   Perso
Account   Sign

Browse ⌄   My Settings ⌄   Help ⌄   Institutional Sign In

Institutional Sign In

All ▼

🔍

ADVANCED SEARCH

Conferences > 2019 Fourth International Con... ❓

Positioning Accuracy of Commercial Bluetooth Low Energy Beacon

Publisher: IEEE   Cite This   📄 PDF

Moch Fachri ; Ali Khumaidi   **All Authors**

Alerts

Manage Content Alerts

Add to Citation Alerts

More Like This

Design and Implementation of an RSSI-Based Bluetooth Low Energy Indoor Localization System

2021 17th International Conference on Wireless and Mobile Computing, Networking and Communications (WiMob)

Published: 2021

Improved localization algorithm based on RSSI in low power Bluetooth network

2016 2nd International Conference on Cloud Computing and Internet of Things (CCIOT)

Published: 2016

Show More

Abstract

Document Sections

I. Introduction

II. Related Work

III. Experiments Method and Scenario

IV. Results and Discussion

V. Conclusion

Authors

Figures

References

Keywords

Metrics

More Like This

📄
Downl
PDF

Abstract: This research presents the positioning accuracy of various commercially available BLE(Bluetooth Low Energy) beacon devices. Accurate data is obtained from beacon devices ... **View more**

▶ **Metadata**
Abstract:
This research presents the positioning accuracy of various commercially available BLE(Bluetooth Low Energy) beacon devices. Accurate data is obtained from beacon devices for indoor positioning taken from various mobile devices with BLE support. We utilize RSSI data to determine distances without any filter in order to present raw performance of the devices. The average result is not too deviate by various kinds of bluetooth beacons being tested. Compared to other related work, our data show nearly similar result. Our result shows various accuracy from 0.07 meters and up to 7.81 meters.

Contents

I. Introduction

To face the challenge of microlocation in the indoor scope, the iBeacon protocol can be used as one of the challengers. Using BLE (Bluetooth Low Energy) beacon-based proximity sensing technology, iBeacon can provide location information accurately in indoor spaces [1]. This BLE-based technology can allow the determination of microlocation in an ubiquitous manner [2].

Sign in to Continue Reading

Authors	⌄
Figures	⌄
References	⌄
Keywords	⌄
Metrics	⌄

ICIC 2019 notification for paper 66

1 message

ICIC 2019 <icic2019@easychair.org>   Mon, Aug 19, 2019 at 6:12 PM
To: Ali Khumaidi <alikhumaidi@unkris.ac.id>

Dear Ali Khumaidi,

We are pleased to inform you that your paper:

PaperID: 66
Title : Positioning Accuracy of Commercial Bluetooth Low Energy Beacon

submitted to The Forth International Conference on Informatics and Computing (ICIC 2019) has been ACCEPTED for an oral presentation. We cordially invite you to attend the ICIC 2019 conference in Semarang-Central Java, Indonesia.

It is mandatory to prepare the camera ready paper as per the instructions listed on http://icic-aptikom.org/ and your paper will not be published unless the following are done:

1.   Revise your paper(s) according to the reviewers' comments. The detail reviews are in the bottom of this email.
2.   The accepted similarity level is maximum 20% which you may check using Turnitin or other similiar plagiarism check.
3.   Format your camera ready paper as per guidelines and follow strickly the A4-IEEE format in pdf file by creating it using IEEE pdf express. (https://www.pdf-express.org/plus, Conference ID:47613XP)
4.   Upload your camera ready paper according to Easychair by 28 August 2019 (hard deadline)
5.   Fully-completed signed IEEE copyright form and send it to icic4aptikom@gmail.com with subject: Copyright 2019-your paperID. As well there will be e-Copyright for IEEEXplore publication that will be informed later.
6.   Fill in the registration form that can be downloaded from the ICIC website (registration) and send it to icic4aptikom@gmail.com including the proof of your payment and proof of membership (e.g. IEEE, Aptikom) and student status when it is relevant with subject: Registration 2019-your paperID.

Please be reminded that the due date for earlybird registration is 30 August 2019. At least one author has to register for the conference.

The conference will take place in Semarang-Central Java Indonesia, from 23-24 October 2019 with optional activities after the conference. As soon as the schedule is completed, it will be posted on the conference website.

All related conference materials can be found at http://icic-aptikom.org/ Please let us know if you have any queries regarding registration.

We sincerely look forward to welcoming you in Semarang-Central Java, Indonesia in October 2019.

With a warmest regards,
Media A Ayu, PhD
Prof. Dr. A. Nizar Hidayanto
Dr. Suryono
Chairs of ICIC 2019

Reviews of your paper 66

SUBMISSION: 66
TITLE: Positioning Accuracy of Commercial Bluetooth Low Energy Beacon

----------------------- REVIEW 1 --------------------
SUBMISSION: 66
TITLE: Positioning Accuracy of Commercial Bluetooth Low Energy Beacon
AUTHORS: Mochammad Fachri and Ali Khumaidi

----------- Overall evaluation -----------
SCORE: 1 (weak accept)
----- TEXT:

1. English writing must be improved. In abstract, accurate data (NOT accuracy data). After punctuation must be capital letter: ..support. We use .. (NOT ..support. We..), etc..etc..
2. How did Eq. (1) come from?, what is the literature ? Is it physically correct?
3. Did the authors do any calibration?
4. Fig. 1 and 2, what is the vertical axis of the graphs?

----------------------- REVIEW 2 ---------------------
SUBMISSION: 66
TITLE: Positioning Accuracy of Commercial Bluetooth Low Energy Beacon
AUTHORS: Mochammad Fachri and Ali Khumaidi

----------- Overall evaluation -----------
SCORE: -1 (weak reject)
----- TEXT:
This research presents the positioning accuracy of
various commercially available BLE(Bluetooth Low Energy)
beacon devices.

methodology and discussion are unclear

what is the measurement model?
what tools are used?

improved english writen.

----------------------- REVIEW 3 ---------------------
SUBMISSION: 66
TITLE: Positioning Accuracy of Commercial Bluetooth Low Energy Beacon
AUTHORS: Mochammad Fachri and Ali Khumaidi

----------- Overall evaluation -----------
SCORE: 1 (weak accept)
----- TEXT:
Below are my comments on this paper:
1. Please discuss the states of the art in the introduction section. Are there any studies related to your work? Why did you need to compare the position accuracy of commercial Bluetooth?

2. Please add a related work section to demonstrate your contributions among other studies.

3. Please discuss in more detail your methodology, in particular, related on how did you calculate the performance.

4. The authors said they used devices from students. Please clarify, how did the authors produce Fig. 1 (averaging the accuracy from all devices or what).

5. Please discuss the limitations of this study and future research direction in the conclusion section.

CERTIFICATE

OF APPRECIATION

Awarded to :

Mochammad Fachri and Ali Khumaidi

for his/her participation as a **Authors** in

Titled: Positioning Accuracy of Commercial Bluetooth Low Energy Beacon

The Fourth International Conference on Informatics and Computing (ICIC 2019)
at Dian Nuswantoro University (UDINUS), Semarang Indonesia
on 23-24 October 2019

IEEE
INDONESIA SECTION
APTIKOM

ICIC 2019

Prof. Zainal A. Hasibuan, PhD
Ketua APTIKOM

Assoc. Prof. Dr. Media A. Ayu, SMIEEE
General Chair

BINA INSANI UNIVERSITY

Positioning Accuracy of Commercial Bluetooth Low Energy Beacon

Moch Fachri*, Ali Khumaidi†

Informatics Engineering, Krisnadwipayana University, Jakarta, Indonesia

Email: *moch.fachri@unkris.ac.id, †alikhumaidi@unkris.ac.id

Abstract—**This research presents the positioning accuracy of various commercially available BLE(Bluetooth Low Energy) beacon devices. Accurate data is obtained from beacon devices for indoor positioning taken from various mobile devices with BLE support. We utilize RSSI data to determine distances without any filter in order to present raw performance of the devices. The average result is not too deviate by various kinds of bluetooth beacons being tested. Compared to other related work, our data show nearly similar result. Our result shows various accuracy from 0.07 meters and up to 7.81 meters.**

Index Terms—**Bluetooth low energy, bluetooth beacon, indoor positioning**

I. Introduction

To face the challenge of microlocation in the indoor scope, the iBeacon protocol can be used as one of the challengers. Using BLE (Bluetooth Low Energy) beacon-based proximity sensing technology, iBeacon can provide location information accurately in indoor spaces [1].This BLE-based technology can allow the determination of microlocation in an ubiquitous manner [2].

Bluetooth beacon devices with iBeacon protocol have been produced by various companies. The diversity and the availability of these devices commercially, on the one hand provides an option for consumers to choose a device according to their needs and available budget. However on the other hand, various devices from different manufacturers may cause a variety of device performance. This may impact the accuracy of the data from BLE beacons.

Bluetooth technology utilized by BLE beacon carried out using optimized power [3]. This technology has been deployed in many dense environment for various usage [4]. One example for commercial usage shows the device feature and capability for shopping activity [5], and also another example for monitoring activity [6]. In the use for location and position at the indoor environment, several research has shown the capability of beacon devices. One research shows Location Fingerprinting With Bluetooth Low Energy Beacons usage in a building, and proven its superiority against wi-fi technology for positioning purpose in term of accuracy [7]. Deployment of multiple beacon also enhance it's performance in indoor positioning system [8]. Despite all of that example, accurate distance estimation still pose challenges, due to unstable signals of BLE beacon more research needs to be done in order to achieve more improved result [4].

Our research aims to evaluate the effectiveness of this bluetooth beacon for microlocation usage. We are testing various beacon devices that can be obtained commercially. We believe that this study is important for wide audiences, especially engineers who deploy beacons, as well for various service providers that support beacon-based microlocation services. We highlight our experimental results to show the accuracy of these bluetooth beacon devices for ubiquitous use.

II. Related Work

Previous research has shown various advantages of using beacons in position and distance information. The survey on the ubiquitous location determination system [2] shows that challenge faced during that time (2001) was around indoor positioning. In a more recent survey on microlocation technology [9], bluetooth beacon shows several advantages which is small size, energy efficiency and low cost of deployment.

The accuracy of the bluetooth beacons has been tested in various researches. In one comparison with other radio frequencies, namely wi-fi [10], bluetooth beacons have an accuracy of less than 2.5 m 95% of the time compared to less than 8.5m 95% of the time for the Wi-Fi Network. Another study also presents the accuracy value of the use of beacons in a scenario on a museum building [9], and it shows good results. However the test scenario involves only beacons from one manufacturer and tested just with one smartphone as a receiver. Detailed analysis of the position accuracy with beacons has also been done [8]. In that research, the author using bluetooth beacons only from two commercial brands and also tested with two smartphones device, which beg some question about capability for various kind of many devices, especially when deployed in real life application.

III. Experiments Method and Scenario

We conduct BLE beacon devices accuracy testing with various kinds of BLE beacon and smartphones from many manufacturer. We have tested five BLE beacons from different companies brands, namely Cubeacon, Bytereal, Nordic, Wellcore, Nyvida. All of our beacons are set to the default factory settings, which means there is no custom user calibration involved in BLE parameter. We measured the accuracy of distances on 23 smartphones owned by our class student as a test subject. Each smartphone devices is placed at a distance from each beacons at 1 meter, 5 meters and 10 meters with an interval of 2 minutes for each distance point. The entire measured distance is stored in a log file that shows variations
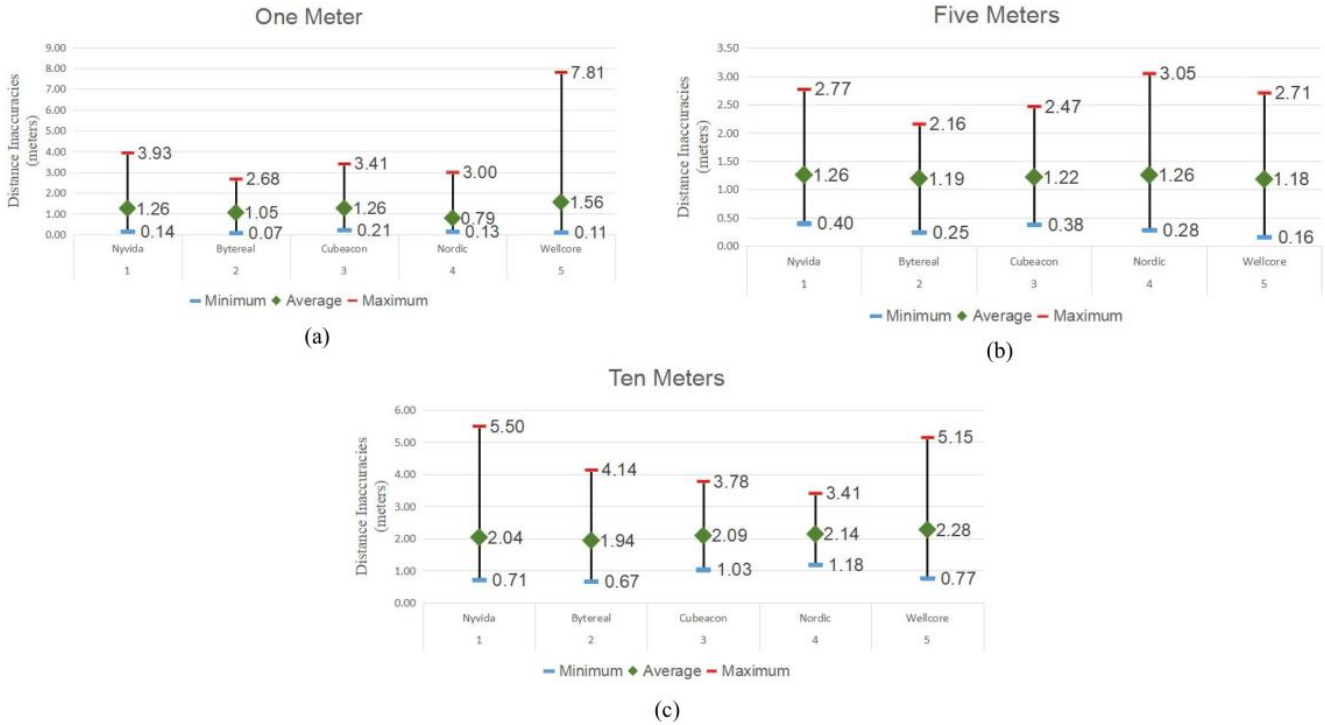
Fig. 1. Result of the experiment at (a)one meter, (b)five meters, (c)ten meters

in the accuracy performance of each beacon devices and smartphone devices.

$$D = 10^{(\frac{TxPower - RSSI}{10n})} \qquad (1)$$

In order to get distance data from the BLE beacon, we use RSSI(Received Signal Strength Indication) reading from our test subject. We used equation 1 [6]to convert the distance (D) based on received RSSI value. TxPower is the signal strength at a one meter distance, while n is the value of exponential path loss. We do not apply any filter, so the distance value are purely based on device performance.

IV. RESULTS AND DISCUSSION

The results of the experiments shows in figure 1 and 2. Figure 1 show the compilation of the accuracy results of the distance readings for each beacons from distance point at 1 meter, 5 meters and 10 meters. the value in the figure, indicates the average value of the inaccuracies in distance reading from the entire test subject(our students smartphones) as well as the maximum and minimum inaccuracies that have occurred. During 2 minutes distance read by the entire smartphones, the accuracy variation that occur is quite diverse. Reading at a time can be quite accurate with only 0.07 meters inaccuracy, but it can also miss really far up to 7.81 meters. At certain device, the average value obtained is quite satisfactory. The average value of one beacon reaches 0.79 meters at 1 meter measurement. The highest inaccuracy is found in the reading of one of the beacon at a measurement of 10 meters, which averages at 2.28

meters. Figure 2 shows some interesting result, while graphs of average and minimum accuracy values have a tendency to rise along with the increase in measurement distance, but the maximum inaccuracy value is at the best value in a 5 meter measurement.

The data we collected shows that the accuracy of distance measurements can vary due to devices heterogeneity. Compared to other researches [8], BLE beacon have an accuracy of less than 2.5 m error similar to our result. Those data however is obtained from two smartphone devices, while our experiment employ more devices. Another study also presents the accuracy value of the use of beacons in a scenario on a museum building [9], and it shows good results. However the test scenario involves only beacons from one manufacturer and tested just with one smartphone as a receiver. The data shows comparison of measured estimated distance from distance up to 5 meters and the error at that distance is within 3 meters. Our data also shows a maximum value of errors at 3.05 meters for the 5 meters measurement at certain BLE beacon, while other BLE beacon we used shows a maximum value of errors at 2.16 meters.

V. CONCLUSION

In this paper, we shows the performance of bluetooth beacon devices that vary in accuracy when used in distance measurements by various smartphone devices. This result shows the average accuracy that is not too deviate by various kinds of bluetooth beacons being tested. The accuracy of the beacons we get varies from the highest accuracy with 0.07 meters at
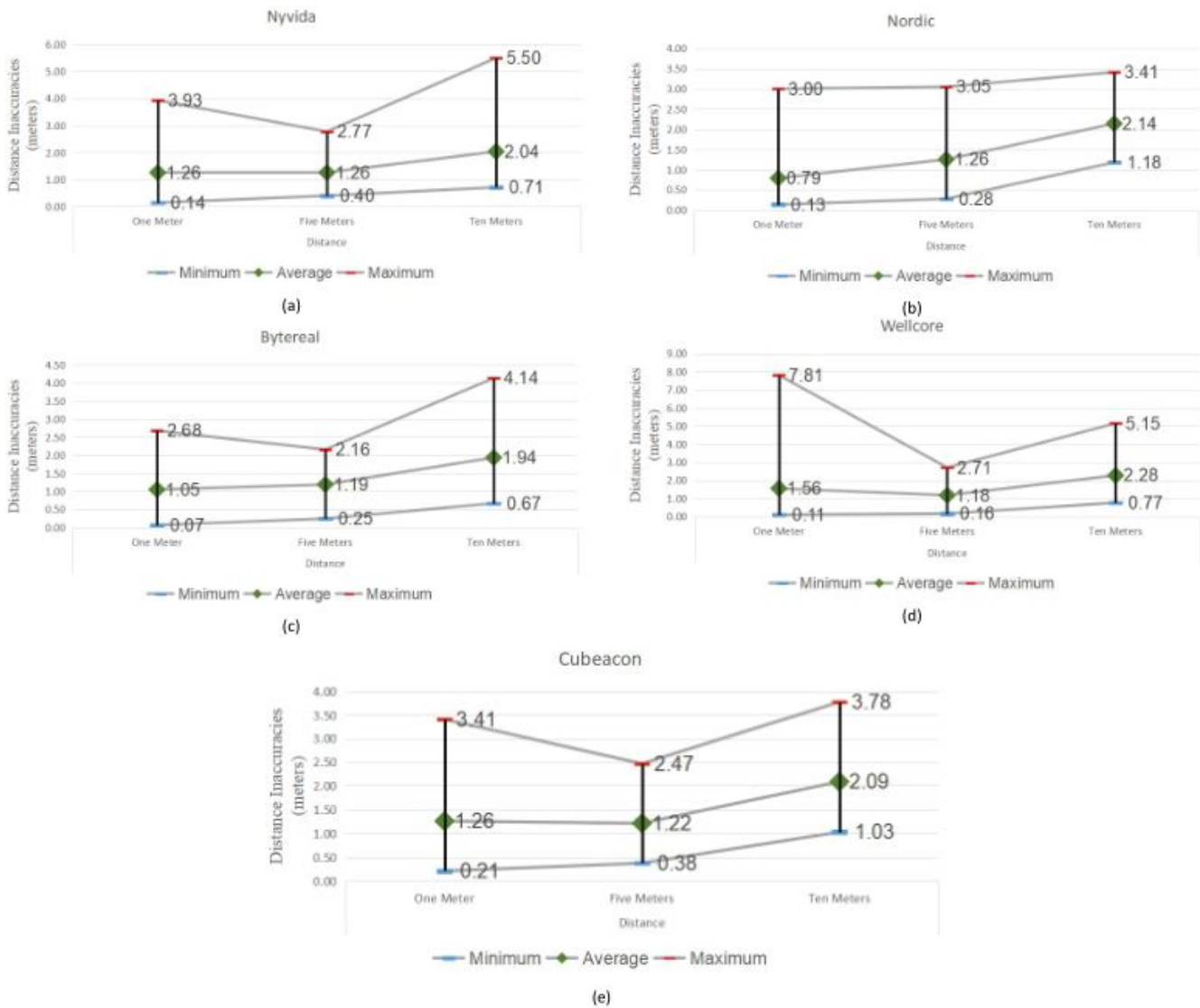
Fig. 2. Result of the experiment for each beacon: (a)Nyvida, (b)Nordic, (c)Bytereal, (d)Wellcore, (e)Cubeacon

one meter measurement, and the most inaccurate result with 7.81 meters at 10 meters measurement. The average accuracy of distance measured on a user's smartphone is between 0.79 meters to 2.28 meters.

Our current study presented in this paper is limited to the use of bluetooth beacons as device to obtain distance data. Our work in the future will extend this bluetooth beacons device to use to determine indoor location information. We plan to create a bluetooth beacon network in a building using various devices from many manufacturers to observe the impact of location information generated from these beacons.

REFERENCES

[1] F. Zafari and I. Papapanagiotou, "Enhancing ibeacon based micro-location with particle filtering," in *2015 IEEE Global Communications Conference (GLOBECOM)*, Dec 2015, pp. 1–7.

[2] J. Hightower and G. Borriello, "Location systems for ubiquitous computing," *Computer*, vol. 34, no. 8, pp. 57–66, Aug 2001.

[3] J. Kuriakose, V. Amruth, A. Sandesh, V. Abhilash, G. Prasanna Kumar, and K. Nithin, "A review on mobile sensor localization," vol. 467, 09 2014, pp. 30–44.

[4] K. E. Jeon, J. She, P. Soonsawad, and P. C. Ng, "Ble beacons for internet of things applications: Survey, challenges, and opportunities," *IEEE Internet of Things Journal*, vol. 5, no. 2, pp. 811–828, April 2018.

[5] R. Pugaliya, J. Chabhadiya, N. Mistry, and A. Prajapati, "Smart shoppe using beacon," in *2017 IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM)*, Aug 2017, pp. 32–35.

[6] A. Y. N. Pratama, A. Zainudin, and M. Yuliana, "Implementation of iot-based passengers monitoring for smart school application," in *2017 International Electronics Symposium on Engineering Technology and Applications (IES-ETA)*, Sep. 2017, pp. 33–38.

[7] 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.

[8] M. Ji, J. Kim, J. Jeon, and Y. Cho, "Analysis of positioning accuracy corresponding to the number of ble beacons in indoor positioning system," in *2015 17th International Conference on Advanced Communication Technology (ICACT)*, July 2015, pp. 92–95.

[9] P. Spachos, I. Papapanagiotou, and K. N. Plataniotis, "Microlocation for smart buildings in the era of the internet of things: A survey of technologies, techniques, and approaches," *IEEE Signal Processing Magazine*, vol. 35, no. 5, pp. 140–152, Sep. 2018.

[10] 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.