POSITION LOCATION METHODOLOGY BASED ON RSSI USING RFID

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ABSTRACT

The proposed method enables self-recognition of a person’s current position by utilizing high frequency passive radio-frequency identification (RFID) tags. The system is used by each and every person who wants to locate the person within the network established by the system. The locating network is set up by the use of RFID readers and tags. Computer server is built to send and receive the request and result of location in association with RFID tags and reader. The readers will emit the frequency allocated to particular person and will find the tags present in their respective area. By using frequency matching method, the position of person is detected and finally gets position information on the server in the map of particular organization and also the guide message. The system is built without use of GPS technology.

Keywords:- RFID, Readers, Tags, Localization

1. Introduction

Localization: Finding the exact location of any object that resides on earth surface by using various detecting technologies is localization. The localization may be indoor or outdoor. Various technologies used for position detection

Many different technologies have been emerging for position location. There are three approaches by which we can find the locations of anybody are as follows:
1. GPS (global positioning system)
2. RFID system (Radio frequency identification)
3. NFC (near field communication).

GPS is generally used for outdoor applications whereas RFID and NFC can be used for outdoor as well as indoor applications. But RFID and NFC are more suitable for indoor application because of the related range used by their reader and tag.

1. GPS: A Global Positioning System is a system designed to help in navigation on the Earth. GPS satellites cover the whole earth in four directions, and a group on the equator. Radio signals are taken from satellites in space in orbit around the Earth. signals can be received by the GPS unit from 6 to 12 satellites at a time. An atomic clock is contained by every satellite which is carefully set by NORAD several times every day. [9].GPS devices may provide latitude and longitude information. Some may calculate altitude information. But this information related to altitude may not be accurate and rely on exclusively to pilot aircraft. The radio signals can give good time and position of the satellite. The current time is subtracted by a GPS receiver from the time the signal was sent. The difference tells that how long before the sender sent the signal.. The time difference multiplied by the speed of light is the distance to the satellite [7]. Trigonometry is used by GPS unit to calculate where it is from each satellite’s position and distance. Four satellites are required for solving the geometric equations .[10]

2. RFID: Radio Frequency Identification (RFID) is used for the identification of any particular object uniquely. Some applications are creating demand for high-accuracy, low cost indoor location methods [2]. However, due to the higher complexity of indoor environments, navigation systems i.e. GPS that perform well outdoors, may work poorly indoors. As name suggests, each RFID is provided with the frequency. Frequency can be of any range from very low frequency to ultra high frequency. It is observed that frequency is inversely proportional to the wavelength (f=c/λ, where f:=frequency:=velocity, λ:=wavelength)[1]. So, the distance to be covered can be adjusted by using the frequency. RFID
readers and RFID tags are used for object’s identification. An RFID reader generally acts as sender as well as receiver. It captures an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information.[2] RFID tags can be passive, active or battery-assisted or passive. Active tag is having its own battery and sends its id periodically. Battery assisted passive tag has small battery and can work after coming in contact with the reader. Simple passive tags are without battery. The reader has capacity to read simple tags frequency after coming in range of reader. To create a specific interrogation zone, fixed readers are set. The reading area is created when tags go in and out of the interrogation zone.[5]

3. NFC: Near Field Communication is a short-range high frequency wireless communication technology. It enables the exchange of data between devices. The distance can be over about a 10 cm distance. NFC is an upgrade in the RFID technology. NFC combines the interface of a smartcard and a reader into a single device. Sometimes it works like Bluetooth system. The connection between two NFC devices is established at once.[23]

2. LITERATURE SURVEY

Existing Position Location application and related algorithms using RFID Technique

2.1. Received Signal Strength Indicator (RSSI)
[1] A radio frequency identification (RFID) wireless sensor-network location tracking system was implemented by the wireless communication technology (WCT), micro-sensors and location tracking algorithm (LTA), and developed to be a network node communication system.

Technology used: The Space Signal Attenuation Model (SAM), Received Signal Strength Indicator (RSSI), Link Quality Indicator (LQI), and Network Node Location Calculus (NNLC) were adopted in this system. The RFID WSN system provided real-time position for object recognition, and return the information as an object path information was recorded on the sensors.

[2] The method that enables self recognition of a mobile vehicle’s current position by utilizing ultrahigh frequency (UHF) passive radio-frequency identification (RFID) tags. It can be used in real industry environments such as complex storage warehouses where many different goods are dispersed throughout a wide area.

Technology used: The particular method makes use of two UHF RFID readers with identical emission configuration attached to a vehicle to identify a reference RFID tag. By utilizing the received signal strength indicator obtained by the readers from the reference RFID tag, the precise position of the moving vehicle can be obtained. If more than one antenna is attached to a monostatic reader, they would function by switching to a single active antenna per each reading. Also, readers provide estimated RSSI similar to analog-to-digital converter (ADC) output.

2.1.1 Positioning Algorithms based on RSSI
a) Lateralion: For all the mobile nodes, each anchor node measures the power received from the mobile and, by computing the distance, draws a circle around itself.[17] The anchor node assumes that the mobile should be at one of the points on the circumference of the circle. If the calculus of the distances is exact, given three anchor nodes it is possible to discover where the mobile node is by the intersection of three circles. In case of overlapping, the problem is to find which ones are correct and which are false. In order to do this “minimum path discovery” is implemented. For each estimated position the distance between it and the others is computed. Two equally sized sets are created. The first set collects the estimated positions with smaller respective distances. The other set contains the remaining nodes. Comparing the sets by the sum of the distances between them, it is possible to find the cluster containing the closest estimated coordinates.

b) Minimum Maximum: This algorithm is very simple and robust in the presence of noisy channels. For all mobile nodes, an anchor node measures the power received, but, in the minimum maximum case, the computation of the distance allows a square to be drawn around the fixed node, with sides equal to twice the estimated distance. The anchor node assumes that the mobile is within this region. The same thing happens for all other mobile nodes. By overlapping the square regions it is possible to identify a mobile node within a rectangle whose area gets smaller as the number of anchor nodes increases. The algorithm’s output is the centroid of this rectangle.

c) Ring Overlapping Circles: This algorithm is complex to implement than the previous two. It works on comparing the received power from the anchor nodes. Therefore it does not need an accurate estimate of the distance among nodes. Circles are drawn by anchor nodes around itself by measuring the received power to any other fixed node. The circumferences of these circles are centered on an anchor node and ideally means in a channel which only contains path
loss, will intersect the others. In this way each anchor node draws boundaries around itself that identify different regions of the space. By comparing the received signal strength from the mobile node (for all the mobile nodes) with the one coming from the other anchor nodes, each anchor node can apportion the mobile node to one of these regions. The same procedure is repeated for each anchor node. Several overlapping regions, i.e. a slice is found. The output of this algorithm is the centroid of the region’s slice where the majority of anchor nodes have established the mobile to be. This algorithm does not need to estimate the distances among nodes. It just compares the received powers. This is very important for the realization of cheap sensors.

d) Modifying Minimum Maximum: If an anchor node assumes that the mobile position is represented by a square region, instead of a circumference around itself, there is an additive estimation error. To remove errors, two solutions are proposed: one is impracticable because of the high complexity required, but the other provides the basis for the implementation of MINMAX+. MINMAX+ is a modified version of the MINMAX function which aims to correct the bias.[10]. This method use both lateration and minimum maximum positioning. The new approach called Cooperative Overlapping Circles and Minimum Maximum (COCMM) is introduced. The core idea of this method is to always use the square region provided by the minimum maximum approach to estimate node positions, but in case of a good channel the algorithm corrects the minimum maximum output using lateration. For a channel with low noise levels, lateration can potentially provide good positioning estimates that should be inside the square box built by MINMAX. This square is therefore used to select the cluster of estimated locations obtained by lateration. If the square region does not contain any estimate computed by lateration, the output of COCMM will be the same as the one for MINMAX.. It is observed that, the bias of both MINMAX and COCMM become smaller with an increase in the number of anchor nodes.[16]

2.2 The mathematical tool for positioning: Kalman filtering

A global localization system combining odometry data with radio frequency identification (RFID) readings is proposed. RFID tags are placed at the ceiling of the environment and can be detected by a mobile robot unit traveling below them.[3]

Technology used. This is possible using a suitable tag’s antenna in ultrahigh frequency band, expressly designed to obtain regular and stable RFID detection regions, which allows us to consider an efficient Kalman filtering approach to fuse RFID readings with the vehicle odometry data.

2.3 Combination of RSSI (technology) and kalman filtering (tool)

A system that localizes and identifies trolleys in the entry area of a distribution center is presented in .The area is monitored by an RFID reading system (consisting of four antennae and a fixed RFID reader) and an inexpensive pair of webcams. The trolleys are equipped with a passive RFID tag and an optical marker.[4]

Technology used: The system uses a Particle Filter to combine Received Signal Strength Indication (RSSI) data from the RFID system and image data from the webcam and propose procedures to improve RFID and camera localization accuracy. The resulting system achieves an accuracy of less than 30 cm in static and the most likely dynamic scenarios.[4]

2.4 Comparative study:

2.4.1 Comparison Table for Technologies:
2.4.2 Comparison Table for various positioning algorithms based on RSSI

<table>
<thead>
<tr>
<th>NO</th>
<th>ALGORITHM</th>
<th>OUTPUT REGION</th>
<th>RESOURCE UTILIZATION</th>
<th>ROBUSTNESS</th>
<th>PERFORMANCE</th>
<th>ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Lateration</td>
<td>Circumference</td>
<td>LESS</td>
<td>MEDIUM</td>
<td>ADEQUATE</td>
<td>LESS</td>
</tr>
<tr>
<td>2.</td>
<td>Minimum Maximum</td>
<td>Centroid of rectangle</td>
<td>VERY LESS</td>
<td>HIGH</td>
<td>GOOD</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>3.</td>
<td>Ring Overlapping Circles</td>
<td>Centroid of the region’s slice where the majority of anchor nodes</td>
<td>MORE</td>
<td>VERY HIGH</td>
<td>ADEQUATE</td>
<td>MORE</td>
</tr>
<tr>
<td>4.</td>
<td>Modifying Minimum Maximum</td>
<td>Combination</td>
<td>LESS</td>
<td>LESS</td>
<td>GOOD</td>
<td>LESS</td>
</tr>
</tbody>
</table>

3. CONCLUSION
This paper focuses on various technologies for the position location such as Global Positioning System, Radio Frequency Identification and Near Field Communication. Also proposes the system for the position location of the person using RFID for the indoor application for the organization using the reader, tag and AVR controller. Out of these various technologies, the RFID technique has been chosen. RFID technology is generally used for the indoor application. Cost involved in RFID is very less. As no. of readers increases more exact location can be found. So, accuracy is more than that of GPS. Network can be easily established. No use of internet for the application.
Using Received signal strength indicator, position detection is possible. Kalman filtering is an interesting and powerful mathematical tool to optimally and dynamically process data hampered by white Gaussian noise. Filtering also allows one to interpret measurements coherently with mathematical formulas. It is possible using Kalman filtering to realize tracking applications, achieving a good performance after a specific delay to achieve the best filter state.

Paper also finds that RFID technology along with RSSI and Kalman filtering is best combination for position detection for indoor application.

REFERENCES


