International Journal of Scientific Engineering and Technology Research
www.ijsetr.com
ISSN 2319-8885
Vol.07,Issue.02,
February-2018,
Pages:0276-0279

RSSI based Trilateral Indoor Localization System using Reference Tags of Radio Frequency Identification System

NWAY EI HTET LIN[1], CHAW MYAT NWE[2]
Dept of Electronic Engineering, Mandalay Technological University, Patheingyi 5071, Mandalay Region, Republic of the Union of Myanmar.

Abstract: Indoor Localization System has led to increased efficiency in many types of organizations and industries. Radio Frequency Identification (RFID) is an information exchange technology based on radio waves communication. It is also a possible solution to indoor localization. Because, RFID system is the longest reading range depending on their frequency, the smallest tag size and overall commercial application fields. The system uses received signal strength (RSS) measurements as the baseline for range determination. It becomes the mainstream localization algorithm in wireless sensor networks due to its low cost, no additional hardware support, and easy understanding. This paper proposes an RSSI based indoor localization using the Trilateration estimation. In this research method, the RFID reader can track any target within 3m×3m×3m room with less localization error.

Keywords: Indoor Localization, Radio Frequency Identification(RFID), Received Signal Strength Indicator(RSSI),Trilateration.

I. INTRODUCTION

The problem of locating a user is a fundamental problem in many research areas. Positioning system can categorize depending on the target environment as indoor, outdoor and mixed type. In outdoor environment, the Global Position System (GPS) can provide good location estimates. However, the GPS solution cannot use in indoor environment because of the lack of line of sight between satellites and the receiver. In indoor environment, radio frequency signal is used to perform localization has become an interesting and promising technique to build better location systems.[5] In some public places, such as shopping malls, airports, exhibition halls, office buildings, warehouses, people need precise location information. Precise indoor location information can use to achieve efficient management of the available space and inventory substances; can help police, firefighters to complete specific tasks. So currently, indoor localization is a hot research with broad application prospects.[2] Radio Frequency Identification (RFID), which uses radio waves to wirelessly transmit the identity and other information of an object, is an emerging technology for indoor localization. An RFID system comprises of a number of a readers and a large amount of tags. The reader interprets and reports the radio frequency messages emitted by the RFID tags.

Received Signal Strength Indicators (RSSI) is commonly built into the transceiver chips used in commercial RFID readers and thus this measurement method does not require additional hardware. A RFID is typically used to perform localization using a Received Signal Strength (RSS) measurement.[6-11], Here, The RFID readers each have RSSIs used for ranging. Localization is accomplished using Trilateration Localization. The primary challenge is to develop a robust RSS-based ranging algorithm that is capable of achieving acceptable localization accuracy in indoor environments without additional hardware. This paper organized as follows. In section II, we described system block diagram description and theoretical background for ranging using log-distance path loss model with RSSI and RFID. Section III presents the system design and position of the reference tags with their signal strength in reference paper. Section IV represents the simulation results and performance. Finally, in section V we conclude the paper and provide insight for future work.

II. SYSTEM BLOCK DIAGRAM DESCRIPTION

Before performing the indoor localization, the system first reads signal strength of reference tags from the RFID reader. In this paper, the signal strength and reference position of readers has used from reference paper. Using this RSSI value, we can calculate distance using log-distance path loss model, which will explain in further detail in this paper. When the distances have calculated, they plugged into a system on quadratic equations called trilateration. Using 3D trilateration makes it is possible to find the tagged object on the x, y and z plane. The overall system block diagram is as shown in fig1. The system flow chart of the indoor localization is shown in Fig.2. In the flowchart, there are several input parameters to declare and then calculate the distance for each reference nodes depending on the input parameter. After calculating the distance function, the trilateration method will be applied. After applying the trilateration localization algorithm, we will get the location coordinate output in 3D.

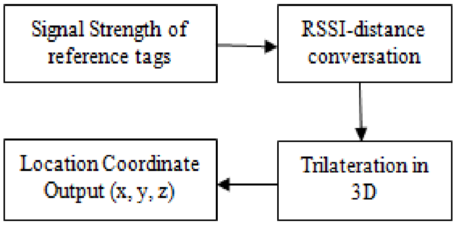

Fig.1. Overall System Block Diagram.

A. Log-Distance Path Loss Model

To locate an object that is in the field a system has created that uses radio frequency signals. The strength of frequency signals has used to measure the distances between reference nodes and target node. After the signal strength has gathered, it can convert into distance using log-distance path loss model. The log-distance path loss model used to express the relationship between received power and the corresponding distance.

$$P_r(d_0)\ \alpha\ \left(\frac{d}{d0}\right)^n \quad (1)$$

$$d = d_0 * \exp\left(\frac{Pr(d0) - Pr(d)}{10n}\right) \quad (2)$$

In the above formula, d_0 represent near earth reference distance, $Pr(d_0)$ is the signal strength at reference distance d_0 and n is the Path-loss exponent and its value is between 2 to 6 depending on the environment.

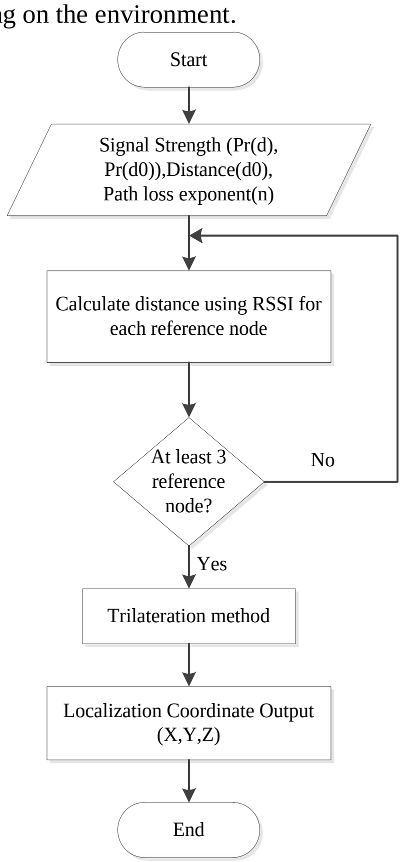

Fig.2. Overall System Flowchart.

B. Trilateration in 3D

There are two types of trilateration in indoor localization, such as two-dimensional trilateration and three-dimensional trilateration. 2-D trilateration, which only allows you to find a tagged object on the XY plane and 3D trilateration allows you to find a tagged object on the X, Y, and Z coordinate system. The indoor localization system was supposed to find an object within a warehouse. In fig.4, there is a four reader. This four reader gives an extra component, therefore linear algebra can be used to find the height of the tag object. The equations for 3D trilateration are as follows:

$$(x-x_1)^2+(y-y_1)^2+(z-z_1)^2=d_1^2 \quad (3)$$

$$(x-x_2)^2+(y-y_2)^2+(z-z_2)^2=d_2^2 \quad (4)$$

$$(x-x_3)^2+(y-y_3)^2+(z-z_3)^2=d_3^2 \quad (5)$$

$$(x-x_4)^2+(y-y_4)^2+(z-z_4)^2=d_4^2 \quad (6)$$

Fig.3 shows the program flowchart of Trilateration in 3D. First, the user declares the position of four readers, the distance from the tag to reader, the xyz coordinate. Then, the reader location is plot using the scatter plot in MATLAB. After plotting the reader location, the positions of the target are calculated using Trilateration localization algorithms and plot the target tag location in MATLAB.

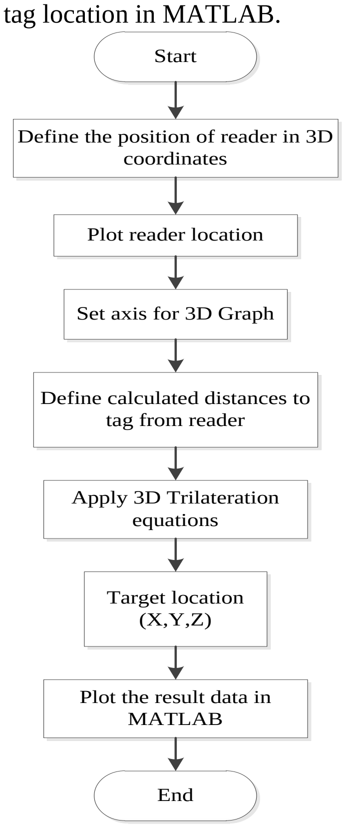

Fig.3. 3D Trilateration Flowchart.

III. SYSTEM DESIGN

The RFID signals (i.e. RSSI) of an object attached with a tag automatically detected and recorded in the database for location detection. Firstly, the localization environment assumes to locate in a room with the dimension of 3×3×3 cubic meters. Fig.4 shows four RFID readers have installed at each corner of the selected area and corresponding high. Each RFID reader can have an interrogation range, which defined as the maximum distance at which the reader can recognize a tag. In addition, the number of readers required will increased for larger areas. A tag derives its power from the signals it receives from the reader and produces a signal back to the reader. The strength of the RSSI received by RFID readers is collected. Each of the four RFID readers will record the specific RSSI of the tag within corresponding environment and such data are stored in database. The RSSI reading can varies for different tags, their orientations, and distance from tag to reader. According to the reference paper, table.1 shows the location of the RFID readers consist of the four active 433MHzRFID location with corresponding signal strengths in 3m × 3m×3m room.

TABLE I: RFID Reader With Corresponding Signal Strength [12]

Reader	Height	Depth	Antenna	RSSI
1	1	1	1	-51
	1	3	3	-55
	3	1	1	-57
	1	3	1	-56
	3	1	3	-53
	3	3	3	-53
2	1	3	1	-60
	1	3	3	-53
	3	1	1	-63
	3	1	3	-56
	1	1	1	-53
	3	3	3	-52
3	3	1	3	-55
	1	3	3	-56
	1	1	1	-52
	3	1	1	-62
	1	3	1	-55
	3	3	3	-55
4	1	3	3	-57
	3	3	3	-58
	1	3	1	-61
	1	1	1	-54
	3	1	1	-60
	3	1	3	-53

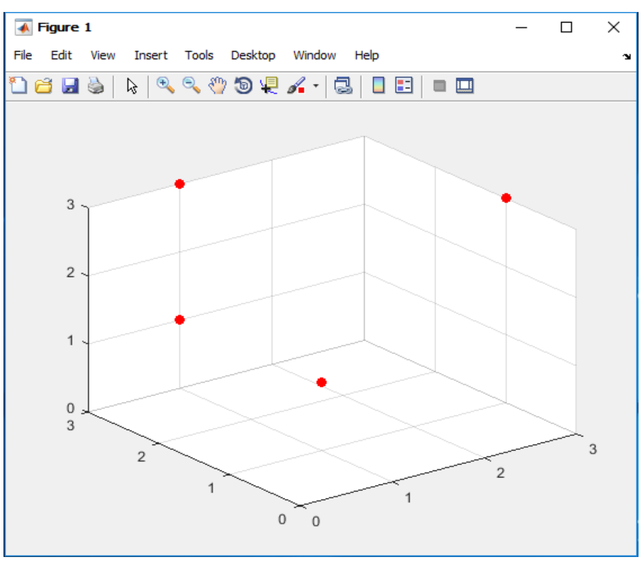

Fig.4. Position of the RFID reader in selected area.

IV. SIMULATION RESULTS

In all figure, each red dot symbolized a reader. The four readers are located at (1,1, 1), (1, 3, 1), (3, 1, 3) and (1, 3, 3). The location of the object shows by a yellow dot within the red dots. The location of the target tag is 1.5, 1.5, and 2.313 is as shown in fig.5.

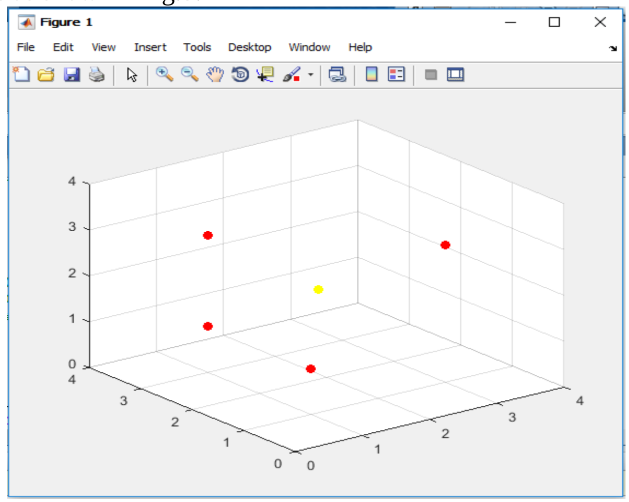

Fig.5. Simulation for 3D Trilateration with target tag.

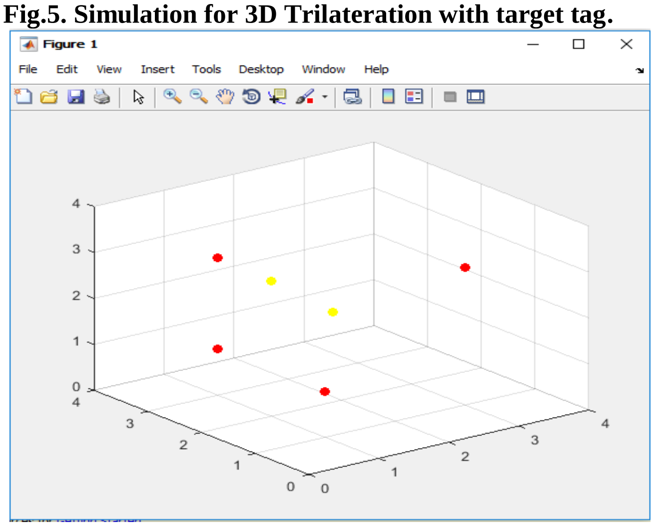

Fig.6. Simulation for 3D Trilateration with two target tags.

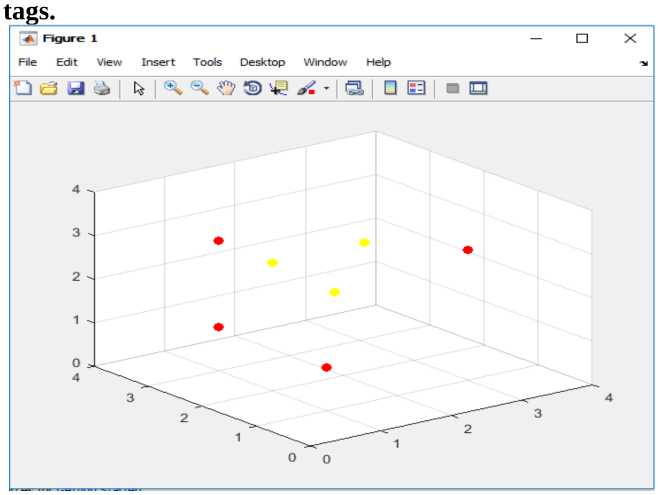

Fig.7. Simulation of 3D Trilateration with three target tags.

Fig.6 shows the two target tags with the value are (1.5, 1.5, 2.313) and (2, 3.131, 2). In Fig.7, the value of target tags are (1.5, 1.5, 2.313), (2, 3.131, 2) and (3.312, 3.312, 2). Fig.8 shows the location of four target tags with the value is -1.937, 1.938 and 4.438. Note that the readers are at different heights and the system still works correctly for three or more target.

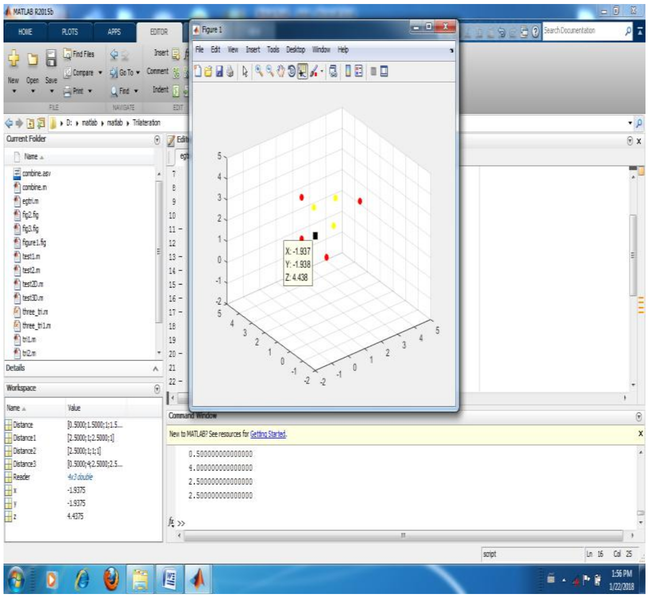

Fig.8. Simulation of 3D Trilateration with three target tags.

V. CONCLUSION

In this paper, Trilateration method used to track the position of the targets. RSSI-Distance conversation used to find the distance between reference nodes and target nodes. The system can track any target within $3m^3$ room with less localization error. To improve the signal quality of RSSI indoor environment will be used hybrid localization algorithm such as combination of RSSI and k nearest neighbor (kNN) for accuracy and precision improvement. This system will promote in real time localization system with better performance on characteristics of scalability, robustness and accuracy.

VI. ACKNOWLEDGMENT

The author is very thankful to Dr.Sint Soe, Rector of Mandalay Technological University, for his encouragement, invaluable permission and his kind support in carrying out this paper work. The author is deeply grateful to Dr.Tin Tin Hla (Professor and Head), Department of Electronic Engineering, Mandalay Technological University for supplying all necessary things. The author also wishes to thank to supervisor Dr.Chaw Myat Nwe (Professor), Department of Electronic Engineering, Mandalay Technological University accomplished guidance, his willingness to share his ideas and, helpful suggestions and for his patience, continuous supervision and encouragement during a long period of this paper. The author especially appreciates and thanks all her teachers for paper support, and guidance during theoretical study and paper preparation durations.

VII. REFERENCES

[1]K. Vadivukkarasi, R. Kumar and Mary joe, A Real time RSSI based novel algorithm to improve indoor localization accuracy for target tracking in wireless sensor networks, ARPN Journal of Engineering and Applied Sciences, September 2015

[2]Xiuyan Zhu, Yuan Feng, RSSI based Algorithm for indoor localization, Journal of Ocean University of China, May 2013

[3]Adalja Disha M, A Comparative Analysis on indoor positioning Techniques and Systems, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 3, Issue 2, March -April 2013, pp.1790-1796

[4]S.L. Ting, S.K. Kwok, Albert H.C. Tsang and George T.S. Ho, The Study on Using Passive RFID Tags for Indoor Positioning, The Hong Kong Polytechnic University, China.

[5]Zahid Farid, Rosdiadee Nordin, and Mahamod Ismail, Recent Advances in Wireless Indoor Localization Techniques and System, University Kebangsaan Malaysia (UKM), 43600 Bangi, Selangor, Malaysia. Received 17 May 2013; Accepted 17 August 2013

[6]Jinsong Han, Yiyang Zhao, Yan Shun Cheng, Improving accuracy for 3D RFID localization, International Journal of Distributed Sensor Networks, January 2012

[7]Kirti Chawla, Gabriel Robind, and Liuyi Zhang, Object localization using RFID, University of Virginia Charlottesville, Virginia, 22904, USA.

[8]Ms.Aarti Vaidya, Prof.A.Meshram, Prof.A.Sakhare, Position Location Methodology based on RSSI using RFID, International Journal of Application or Innovation in Engineering & Management (IJAIEM), January 2014

[9]Junhuai Li, Bo Zhang, Hailing Liu, Lei Yu and Zhixiao Wang, An Indoor Hybrid Localization Approach Based on Signal Propagation Model and Fingerprinting, International Journal of Smart Home, Vol.7, No.6 (2013), pp.157-170

[10] Prajakta Shirke1, Amol Potgantwar1, V. M. Wadhai2, Analysis of RFID Based Positioning Technique Using Received Signal Strength and Directional Antenna, Sandip Foundation’s Sandip Institute of Technology and Research Centre, Nashik, India

[11]K. Olejnichenko, Simulation of Networked Control Systems using TrueTime,International Conference Technical Computing Prague, 2009 p. 27

[1]JiaquingWu,Three-dimensional Indoor RFID Localization System, University of Nebraska-Lincoln, 2012

[2]Jason L.Brchan, Lianlin Zhao, Jiaqing Wu, Robert E Williams, Lance C.Perez, A Real-time RFID Localization Experiment Using Propagation Models, IEEE international Conference on RFID, 2012

[3]Chuan-Chin Pu, Chuan-Hsian Pu, Hoon-Jae Lee, Indoor Location Tracking using Received Signal Strength indicator, Malaysia, South Korea.

Ramazan Aktas, Distance Estimation using Received Signal Strength for RFID Tracking System, Isanbul Technical University, May 2015.