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A new methods of mobile object measurement by using radio frequency identification

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ABSTRACT

In this study, the mobile robot conducts tag of RFID and the antennas' reader was scattered at the indoor-outdoor environment, which represents the novelty of the study, as this has not been done in the previous studies. This protects the mobile robot from weight increase reduces the consumption of the battery. Moreover, mobile object increase demands an increase in cheap passive Radio Frequency Identification tags in the system of navigation. Techniques of Signal processing utilize both accompanied by the theories of electromagnetics in locating the robot's position. Numerous antennas usage provides a breadth of comparisons. In this work, have been provide a new RFID tracking approach that can also be used for interior positioning. This technique employs RSS to gather the signal intensity of reference tags before they are used. The next step is to send a signal. Setting up Power Level ranges via reference tags uses strength as a setting parameter. Then, based on the intensity of the signal, you can determine how far away you are. Reference tags are used to match the signal intensity of track tags. Finally, when track tags are installed in indoor locations, they can be used to monitor the movement of people. It will use the arithmetic mean of the positions of surrounding reference tags to determine the location. Values. According to preliminary results from an experiment, our approach is more precise than the antenna system. Approximately 10 to 20 lines.

Keywords: Diversity of Antenna, Passive RFID, Signal Pattern Matching, Indoor Localization.

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1. Introduction

Mobile robot utilization in applications like show business industry and the military is maximizing recently. These applications demand organized management of mobile robots' navigation. Mobile objects localizing of in indoor environment has been investigated extensively due to its high value commercially and academically. However, despite the rich literature in investigating the use of mobile robots, satisfactory and valuable results have not been reached yet. A plethora of navigation algorithms have been proposed in the previous studies. These techniques are behavior-based, dead reckoning and classified as a landmark [1], Anyways, the aforementioned techniques demand attaching high-cost gadgets or complex algorithms to the mobile robot.

The latest investigation of mobile robot navigation has been carried thru utilizing the system of RFID (Radio Frequency Identification) and a fuzzy logic control circuit. Regarding the current study, the robot is attached with two antennas and reader of RFID [2]. The Navigation process was carried out through the comparison of the phases of the received signal from every Radio Frequency Identification active tag [3].

Based on different research, following system and target tracking utilizing the direction finding. The study proposed a reader of Radio Frequency Identification that connected antenna with dual-directional.in terms of localizing; (DOA) Direction of Arrival Two RF modules operating in two separate frequency bands have been used to connect the reference nodes. To compute distances between nodes, (RSSI) is utilized instead of LQI. [4, 5] have utilized the system of laser-activated Radio Frequency Identification to for mobile robot localizing.

study has used a method of tri-angulation and the mobile robot to activate many Radio Frequency Identification tags so that the researchers were able to located mobile robot.

WCL (Weighted Centroid Localization) was suggested in WSN (Wireless Sensor Networks). The decision about the distance between the beacon and the unknown node has been taken by the LQI (Link Quality Indicator), distances were transmitted to the weights. Through weights comparison, the study located the unknown node [7]. In WSN, Adaptive Weighted Centroid Localization (AWCL) a new methodology was suggested. This technique compares the weights' magnitudes and differences to eliminate the errors of ambiguity in the communication range. Furthermore, research has been conducted based on Weighted Centroid Localization, to locate eight reference nodes with the blind node using (SAWCL). (RSSI) is used instead of LQI to compute distances between nodes. [6].

Radio Frequency Identification is a reliable, flexible and rapid technique of locating controlling, identification various substances electronically. The system of Radio Frequency Identification comprises of reader and tag. Information identity in the microchip of the tag reads wirelessly. The system of Radio Frequency Identification contains two used antennas, one connected to the reader and on the tag. There are four types of tags due to the source of the power for and other functionality including communication. Since passive tags utilize emitted signal power to radiate, they radiate without battery. Active tags radiate over a greater distance and rely on a battery for power the battery is located inside, active tags are more expensive and larger and with long-live battery.From reviewing the literature, methods of triangulation, comparison of received signal strength [1], and comparison of phase have been carried out and gaining in-formation about location aimed for the applications of navigation in indoor environment. The Radio Frequency Identification's reader was located the top of the mobile robot while tags were attached in interior space, the findings showed an in-crease in the mobile robot's weight and consumption of power. To solve this, it de-pends on the tags' number in the interior space. The complexity of calculation is increased by increasing the tag.

1.1. Localization algorithm

According to the past research, three main various algorithms have been introduced according to the utilization of measured signal parameters namely Proximity Scene Analysis and Triangulation, [1].

2. Triangulation

Triangle technique is used in detecting the target geometric properties locations of the. Triangulation has categories: angulation and alteration. In the method of alteration, location is calculated thru distances among the target and references points. In distances estimation, roundtrip time of flight, RSS (received signal strengths), or the phase of received signal are could be utilized. From TDOA and TOA, distance is calculated from multiplying time by the velocity of the signal. From the values of RSS, distance is calculating thru the calculation of the attenuation.

On the other hand, the Angulation method, AOA (angle of arrival) directional antennas or an array had detected it. The target's location is determined by the angle direction lines' intersection point.

Regarding indoor environments, the multipath effect affects the AOA parameters and time decreases the location estimation's accuracy. TOA has better performance than attenuation [14]. Regarding distances with short propagation, it is a complicated process to sense the time and time differences [15].

2.1. Scene analysis

The methods of Scene analysis were applied in two steps. One features of collection of scenes, second estimating object's location by connecting online measurements to the nearest fingerprints of previous locations. For thee analysis of scene, which relies on RF, values of RSS, are usually utilized. Two techniques of fingerprinting-based namely radio map or probabilistic methods and KNN (k-nearest neighbors) are utilized.

In the application of KNN technique, the database was designed with measurements of RSS at familiar locations. After that, the authors perform real-time measurements of RSS connected to the target to find matches of k nearest in the previous-built space of the signal. For target localizing, the errors of root mean square prickle has been performed on chosen neighbors.

In the approaches of probabilistic, the issue stated is to find the target's location assumes that there are one observed signal strength vector and n possible locations during the real-time measurements due to Bayes formula and the probability of posterior. Therefore, the highest probability location is selected. In general, methods of probability contain various stages like history tracking, estimation of error, active learning and calibration. Therefore, [11] proposed tracking-assisted positioning or/and Bayesian-network-based.

2.2. Proximity

Algorithm of proximity detects targets' locations in previously selected sub-areas. Targets usually approximately located based on the antennas and positions of antenna are well-known [12]. Particularly, systems usually utilize WSN, RFID, IR (infrared radiation), and based on the proximity algorithms. Moreover, COO (cell of origin) or Cell-ID (cell identification) method. This technique depends on the fact that mobile networks is able to detect the mobile handset's approximate position through knowing device that the cell site utilizing at a specific time. Hypothetically, the implementation of current technique is simple. However, in the indoor environment the ranges of communication were not simply predicted [13].
In the current research, antennas' reader was put at the sides of indoor environment and the tag of passive RFID is to the robot of the mobile, which protects it from weight increase and results in saving power consumption. Moreover, mobile object increasing in demands an increase in cheap passive tags of radio frequency identification in the system of localization. Tag's RSSI parameter is calculated using the indoor environment's reader in numerous points. Techniques of SAWCL and WCL were tested with the values of RSSI and for mobile robot locating; the study developed an algorithm of signal pattern matching.

3. Localization systems

Algorithms of localization utilize various parameters such as RSS, TDOA and TOA signal's phase. In parameters measurement, the established systems like Bluetooth, GPS, UWB, WLAN, or RFID are utilized or new systems at [5] would be developed.
Topologies system of localization can be categorized in two groups. First, the tag attached to the mobile unit or signal transmitter unit, as well as the stationary measurement equipment receives the transmitted signals. Computation station carries out the localization. In the second group, mobile is the unit of measuring and receives the signal of numerous fixed transmitters. Master station or mobile unit carries out the localization.

3.1. RFID systems

Radio frequency identification is a system works in band RF of auto detection sys-tem. The system has two main components, tag and reader. Defined protocols carry out the communication between tag and reader. Spot ON is a famous system of location sensing which is used by the RFID technology Spot On relies on the measurements of RSS from long-range adjustable active tags of radio frequency identification [16]. Gathering measurements of signal strength with antenna or multiple reader were utilized for distance approximating through a function defined with empirical data. Tags localizing is performed by classic alterations.
LANDMARC is an example of famous techniques in the systems of radio frequency identification. This system relies on the technique of KNN. The reference tags' positions were positioned frequently on the areas that are covered. The readers contain eight various levels of power. This technique comprises of choosing the closest k tags of reference from the strange active tag. Utilizing the technique of e KNN, Radio frequency identification tag location could be estimated.

3.2. RFID systems

Recently, the local wireless networks became the famous wireless systems [3]. Suggested an approach, which utilize RADAR or KNN. This technique contains two approaches. In the first, measurements of RSS conducted offline and the target was located with the measurements of real time. Secondly, propagation model (FAF) floor attenuation factor and WAF (wall attenuation factor) are utilized regarding the model of signal propagation.
The probabilistic model that is the Horus system was utilized based on the measurements of RSS [16], [17]. Every candidate location coordinate is thought to be category or class. To minimize the error of localization, Algorithm of likelihood selects location.

4. Current indoor localization comparison

A variety of methods of localization in the indoor environment is compared in Table 1 based on, cost and robustness, accuracy, complexity, algorithm, utilized technology [5].

Table 1. Indoor position types and solve

System	Wireless System	Position	Accuracy	Complexity
RADAR	WLAN, RSSI	Viterbi	4~6m	poor
Horus	RSSI	Probabilistic	3m	Poor
Where Net	TDOA	Least Square	3-4m	Moderate
Sappier Dart	Ultrasound	Least Square	Less 0.3 m	Poor
Spot On	Active RFID RSS	Ad-Hoc	Relay on size	Moderate
LANDMARC	Active RFID RSS	KNN	Less than 1m	Moderate
GSM fingerprinting	GSM Cellar Net-work	Weighted KNN	4.5m	Moderate
Pin Point	UHF (RTIF)	Bayesian approach	1.5m	High

4.1. Radio frequency system

The Infinity reader, Is a multiregional and multiprotocol radio frequency identification system. In Figure 1 reader physical appearance is illustrated. Reader enhance communications of machine and human across ports either the Ethernet or serial and supports up to four antennas Rx/Tx. In Figure 2, connections of O/P and I/P are predicted. The Infinity reader have been be controlled by Java and NET returns numerous parameters like signal to noise frequency and ratio tag identification number, phase, RSSI [18].

Figure. 1. Upper High Frequency Reader Infinity 510

For each antenna, the Infinity 510 radio frequency identification reader delivers RSSI measurements in the form of dB. The reader returns the predicted phase as a two complement 16bit range from – 180 to with 1x8000 and π x7 to 360 . by use the Infinity reader, additional 1820 phase ambiguity is consequently referred to as or θ +π. Appendix A contains the specifications for Infinity's technical radio frequency identification reader.

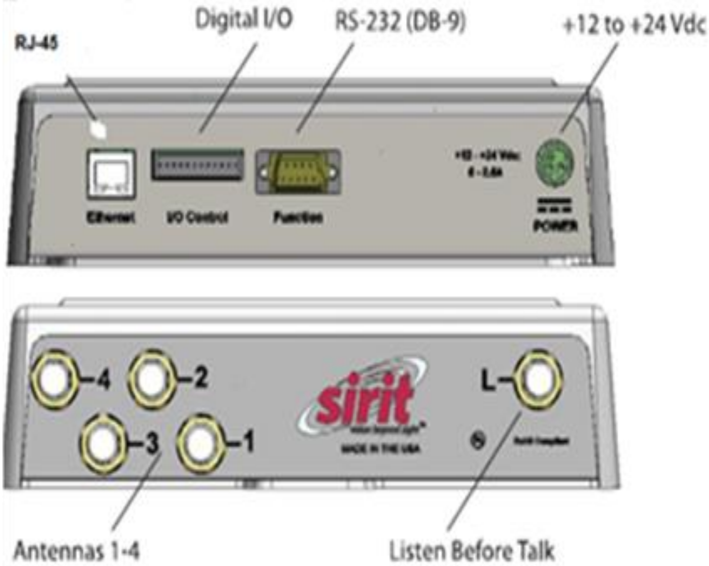

Figure. 2. Connections for Power and I/O on the Infinity 510

4.2. Antennas

In waves' receiving and transmitting, the, the study used 4 antennas operating in range (875 – 879) MHz frequency band with an 8.4 dB gain, MTI Wireless Edge LTI produced the used the antennas. The pattern of radiation is shown in Figure 4. MT-242040 antenna's technical specifications are included in Appendix B.

5. Indoor wave propagation model

Algorithms of localization in Indoor environment require distance among the tag and the antenna. In the radio frequency, identification systems measured RSSI, or the receiver's power output, is proportional to the distance. To decide about the RSSI values' variations, the channel of propagation is demanded to be designed.

In the channel of propagation, waves' transmission is located with (LOS) and (NLOS) links. In propagation channels, both in indoor and outdoor, received signal's interfered component is located because of electromagnetic waves' dispersion, diffraction and reflection. These effects can be noticed in the indoor environment as electromagnetic field polarization, refraction by medium with varied propagation velocity, diffraction at edges, superposition of electromagnetic fields, and reflection on metallic objects, [18]. In addition, within small propagation zone, signal's rating becomes more difficult. To gain distance-using values of RSSI and overcome these effects, the literature suggested numerous models of propagation.

With Equation 1 and the calculated average power, While d>d0 exists, to compute average path loss used Path Loss Model.

$$\overline{PL}(d) = \overline{PL}(d_0) + 10 \cdot n \cdot 1og\left(\frac{d}{d_0}\right) \tag{1}$$

Coefficient of Propagation (n) relies s on the building type and surroundings and estimated by the prior measurements using the following Equation.

$$n = \frac{RSSI_{dBm} - A}{10 \cdot \log(d)} \tag{2}$$

The measured values of RSSI referred to by A at 2m from the antenna, corresponding distance d measurements are denoted by RSSI. Using Equation 3 to calculate the distances between the tag and antenna in meter

$$d = 10^{\left(\frac{RSSI_{dBm} - A}{10 \cdot n}\right)} \tag{3}$$

5.1. Measurement procedures

In the current experiment, measurements were conducted in lab to examine the environment of indoor. Measurement's setup included, mobile robot, desktop computer, local area network switch, four antennas, cables, and RFID reader and tag as shown in Figure 3. The reader of radio frequency identification is located at the roof to shorten the lengths of cable. In the middle of sides, antennas were located at 4.8mx4.8m square area. Figure 4 illustrates indoor environment's measurement setup and physical appearance.

The mobile robot comprised of microprocessor unit, battery, two optical sensors and two DC motors, and it detects the black line on the ground. As sensor senses the color, the robot stops for a while for time interval, which is predefined.

The setup of measurement, two various paths are existed. Path 1 starts from front of the mobile robot and antenna 4 the, that is connected with the tag of RFID, moves to the third antenna. On the other hand, the second one ends in front of the first one and begin ahead of time for the second. The mobile system moves between two antennas in straight line. The mobile robot stops every ten 10 cm and waits for measurement.

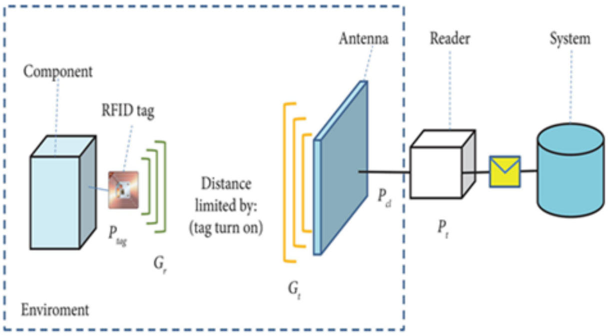

Figure. 3. Process of Measurement Procedures

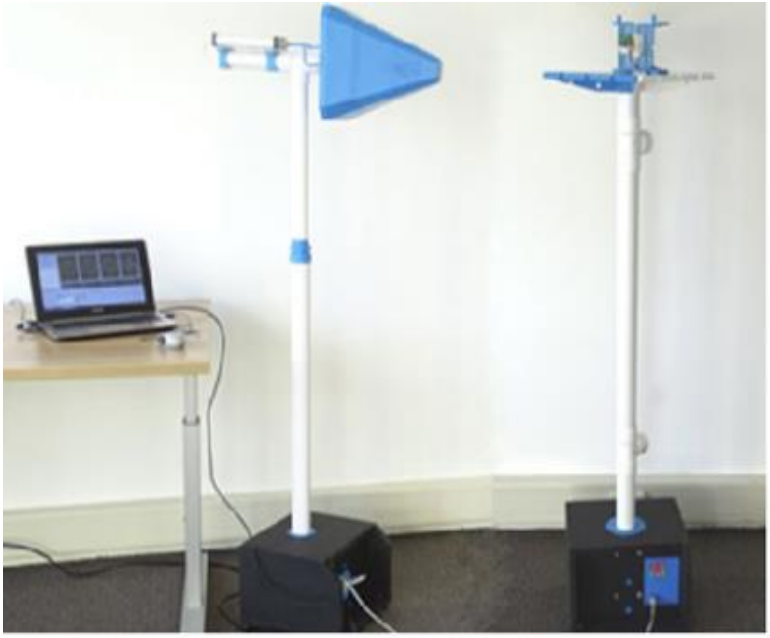

Figure. 4. Measurement procedures laboratory

6. Measurements and results

In the current research, phase of RSSI and semi-passive RFID tags and frequency parameters passive were calculated using the system of RFID. To record the desired parameters and command the reader, the study used Measurement User Interface. RFID tags' radiation observation the antennas in various directions, nine measurements have been conducted for various oriented tags. The mobile robot moves from one meter (d0) far from the fourth and stops one meter before the third antenna. Measurements initiated when distance between the fourth antenna 4 and robot is 1 meter and new measurement is conducted for each 10 cm intervals for 29 points among the third and the fourth antenna. The authors selected the corner among the third and second antenna as (0, 0) and the algorithms of WCL and SAWCL were utilized to estimate the distance between (0, 0) point and tag.

6.1. Measurements of RSSI and predictions of SAWCL

PowerG-W403 semi-passive tag of radio frequency identification was used in the current measurement. Between the fourth and the third antenna, on the measurements of 29 points were conducted. Table 2 shows calculated values of RSSI (dB m) for all antennas. SAWLC and the model of Log-distance path loss was used to esti-mate the distances between (0, 0) point and the mobile robot. In Figure 5 compares the distances both actual and the estimated from (0, 0) point.

Figure 6 shows the highest difference among actual and estimated distance which is 1.91m and noticed at the first point. Between the 2nd and 20th points, 0.5m is the highest localizing error. The localizing error was more than 1m after the 20th measurement point, and observing the ripples some points.

Table 2. RSSI values (db m) mesurements of power g-w 403

First antenna	Second antenna	Third antenna	Fourth antenna	Frequency
-63,76799707	-70,22673025	-65,79757438	-56,39009448	866300
-64,20645241	-73,26692998	-63,31935907	-57,90585167	866300
-63,1544916	-73,62052313	-64,56035006	-58,51897605	866300
-63,15007997	0	-62,92933073	-62,86870001	866300
-67,14687037	0	-60,42823496	-69,20103709	866300
-68,81491823	0	-61,07453427	-69,98010316	866300
-67,66664104	0	-61,08136056	-68,00447218	866300
-66,1863486	0	-63,73592051	0	866300
-64,52715635	0	-58,68106485	-70,87287311	866300
-65,16345511	0	-61,58135173	-74,00933562	866300
-67,93819205	0	-58,19774132	0	866300
-70,13346213	0	-58,40808122	0	866300
-69,74767972	0	-57,68903497	-73,46105796	866300
-67,14173787	0	-57,22094407	-69,22516306	866300
-66,21077502	0	-56,95431578	-69,36626101	866300
-69,97224551	0	-56,74143853	0	866300
-69,71940112	0	-55,63729154	0	866300
-67,05894913	0	-58,38606702	-73,60908723	866300
-69,18571568	0	-57,94389865	0	866300
0	0	-56,97576286	-74,389922	866300
-71,1	0	-55,88449438	0	866300
-70,37720019	-73,45030726	-55,73198798	-72,15376337	866300
0	0	-54,69498334	-72,24860411	866300
0	-72,48975384	-56,90067114	-67,21918785	866300
0	-71,68074839	-64,57374079	-66,60211375	866300
0	-73,73984338	-56,73903982	-69,32558363	866300
0	-73,10867552	-57,9828243	0	866300
0	-74,0604381	-57,75071489	-68,92130261	866300
-70,3	0	-56,73849975	-68,36668608	866300

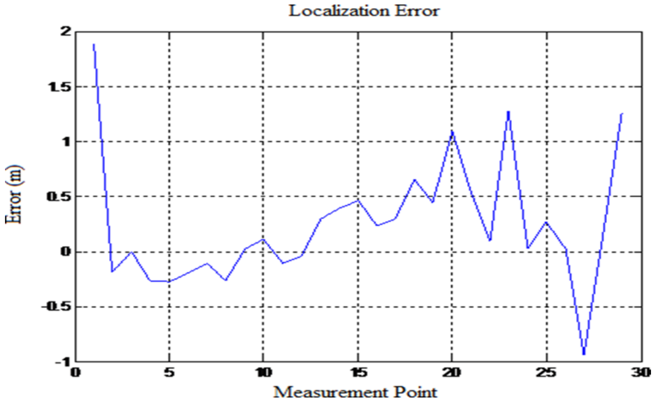

Figure. 5. Distance between powers G-W403 tags predicted and real distance

6.2. Setup 2

This experiment made use of an RFID tag with a semi-passive design, the power G-W403. However, in the current step, radio frequency identification tag is rotated 180o. Table 3 shows the measured values of RSSI from the antennas. Based on the table, the first antenna's measurements could perform two points only. SAWLC and the model Log-distance path loss were utilized to estimate the distances between the point (0.1, 0.1) and mobile robot. Figure 6 compares the actual and estimated distances from (0.1, 0.1) point.

Table 3. Values of RSSI measurements of rotated G-W 403 tag using RSSI

First antenna	Second antenna	Third antenna	Fourth antenna	Frequency
0	-73,42629085	-65,64123888	-57,01739528	866300
0	-70,20724161	-66,70953732	-55,97739866	866300
0	-72,86631789	-68,53488931	-57,243859	866300
-70,24995349	-73,15829923	0	-58,99532186	866300
-70,15319952	-70,65521753	0	-57,49320017	866300
0	-72,07431963	-68,83034635	-55,72381924	866300
0	-73,27098781	-68,92618124	-55,61965542	866300
0	-71,01249376	0	-55,0771126	866300
0	-73,42629085	-65,64123888	-57,01739528	866300
0	-70,20724161	-66,70953732	-55,97739866	866300
0	-71,60142186	0	-54,90984239	866300
0	-72,9625557	-70,1	-59,54579745	866300
0	-70,44024375	0	-55,36661091	866300
0	-71,30951045	-70,7	-57,5205042	866300
0	-72,75545653	0	-55,59372065	866300
0	-71,24637114	0	-56,98561093	866300
0	-65,13447963	0	-55,07523047	866300
0	-64,28090657	0	-58,4733149	866300
0	-64,48818008	0	-59,692172	866300
0	-67,22832447	0	-60,04451004	866300
0	-66,43133498	0	-57,48992056	866300
0	-63,40888	0	-60,02532902	866300
0	-63,3093602	0	-65,65875866	866300
0	-63,61493463	-68,80863068	-62,29510972	866300
0	-63,71637781	-68,31897645	-67,74048245	866300
0	-63,51653139	-69,75474321	-59,915306	866300
0	-64,83554402	0	-58,42008746	866300
0	-65,30140368	-57,62032405	-58,58896393	866300
0	-65,26461411	-63,44156364	-64,16780872	866300

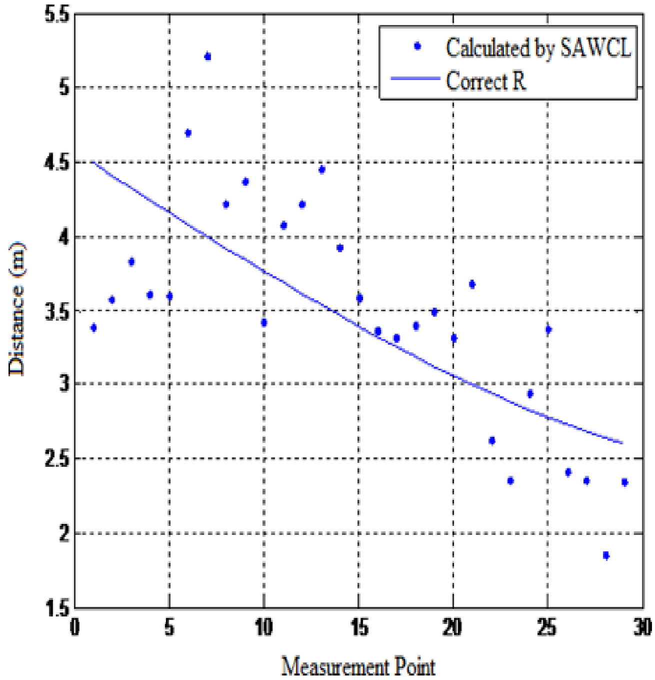

Figure 6. Comparing actual results with those predicted

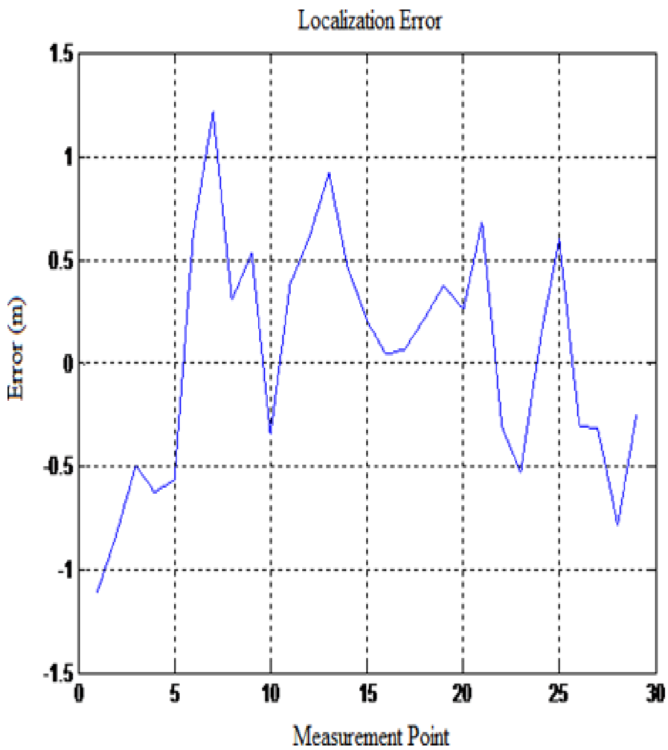

Figure. 7. Rotated power G-W403 tag error, calculated as he discrepancy between a calculated and a measured distance.

6.3. Setup 3

In orientation errors' reducing the, radio frequency identification tag power G-W403 was calculated in 2 various orientations at travelling time of mobile robot from the fourth antenna to the third one. For the second and fourth antenna, measurement conducted as in the step 1 and measurements of the antennas 1 and 3 were conducted with 180° rotated position. SAWLC and the model Log-distance path loss were utilized to estimate the distances between the (0, 0) point and mobile robot.

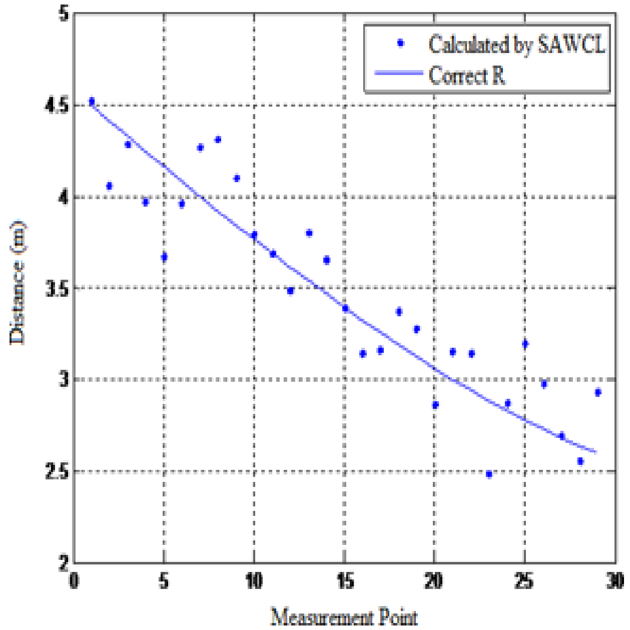

Figure 8. Comparison between power G-W403 tag's estimated and actual distances

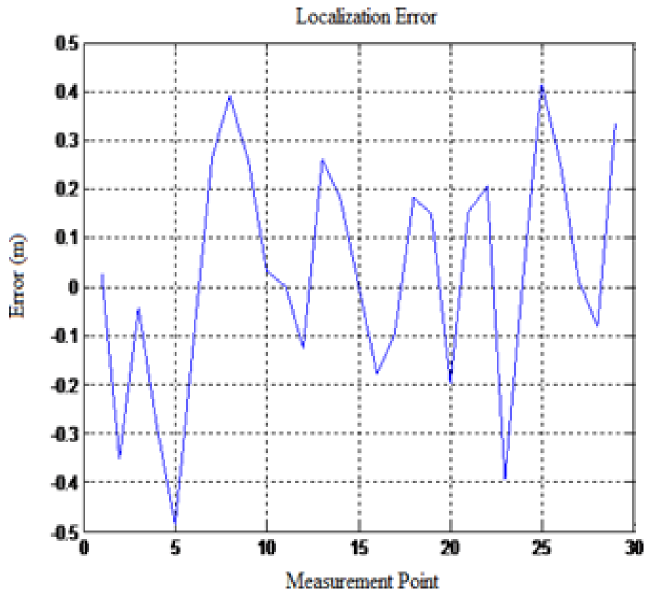

Fig. 9. Measurement error is the discrepancy between a tag's estimated and actual distance.

Figure 9 shows that 0.49m is the highest difference among the actual and the estimated distance. The maximum error in localization was 0.25m for sites closer to the measurement setup's center, and the error reaches 0.34m at a few locations. Figure 10 shows that decreasing the propagation error by improving propagation direction.

6.4. Setup 4

The radio frequency identification tag “Power G-E403 semi-passive” was utilized in the current measurement between the fourth and third antennas, on the measurements were conducted in the 29 points. Table 4 shows the measured values of RSSI (dB m) from each antenna. SAWLC and the model of Log-distance path loss were used to estimate the distances between (0, 0) point and the mobile robot Figure 11illustrates the actual and estimated distances from (0, 0) point.

Figure 12 shows the highest difference between the actual and estimated distance, which is 1.6m. The localization error between the 7th and 23rd points did not exceed 0.56m.

Table 4. Values of RSSI of rotated G-W 403 RFID TAG

First antenna	Second antenna	Third antenna	Fourth antenna	Frequency

-64,65907847	-62,30264569	-64,85641982	-56,62480001	866300
-64,89494307	-61,87102567	-60,15551363	-58,48745755	866300
-63,42494131	-62,8374716	-61,00710164	-59,5949735	866300
-64,52572431	-68,87865111	-61,06572506	-62,72168427	866300
-65,7961547	-66,44526582	-56,95642176	-65,33181076	866300
-64,14633083	-68,145798	-58,83494882	-73,21010057	866300
-64,90082516	-72,68478478	-58,08031413	-63,52344708	866300
-64,82057928	-70,45733929	-61,61311535	-64,75761678	866300
-63,91660886	-71,84465044	-55,28115729	-62,75138973	866300
-63,43406418	-71,3601453	-59,42250302	-66,35714703	866300
-62,95731095	-73,61243618	-54,67774544	-65,01880568	866300
-65,16665034	0	-56,98646769	-72,03935674	866300
-65,76518921	-73,38443872	-55,45108112	-67,71123235	866300
-63,33567329	0	-54,90160201	-66,72830278	866300
-62,33656077	0	-54,7656732	-64,64305275	866300
-63,76780187	0	-54,01022162	-71,0928379	866300
-64,98762162	0	-53,49280945	-73,27738994	866300
-62,67345101	0	-55,93003912	-67,18972011	866300
-62,35500309	0	-56,92947651	-72,8354986	866300
-64,60885337	0	-54,07553242	-69,72619068	866300
-63,01705499	-72,9962355	-53,81196926	-69,74300731	866300
-62,32755619	-72,77683138	-53,50392008	-70,02191409	866300
-65,94817779	-72,21458413	-53,80705797	-65,22087934	866300
-65,37037461	-69,18602382	-55,60267068	-63,06241216	866300
-62,15450106	-66,53511851	-62,0856743	-62,2835902	866300
-63,11609784	-69,47197589	-54,70508453	-66,18151554	866300
-63,04191342	-71,30866002	-56,76029481	-73,4	866300
-62,73927108	-71,12802883	-56,99312284	-65,97549384	866300
-63,99248647	0	-56,13288039	-63,77141931	866300

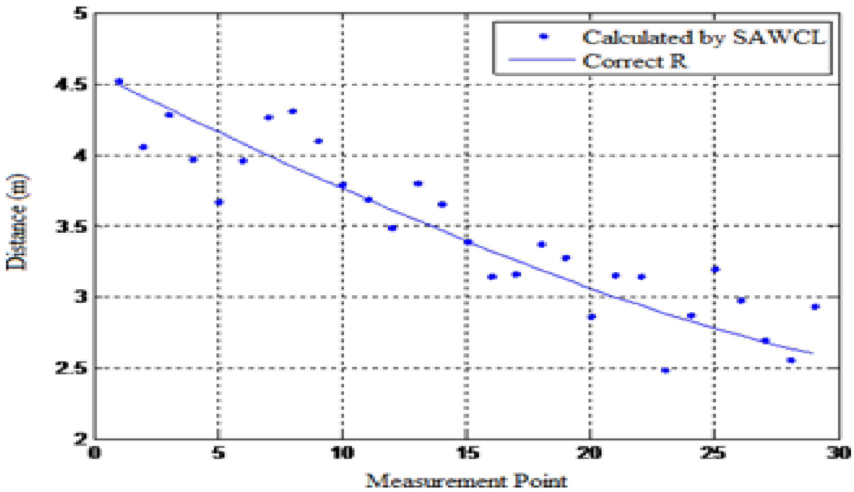

Figure 10. Power G-E403 tag estimated and actual distances are compared.

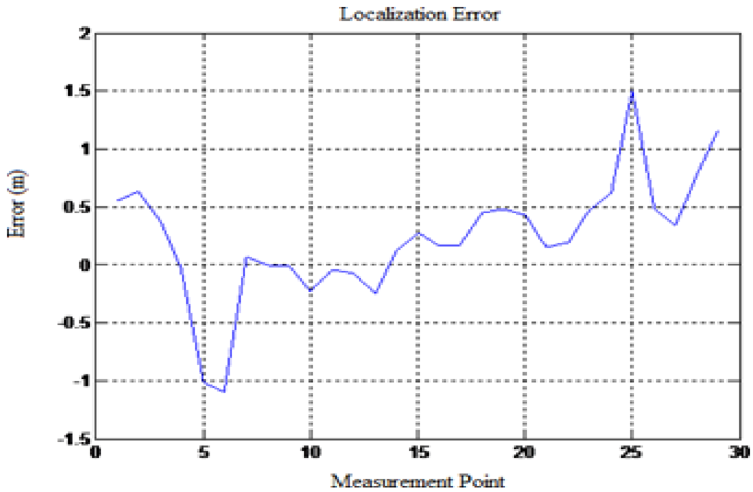

Figure. 11. The discrepancy between the tag's estimated and real range

6.5. Setup 5

Radio frequency identification tag TE14 passive has been utilized in the current measurement. Measurements were conducted on the straight line in the third and fourth antennas in every 10cm. Figure 12 illustrates the comparison between actual and estimated distances from (0, 0) point. This measurement Power G-E403 semi-passive radio frequency tag has been utilized. Between the fourth and third antennas.

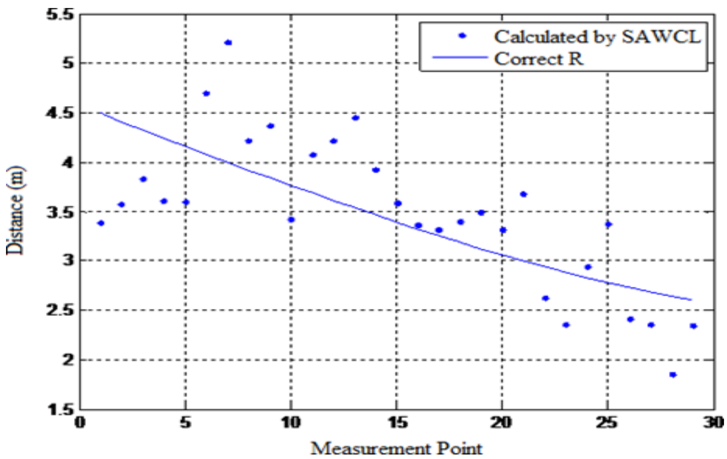

Figure 12. The TE14 tag's actual distances and estimated are compared.

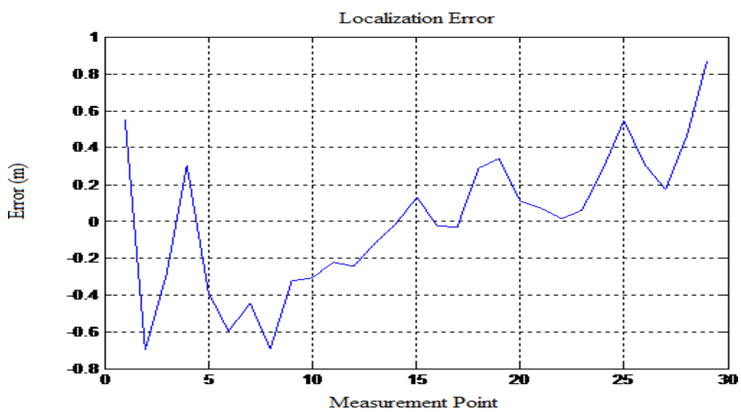

Figure 13. The discrepancy between the tag's estimated and real range

Figure 13 the fourth antenna's error gain in the far field was measured at 0.81m, with the error centering on that. Additionally, the greatest errors in localization occurred in the antennas' near and distant fields. At nearer points to the measurement area's center, errors minimized to 0.2m. Compact microstrip filters can enhance the performance of the projected design of this study [17-20]

7. Discussion

The suggested system is designed for measuring the values of RSSI from every antenna. There is a straight line connecting all of the antennas for the calculations to follow. At intervals of 11 cm, the RSSI values were recorded. The mobile robot is used to transport the tag; it makes 11 cm-long pauses and waits a short period of time between each one. The PC was attached to the compute and reader to calculate the mean of the received values of RSSI. The antennas are placed at the sides of the area.

Numerous measurements were carried out with various types of radio frequency identification tags and various orientations of tag. In the processes of measurement, averaged values of RSSI, transmission signal frequency and received signal phases were recorded. It is observed that with the recorded averaged values of RSSI, the tags' radiation is not uniform for all directions. Various characteristics of RSSI are gained within the similar range of 2 antennas. When the measurements were repetitive with similar orientation and tag and a reliable characteristic of RSSI was gained.

To calculate distances between tag and antenna, transmitting values of RSSI to distance are important. Numerous models of path loss in the in-door environment were examined and Model of Long distance Path Loss is thought as the most suitable due to its easiness in application of various indoor environment.

8. Conclusion

This study applied different algorithms of localization in locating mobile robot connected with passive tag of Radio Frequency Identification in indoor environment. The system contained four antennas reader Radio Frequency Identification, desktop computer and tag of four antennas. The tag's location is calculated with diversity of antenna. The novelty of this research is the mobile system robot is combined a passive four antennas tag which has not been investigated in the literature as the mobile object is carries the reader. Regarding RSSI-based indoor localization technique, that utilizes distance, Due to the non-uniform radiation, passive RFID tags cannot provide accurate location. In the current research, to beat the effect of radiation various orientations were used to measure tags. Using numerous parameters increases the sensitivity of the system.

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