Proceedings of the 6th International Conference on Communication and Electronics Systems (ICCES-2021)
IEEE Xplore Part Number: CFP21AWO-ART; ISBN: 978-0-7381-1405-7

E-SEEK - RFID based Detection System for Localizing the Misplaced Objects

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2021 6th International Conference on Communication and Electronics Systems (ICCES) | 978-1-6654-3587-1/21/$31.00 ©2021 IEEE | DOI: 10.1109/ICCES51350.2021.9488933

ABSTRACT
This paper demonstrates how the E-Seek model assists in locating misplaced objects for industrial and domestic places. Using ultra high frequency passive RFID Tags and readers help in location tracking of assets is done. The random real time inputs generated using python and it's graphical interfaces, RawTurtle via Tkinter helps in the simulation of the distance and direction of the tags.

Keywords- Passive UHF RFID, Raw turtle, TKinter, Asset, Locating, Radio frequency signals (RF), Range, Simulation, Distance, Direction.

1. INTRODUCTION

In the ongoing busy, fast paced lifestyle, searching for lost objects can be a hard task. The E-seek model assists in locating such items in a house and workplace. Keeping track of valuables is made easy by employing active/passive RFID tags. In this project a passive ultra-high frequency RFID is used If a tagged item is lost, it can be tracked and found by a passive RFID reader. The E-seek project proposes to increase the precision and accuracy of the location (distance and direction) tracking abilities of the reader. With the use of four uni-directional antennae which reduces the losses compared to other antenna, the tags are located using the radio frequency(RF) signals that are sent by the reader to the tag, which are then bounced back from the tag to the reader therefore locating the tag. This project proposes a real-time simulation using python 3.8, Raw turtle which is a library function in python that is used in coding virtual graphics and 2D images. Apart from Raw turtle, Tkinter is used which a graphical user interface, that is used for this model to generate

1.1 LITERATURE SURVEY

[1] This paper replaces conventional barcodes with RFID tags for warehouse tracking and shows how RFID can be used to track assets and valuable items with just a tag.

[2] The author in this paper brings out a solution that exists in LANDMARC system that the difference of the received signal strength (RSS) becomes larger as the tags come closer to the reader. The outcome of the above is evaluated and they are differentiated on the basis of normalized weight. In terms of accuracy of location, the simulation of the algorithm proposed will show better performance.

[3] This paper shows how RFID can be used to keep in track with airplane's emergency equipment inside the cockpit. It is planned to be used outside the cockpit where the conditions are much harsher and need the equipments to be on track.

[4] With intense research and development, IoT brings a solution with the help of wireless sensor network. To achieve a low cost asset management solution, for the purpose of warehouse asset tracking, a bluetooth indoor positioning system has been proposed.

[5] This paper resolves problems with switch gears, as they may go a number of kilometers, before they arrive at their last goals. However, with advancements in IoT and RFID, in real time, where the asset's location can be tracked and as they travel, these problems can be deducted or minimized and the losses can be drastically reduced.

[6] This paper makes use of IoT for asset tracking and maintenance. It's goal is to automate the technologies that function in harsh conditions and those which can work without the use of internet. Technologies such as RFID and new Low Power Wide Area Network. Technologies such as LoRa (Low power long range)Sigfox and Near Field Communication and NB-IoT are used for the purpose of the project.

[7] The main technological developments ranging from, radio frequency identification (RFID) tags, barcode and the Internet of Things (IoTs) which are used in asset tracking and are products and in the

supply chain management sector. Supply chains with PUF's add value, particularly to blockchain when newer technologies are added to it.

[8] This paper deals with the problem of RFID augmented robots used by tag localization. Existing RFID tag tracking systems suffer from the requirement of specialized devices, enabling only 2D localization, low scalability, for mobile localization it is having a blind zone, etc. For advanced applications in warehousing, etc, RFID and Commercial Off-The-Shelf robot devices to implement a Mobile RF- robot Localization system is utilized.

[9] Active and passive tags are not used here as they have low battery life and tag range problems, hence Bluetooth low energy tags are used to overcome the situation. From the sensor nodes, data through message queuing telemetry transport protocol are sent to a cloud based central repository and then analyzed further. The data is further analyzed with the help of an application.

[10] This paper deals to improve patient diagnosis, safety, treatment, complexities that emerge from taking care of patients, and precaution, the emerging of Intelligent Hospitals has integrated diverse technologies, to ease information exchange. This has encouraged the integration of RFID by hospitals into a number of operational flows.

[11] Here, a method is proposed in novel UHF-RFID passive tag can be located using RFID antenna. The lower computation cost when compared with the existing grid-based method is the main idea of this paper.

[12] In this paper, using two RFID tags per item is proposed instead of one as it gives higher accuracy, distance between tag and reader is better calculation, and on the orientation of tags it enables fine grained calculation.

[13] Generally, in real time systems, they need high accuracy of localization, where standard systems fail to do so. In this paper, a method is proposed where a conventional RFID system is proposed to be having that accuracy by exploiting the RSSI measurements as observed by setting up multiple spatially distanced tags.

[14] The aim of this paper is to give a solution to car theft by tracking the location of the car for the safety of passengers. This is done by calculating it's speed to find it's distance. The two algorithms, kinematic integration algorithm and positioning algorithm are integrated to track vehicles by formulating a hybrid solution.

[15] This system is same as that of barcode except that an obstacle free line of sight case is not required for it to work. Here, a tag that is chip-less in the RFID technology is used for cost reduction. As the tag dimension increases, cost and number of bits also increases.

[16] This paper concentrates on the safety of school children by using this tracking technology where an indoor and outdoor RFID is used with the aid of an antenna to track human beings and objects . Two antennas one RFID for indoors and one GPS for outdoors is used.

1.2 PROPOSED METHODOLOGY

This project employs an Ultra-high frequency (UHF) RFID reader and tags to aid in tracking the location of the tagged items. A UHF RFID reader sends out radio frequency signals that operate in the 860-960 Mhz band. These signals can reach passive tags that are as far as 6 meters away. In the system proposed by this project, passive RFID tags are attached to items that a user wants to keep track of infinitely. Items that are in motion can also be tracked via this model. In houses, halls or warehouses that are larger than the range offered by a UHF RFID reader, multiple readers can be used to get accurate results. Alternatively, a single reader can be made mobile to catch tags that have been misplaced beyond the given range. In this project, refer fig 1.2, a UHF RFID reader is equipped with 4 unidirectional antennas placed facing away from each other in the Northeast, Northwest, Southwest and Southeast directions. The reader also uses 4 suitable clocks, one per antenna to record the amount of time taken by the radio frequency signals to travel back and forth from the tag to the respective antenna. Depending on the time differences measured, the reader will conclude the distance of the tag from the antenna that recorded the least time. Since radio frequency signals travel at the speed of light, the time difference is measured in nanoseconds for accurate measurement. To achieve this accuracy, the clock has to operate at 10 GHz. This time value is used to calculate the distance. Using the distance calculated by the reader, the received power can also be determined. The received power is a parameter that adds accuracy to the model and acts as an alternative to find the direction of the tag (which can also be achieved by using the time values as the sole parameter). Each directional antenna picks up the power received by the reader in their respective directions. Alternatively, the received power can be calculated. Higher received power indicates closer proximity of the tag. Using this parameter, the direction of the tag given as Northeast, Northwest, Southwest, Southeast. If adjacent antennas pick up the same received power from a tag, the direction can be concluded as hard North, South, East or West.

1.2 INPUT SIMULATION:

A simulation of this system is created in python to illustrate the working of this model. The inputs are represented in Turtle (a python library) via Tkinter. Random locations are simulated and illustrated in a graph that contains a 2D horizontal plane refer fig1.2. All the possible states of the tag are also illustrated in the input simulation. Thereare 5 tags represented here. Tag 1, 2 and 3 are tags that are set in random motion, tag 4 is a stationary tag, and tag 5 is a tag out of range of the reader. The user is asked to choose the tag before the reader begins searching. The tag highlighted in purple is the tag that is being searched by the reader. The other tags in range are orange in colour and the tags out of range are represented in grey. The time taken for the rf signals to go back and forth is stored for each antenna in an array in a pre-set order. The distance for the least time is calculated to be the distance output. Using the time array, the received power is calculated after the time values are converted to the corresponding and input distance values. Using the highest received power, the direction can be determined

1.2 OUTPUT SIMULATION

The output is represented in a new turtle graphics window. The direction and distance is displayed at the bottomof the page. Additionally, the direction is illustrated in a compass. These output values and compass illustration are displayed at the same as the input values i.e simultaneous output values for real time values. Refer fig 1.3.

1.4 ALGORITHM

- Simulate the inputs using the library ‘random’. Calculate the time values for each antenna and store in an array.

- Simulate the graphical representation of the inputs using Turtle via Tkinter.
- Calculate the distance using the time values and the following formula:

$$\text{Distance (m)} = \text{Time (ns)} * \text{Speed (m/s)} \quad (1)$$

- Use the distance obtained and other parameters such as transmitter gain, receiver gain, transmitted power and wavelength to calculate the received power using the following formula:

$$Pr = Pt*Gt*Gr*\lambda\string^2/(4*\pi*d)\string^2 \quad (2)$$

- Use the difference in received power of each antenna to determine the direction of the tag.

- Display the location (direction and distance) in the output Turtle screen via written values and a simulated compass.

3. FIGURES

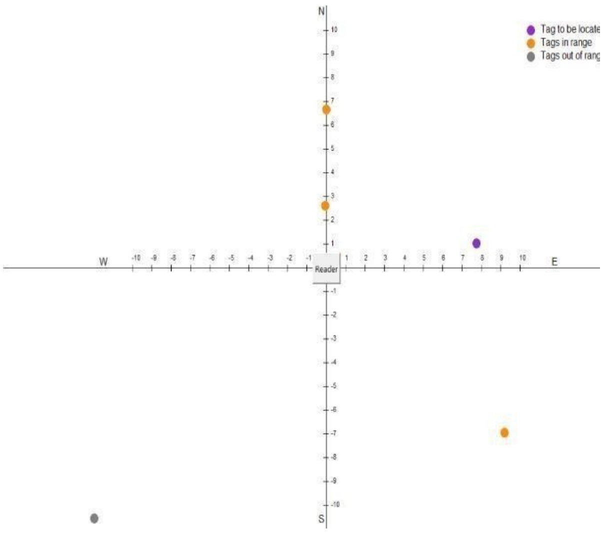

Figure 1 represents the passive UHF RFID tags and the reader. At the output of the code the tag number which needs to be found is typed and the corresponding tag (purple) is located. The orange tags and the ones in range (30m) and the grey tags are the ones out of passive UHF tag range.

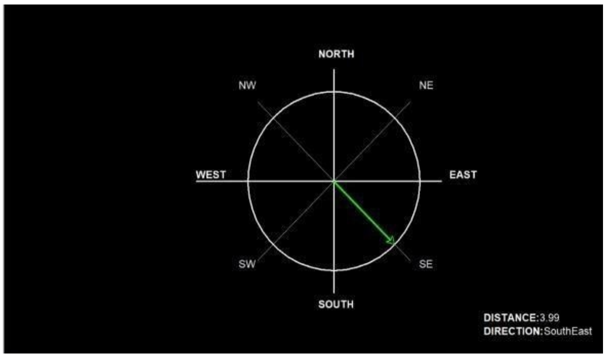

Figure 2 represents the output simulation where the distance and the direction the tag to be found (purple) is found. It shows whether the tag is in northeast, northwest, southeast or in the southwest directions and the distance in meters.

2. MATH AND EQUATIONS

As rf signals travel at the speed of light, the time difference is measured in nanoseconds for accurate measurement. To achieve this accuracy, the clock has to operate at 10 GHz. This time value is used to calculate the distance using the following formula:

Distance (m) = Time (s) * Speed (m/s)

Using the distance obtained and other parameters such as transmitter gain, receiver gain, transmitted power and wavelength the received power using the following formula is calculated,

$$Pr = Pt*Gt*Gr*\lambda^2/(4*\pi*d)^2$$

Where,
Pr –received power
Pt –transmitted power
Gt-transmitter gain
Gr-receiver gain
d-distance
λ-wavelength

The above equation is friis transmission equation, which is used to calculated the received power from one antenna, when the same power is transmitted by another antenna, separated by a distance d and wavelength lambda.

CONCLUSION

In conclusion this project aims to reduce time in searching for assets and maintain cost effectiveness by the use of passive UHF tags. The passive tags has the advantage of recharging of batteries which will help the tag last more than 5 to 10 years or more. The E-Seek model has a drawback of short read range up to 30m but as it is designed to be used for domestic use and small-scale industries this drawback will not be a hindrance.

AUTHORS CONTRIBUTION

The RFID market is not much concentrated in the asset location area, which if done could save a lot of time in this fast-paced lifestyle Unlike existing systems, this project uses passive-UHF RFID tags. This results in cost reduction and lifetime of the system. With the idea of microzoning, zones are divided into subzones are the tags are located. Only one reader with four uni-directional antennae is used, placed in the Northeast, Northwest, Southeast and Southwest directions.

ACKNOWLEDGEMENT

It is with deep sense of gratitude that we acknowledge our indebtedness to our supervisor Mrs.G.Anitha, M.E for her expert guidance and connoisseur suggestions.
We thank all staff members of our department of Electronics and Communications Engineering, for guiding us through the entire project.

1. L. Mo and C. Li, "Passive UHF-RFID Localization Based on the Similarity Measurement of Virtual Reference Tags," in IEEE Transactions on Instrumentation and Measurement, vol. 68, no. 8, pp. 2926- 2933, Aug. 2019, doi: 10.1109/TIM.2018.2869408.

2. B. Hu, H. Peng and Z. Sun, "LANDMARC localization algorithm based on weight optimization", Chinese Journal of Electronics, vol. 27, 2018.

3. S. Yang, M. Crisp, R. V. Penty and I. H. White, "RFID Enabled Health Monitoring System for Aircraft Landing Gear," in IEEE Journal of Radio Frequency Identification, vol. 2, no. 3, pp. 159-169, Sept. 2018, doi: 10.1109/JRFID.2018.2822770.

4. C. K. M. Lee, C. M. Ip, T. Park and S. Y. Chung, "A Bluetooth Location-based Indoor Positioning System for Asset Tracking in Warehouse," 2019 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM), 2019, pp. 1408-1412, doi: 10.1109/IEEM44572.2019.8978639.

5. M. S. Sidhu, S. Saif, N. E. Ghazali, S. M. Shah, T. W. Chun and T. J. Hussain, "Automating Switchgear Asset Supply Chain Management with IoT and RFID Technology," 2020 8th International Conference on Information Technology and Multimedia (ICIMU), 2020, pp. 404-408,doi:1109/ICIMU49871.2020.9243528

6. S. S. Rohit, A. G. Jamkhandi, A. Rao, V. Krishna, A. Naik and M. Parathodiyil, "IOT based Identification and Assessment of Industrial Assets," 2018 International Conference on Computing, Power and Communication Technologies (GUCON), 2018, pp. 378-383, doi: 10.1109/GUCON.2018.8675004.

7. J. Davies and Y. Wang, "Physically Unclonable Functions (PUFs): A New Frontier in Supply Chain Product and Asset Tracking," in IEEE Engineering Management Review, doi: 10.1109/EMR.2021.3069366.

8. X. Liu et al., "Accurate Localization of Tagged Objects Using Mobile RFID-Augmented Robots," in IEEE Transactionion Mobile Computing

9. R. Gandhewar, A. Gaurav, K. Kokate, H. Khetan and H. Kamat, "Cloud Based Framework for IIOT Application with Asset Management," 2019 3rd International conference on Electronics, Communication and Aerospace Technology (ICECA), 2019, pp. 920-925, doi: 10.1109/ICECA.2019.8821897.

10. P. H. Frisch, "RFID in Today's Intelligent Hospital Enhancing Patient Care & Optimizing Hospital Operations," 2019 IEEE International Conference on RFID Technology and Applications (RFID-TA), 2019, pp. 458-463, doi: 10.1109/RFID-TA.2019.8892070.

11. H. Wu, B. Tao, Z. Gong, Z. Yin and H. Ding, "A Fast UHF RFID Localization Method Using Unwrapped Phase-Position Model," in IEEE Transactions on Automation Science and Engineering, vol. 16, no. 4, pp. 1698-1707, Oct. 2019, doi: 10.1109/TASE.2019.2895104.

12. M. Salim, A. Alsadoon, P. W. C. Prasad, A. Elchouemi and A. K. Singh, "RFID Technology for Vehicle Tracking Using Hybrid Kinematic Integration and Positioning Algorithm," 2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon), 2019, pp. 360-365, doi: 10.1109/COMITCon.2019.8862193.

13. F. Xiao, Z. Wang, N. Ye, R. Wang and X. Li, "One More Tag Enables Fine-Grained RFID Localization and Tracking," in IEEE/ACM Transactions on Networking, vol. 26, no. 1, pp. 161-174, Feb. 2018, doi: 10.1109/TNET.2017.2766526.

14. A. Karthik, S. Aiswarya and S. K. Menon, "Compact Low Cost Passive RFID Tag for Object Tracking," 2018 International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2018, pp. 1711-1714, doi: 10.1109/ICACCI.2018.8554640.

15. S. Subedi, E. Pauls and Y. D. Zhang, "Accurate Loalization and Tracking of a Passive RFID Reader Based on RSSI Measurements," in IEEE Journal of Radio Frequency Identification.

16. D. Sugumar and G. Thennarasi, "RFID and GPS antennas design of Heterogeneous tracking system for school children safety," 2019 2nd International Conference on Signal Processing and Communication (ICSPC), 2019, pp. 361-365, doi: 10.1109/ICSPC46172.2019.8976819.