UNIVERSITI PUTRA MALAYSIA

ENHANNCED SAMPLING ALGORITHM IN BLUETOOTH LOW ENERGY FOR INDOOR LOCALIZATION

MOHD FAIZ BIN MAT DAUD

FSKTM 2018 53

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By

MOHD FAIZ BIN MAT DAUD

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Master of Computer Science

June 2018

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the Master of Computer Science

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MOHD FAIZ BIN MAT DAUD

June2018

Chair: Idawaty Ahmad, PhD
Faculty: Computer Science and Information Technology

Wireless network is a network set up by using radio signal frequency to communicate among computers and other network devices that are not connected by cables of any kind. These network mainly used for communication and data exchange. However, it is also being used to acquired one's or device's position with certain accuracy. For outdoor, Global Positioning System (GPS) is being used by peoples to navigate to any places in the world and also used in rocket or guided missile system as well.

In case of indoor positioning or localization, GPS system is not possible due to the satellite signal is being block and therefore weak. Bluetooth Low Energy (BLE) is one of many solutions to cover this problem. BLE indoor localizationtechnology able to obtain the position byutilizing the Receive Signal Strength Index (RSSI) which is then used in positioning algorithm such as fingerprinting or trilateration. But there is limitation with theaccuracy of this systemmainly due to unstable RSSI.

There are algorithms to stabilized the RSSI such as Kalman Filter, Moving Average, Delta Sampling and many more. And by doing so, it will help to improve the accuracy of the indoor localization. Each of the algorithms has their own strength and weakness. Delta Sampling algorithm is simple to be implemented, yet it is good in removing the flier point and doing so will help to stabilize the RSSI. However, it come with problems that is undecided sample size and number of invalid samples which may lead to wrong result.

Therefore, this project enhanced the Delta Sampling algorithm in order to mitigate this issues and through the experiments, it is proven that the proposed algorithm able to stabilize the signal while solving the sample size and number of invalid samples issue.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sarjana Sains Komputer

ALGORITMA DELTA SAMPLING UNTUK MENGATASI MASALAH KETIDAKSETABILAN BLUETOOTH RSSI

Oleh

MOHD FAIZ BIN MAT DAUD

Jun 2018

Pengerusi: Idawaty Ahmad, PhD
Fakulti: Sains Komputer dan Teknologi Maklumat

Rangkaian tanpa wayar adalah jaringan untuk berhubung mengunakan isyarat radio berfrekuensi di antara alat peranti elektronik ataupun computer. Rangkaian ini biasanya digunakan untuk pertukaran maklumat dan komunikasi. Akan tetapi, rangkaian ini juga boleh digunakan untuk mendapatkan maklumat tentang lokasi seseorang ataupon lokasi peranti elektronik tertentu.

Untuk mendapatkan lokasi di kawasan terbuka, teknologi “Global Positioning System” atau GPS digunakan.Manakala untuk mendapatkan posisi ataupon lokasi di kawasan tertutup dengan mengunakan system GPS adalah mustahil kerana isyarat satelit terlindung dan lemah. “Bluetooth Low Energy” ataupon BLE adalah antara teknologi untuk mengatasi masalah ini. BLE mengunakan “Receive Signal Strength Index” ataupon RSSI untuk menentukan posisi di dalam algoritma seperti “Fingerprinting” dan juga “Trilateration”. Oleh kerana RSSI tidak setabil, ketepatan system ini juga terbatas.

Terdapat banyak algoritma untuk menjadikan RSSI lebih setabil seperti “Kalman Filter”, “Delta Sampling” dan sebagainya. Dengan menambahbaik dan menjadikan RSSI lebih setabil, ketepatan dalam menentukan lokasi akan bertambah baik. Setiap algoritma mempunyai kekuatan dan kelemahan masing-masing. “Delta Sampling” adalah algoritma yang mudah untuk di gunakan, malah berupaya menjadikan RSSI lebih setabil. Walaupon begitu, “Delta Sampling” mempunyai kelemahanya tersendiri seperti saiz sampel yang tidak ditentukan dan juga jumlah bilangan sampel palsu yang banyak , oleh itu akan menyebabkan hasil pengiraan akhir yang salah.

Projek ini adalah untuk menambahbaik algoritma “Delta Sampling” bagi mengatasi permasalahan saiz sampel yang tidak ditetapkan dan juga

menghadkan jumlah bilangan sampel palsu yang didapati dari algoritma tersebut. Hasil dari ekperimen mendapati, bahawa cadangan projek ini berjaya mengurangkan ketidaksetabilan RSSI dan pada masa yang sama menyelesaikan kelemahan algoritma “Delta Sampling”.

ACKNOWLEDGEMENTS

I would first like to thank my supervisor Dr. Idawaty Ahmad, at Universiti Putra Malaysia. She was always open whenever I ran into a trouble spot or had a question about my research or writing. She consistently allowed this paper to be my own work, but steered me in the right the direction whenever she thought I needed it.

I am also like to thank many of lecturers and my friends that provide me with lot of valuables information during the whole course of this program. I am indebted to every one of you.

Furthermore, I would like to thank Dr. David, Dr. Alvin and Dr. Ng Seh Chun from Mimos for time and guidance during the I was working there. Besides that, also thank to my current Employer for understanding.

Finally, I must express my very profound gratitude to my parents and to my family for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them. Thank you.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Computer Science.

The members of the Supervisory Committee were as follows:

Idawaty Ahmad, PhD
Senior Lecturer
Faculty of Computer Science and Information Technology
Universiti Putra Malaysia
(Chairman)

ROBIAH BINTI YUNUS, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

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LIST OF ABBREVIATIONS

Abbreviations	Explanations
BLE	Bluetooth Low Energy
RSSI	Received Signal Strength Indicator
WIFI	Wireless Local Area Networking
GPS	Global Positioning System
DBSR-MA	Decay Based Sample Range Moving Average

CHAPTER 1

INTRODUCTION

The BLE RSSI is very much unstable in it raw form, and just barely usable for indoor localization. Filtering algorithm or also called smoothing algorithm is a must in order to make the signal more stable before it is being used as main input into localization algorithm. The benchmark paper introduced the Delta Sampling algorithm to remove some of the flier point or noise in the raw RSSI (Jun-Ho et al.,2016). However, there are some parts of the algorithm which can be improve on especially undecided range of sample size and number of invalid or false data. It is also can be combined with other smoothing algorithm for better result which is the strength of the algorithm itself. Figure 1.1 show exactly where is this algorithm is used in indoor localization technology. As shown in the figure, smoothing algorithm also can be used to stabilized WIFI and Signal Tower as well.

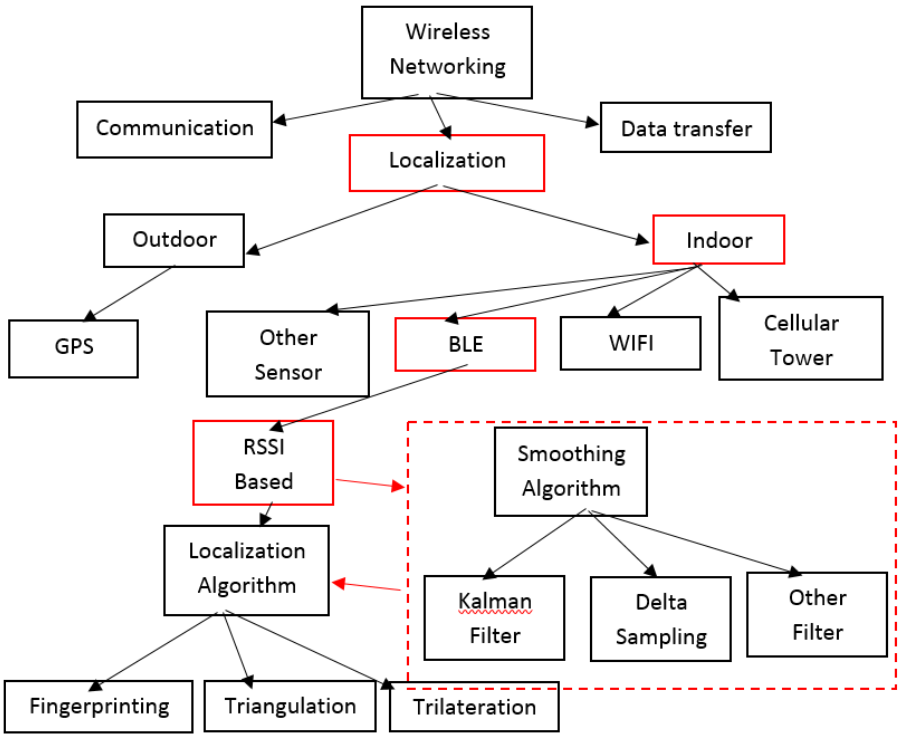

Figure 1.1: Flow Chart for Research Area

1.1 Problem Statement

Bluetooth technology 4.0 also known as Bluetooth Low Energy (BLE) is one of the popular solution to use in Indoor Localization.There are many ways of using BLE in Indoor Localization.Most of them are utilizing the Received Signal Strength Indicator (RSSI) value.

The problem for BLE based localization which utilizing the RSSI as the measurement to get the location isthe signal itself is not stable and tends to fluctuate. Thus introduce error in the location estimation algorithm. This is due to many internal and external factor influencing the radio waves such as absorption, interference or diffraction. Also the further away the smartphone (receiver) is from the beacon (transmitter), the more unstable it becomes.

Furthermore, recent proposal used an algorithm called Delta Sampling in order to mitigate this issue (Jun-Ho et al.,2016). However, the problem with this algorithm is the parameter of range of sample size which is undetermined and also false detection of flier point issue.

1.2 Objective

To stabilize the raw RSSI signal, we need to have post processing filtering algorithm which converted the signal to much more stable version. This project used an algorithm called Delta Sampling in order to mitigate theunstable RSSI issue as proposed by (Jun-Ho et al.,2016). Besides that, further additional of enhancement is added to counter the weakness of the Delta Sampling.

1.3 Project Scope

The bigger aim is to improve the BLE based indoor localization accuracy that used RSSI value in their algorithm for location estimation. Since, this project course is short, the project scope will focus on the study of the basic input for the location estimation algorithm which is RSSI. Inaccurate RSSI will produce inaccurate location estimation, thus it is important to make the basic input close to ideal first before solving others problem. At the end of the day, this project will help the research in the area of indoor localization.

1.4 Thesis Organization

This study present Delta Sampling algorithm to stabilize the RSSI fluctuation and also propose an enhancement as well. The rest of the thesis is organized as follows.

Chapter 2 is about the wireless networking and indoor localization as a whole that is methods and technologies which is available in order to obtain the position of electronic devices. Besides that, also discussing about the problems and solutions that exist in this area.

Chapter 3 provide details on how the experiment is conducted, parameters setting used and also the environment involved. The experiment is divided in two phases which is data collection phase and data analysis phase. The core Delta Sampling algorithm is explained in this chapter as well.

Chapter 4 comparing the Delta Sampling result with the benchmark paper and the analysis with some discussion. Furthermore, this chapter also presenting the enhanced version of the Delta Sampling along with the result analysis.

Chapter 5 concludes the work and recommends some promising direction for the future work.

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