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A Study on Positioning Issues in u-Learning Environments

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Abstract: The applications of ubiquitous learning is still considered to be very limited theses days, which has to do with many of the issues that have yet to be compromised involving some of the key technologies required; among which would be "positioning issues". Complications involving positioning issues can be divided into three categories: In the first category would be those of the global positioning system (GPS), since it consumes much of manpower in obtaining environmental parameters needed in order to ensure its functioning to be free of problems. The second category has its roots in the sensitivity of signals received by the wireless network equipment; units or systems would be greatly affected by whether or not the signals are being received on a reliable basis. Finally, there stills exists considerable inaccuracy in the practical usage of positioning methods, which has prevented them from being applied in reality. By integrating the Exponentially Weighted Moving Average (EWMA) and the concepts of the Sequential Positioning Method, this study has outlined the "Integrated Positioning Method" ("IPM") which, through segmentation and comparing of signal strengths, not only would decrease the degree of complexity in computing performed but would also reduce the positioning error rates. The results of this experiment shows that besides its capacity to have the environmental parameters figured out automatically so that the instability of signals received get to be improved, the IMP also simultaneously provides a location error rate of 1.3m on average, whish is of a great precision. As the effects of the impacts of the parameters used get to be more closely observed in details, even greater improvements could be achieved in the accuracy of positioning. Since the IPM that has been developed out of this research has a positioning function that is automatic in its operations, it is more of a system that is going to meet practical applications.

1. Introduction

The positioning objects in applications of indoor positioning systems are usually humans, for instance, the management of patients in a hospital; ensuring the safety of the miners working in a mine; monitoring of prisoners at a prison, etc If holding mobile devices, instead of humans, accountable as the objects of positioning, the network base stations will be able to provide superior quality of networks connections. The applications of such technology can be best illustrated when it is used in location-oriented guiding tours at a museum, when it is used to position items in management of inventory at a warehouse, or when it is used to track the production objects at a factory. Such advancements developed in the sphere of wireless network transmission technology actually spur on the developments of the indoor positioning systems that take full advantage of all sorts of wireless technology [1-7]; it explains how it is that one such application appears after yet another one.

2. Indoor Positioning System

The global positioning systems in general deliver reliable performance when utilized in the outdoors setting set in open spaces, though when used in such indoors settings as in factories, offices, or conference rooms, since the signals often times are blocked by buildings or other units of complex, they become relatively weak and unreliable for receiving. The positioning of such weak signals would usually acquire additional applications being employed, and this holds true in cases where more detailed information or other services are needed. This section will thus be focusing mainly on indoor positioning systems in particular by illustrating the indoor radio wave positioning systems that have been proposed in the past and the alternatives that might replace them.

The wireless positioning systems nowadays rely on radio frequency (RF), or, the transmitter and the receiver of radio waves as the chief means of transmission. The transmission of the infrared -- though not as popular as it once used to be -- has been the most widely-used method before the emergence of the "transmission-by-radio frequency market. In addition, because "ultrasound" has often been used as a way of assisting radio wave positioning systems it has long been considered as one of wireless means of transmission. The following would be an introduction of the radio wave positioning systems which take radio frequency as their basic structures.
Adopting radio frequency as a positioning system has become a trend. As [7] has illustrated, the outcome would turn out to be more desirable when a positioning system has integrated numerous kinds of positioning technologies. With the range measurement technique, it uses geometric figures to form conjectures on positioning of objects, which requires that information on relative distancing be obtained prior to any calculations can be performed. This techniques can be further divided into the two sub-categories of the "late ration technique" and the "angulations' technique". Still then, the late ration technique is either time-based -- basing calculations on time of arrival (TOA) or time difference of arrival (TDOA) -- or Really Simple Syndication-based (RSS-based). With the environmental analysis technique, there is the off-line stage and the on-line stage. This technique is commonly used in indoor positioning systems. RSS information displayed in the off-line stage, along with reference point signal strengths displayed in the on-line stage, are collected for establishing a radio map of the positioning environment to save into and be compared against each other in a central computer, which would have the coordinates computed after putting matching algorithms into the equation.

What radio map is is a RSS database that can determine the connectivity from being centralized or distributed. Generally speaking, the greatest of the population that composes the data the higher in accuracy of the data. When the connectivity is centralized, the antenna situated in the certain spots detects the likelihood of the locating point approaching, in this way; the centralized computer would then be able to pinpoint the specific coordinates. In case where more than one locating points are received, the one with the strongest in reference point signal strength would be determined as the defining coordinates amongst the many others. When the connectivity is distributed, meaning with a layout of a large number of locating points with coordinates, the locating point that is detected to be the nearest determines the defining coordinates.

3. Integrated positioning method

We integrated the concepts of the maximum-likelihood estimation (MLE) and the sequence-based localization (SBL) in designing of the "integrated positioning method". The areas in which the locating points are located depend upon the received signal strength indicator being great or small in values. If the maximum RSSI value received on the latest is identical to the previous one received, it would be fair to make the judgment that it is going to be the first area that is where the location point is going to locate, as so demonstrated in Section 1 in Figure 3.1

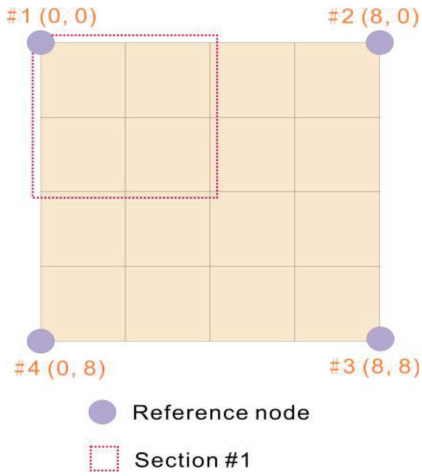

Figure 3.1 Determining of the major section

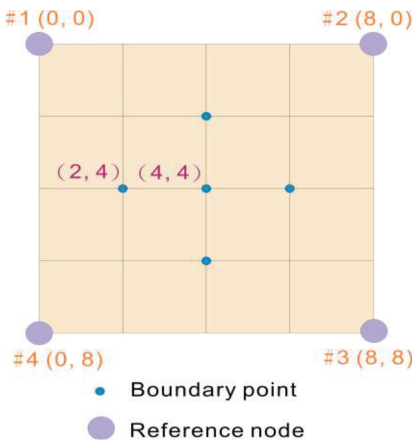

Figure 3.2 Determining of the boundary point

If the maximum RSSI value received on the latest is different from the previous one received, then it could be judged as the boundary point in different areas where locating points may sit, as illustrated in Figure 3.3. For example, if taking the maximum value of "1" received in the first instance as the reference point and compare it to a maximum value of "2" received in the second instance, then it can be judged that the locating point is moving from the first coordinate plane towards the second coordinate plane, making the coordinates of (2, 4). If the maximum value received in the first instance was "1" and "3" in the second instance, then the locating point would be coordinated at (4, 4). The boundary points are taken into considerations for that with those locating points that are really of short distance to the positioning regional center, the RSSI values are usually not far off.

After the major section has been determined, having the minor section determined breaks down into a two-fold process. The four centers of sections as shown in Figure 3.4 amplify the more specific coordinates and by using MLE, the nearest coordinates can be located. Provided that it would simply take four centers of sections as such for referral, it would be the reference points that need be determined in the beginning of the process.

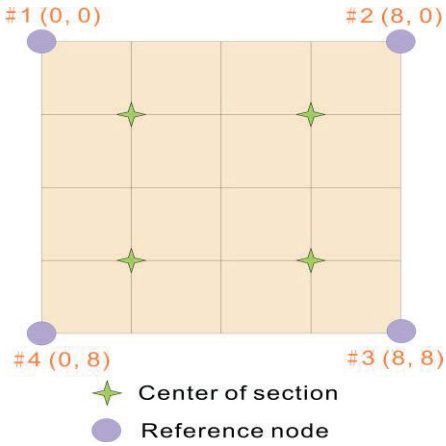

Figure 3.3 The reference nodes

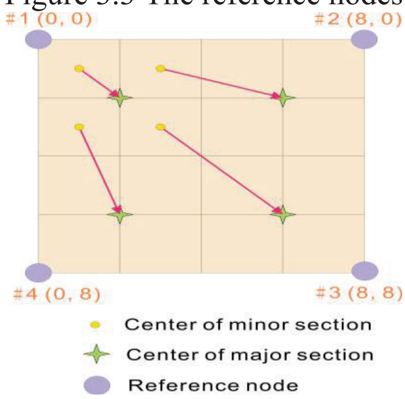

Figure 3.4 The relationship between the reference nodes and center of minor section

Provided that there are only four reference nodes taken into considerations for the present study, there are relatively fewer sort restrictions need be considered in regards to the sequences concerned. Only sequence other than the maximum value received because the locating point has been determined to locate in the minor section. When the sequences received are (1, 4, 2, 3), for instance, the second sequence being four, it is indicative of the possibilities for the coordinates to be either (1, 2) or (2, 3). If the sequences received are (1, 3, 2, 4) or (1, 3, 4, 2), with the second sequence being three, the sequences may be deemed problematic and the locating point would then be set on default, or at (2, 2), which is approximately the center point of the section concerned. In the case scenarios of the sequence being either a "2" or a "4", chances are there would be two sets of coordinates located. The actual coordinates can be specified after determining whether the maximum RSSI value is close to the reference point. See Figure 3.5.

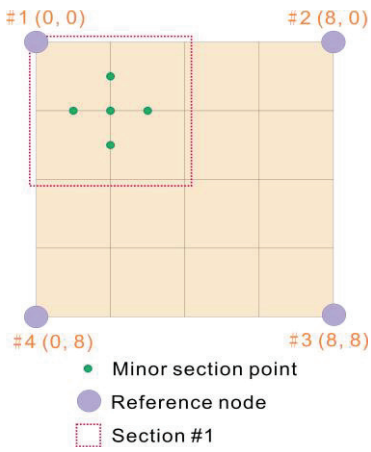

Figure 3.5 Determining of reference point by sequence

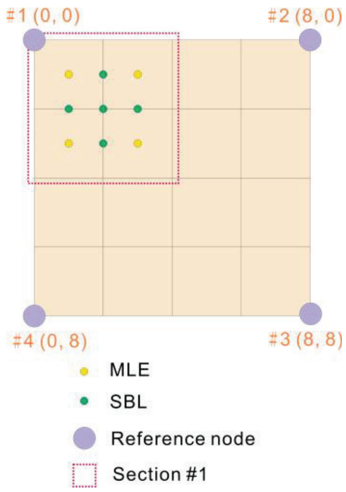

Figure 3.6 Illustration of integrated positioning determinants

After both the MLE (yellow spots shown in Figure 3.6) and the SBL (green spots shown in Figure 3.6) have been applied, the values are taken and averaged to determine the coordinates in the minor section. This way, it would not be necessary to convert the RSSI into a distance value and the coordinates are also be prevented from deviating from the positioning range. Also, the section in which the location point is detected can still be identified correctly even when erroneous RSSI values are received.

4. Conclusion & Analysis

After the Exponentially Weighted Moving Average of the RSSI values are treated with flip-flop filter, it is compared against the original RSSI value. In the experiment, the location point is adjusted from being ten meters away from the reference point to one meter away instead and back to the starting point, while the nodes are situated 60 centimeters above the ground, with the speed of travel of 60 seconds being the constant.
In positioning the amount of environment used in this study takes 1 to 10 meters as the interval in the path loss index

4.1 The Dynamic adjustment path loss index test

In positioning the amount of environment, the intervals was set at ten meters in the path loss index. The path loss index is calculated by taking into considerations of the minimum mean square error; a locating point is paired up with a reference point to form a data set by the unit of one meter that will allow the RSSI value of each point to be obtained. The index figure obtained from using the minimum root mean square error method is 2.769, which is a common value applicable to such indoor setting as offices. The path loss index can be automatically calculated when the distance is used along with the RSSI value.
In simulation, the reference points were arranged in a manner that was identical to the actual positioning, as illustrated in Figure 4.1. The RSSI values of the four reference points picked were recorded, and then also recorded were those of the four locating points. There were thus sixteen pairs of RSSI values. Figure 4.2 is a diagram displaying node #03 collecting the RSSI values of the four reference points. The RSSI values of the four location points were then used to substitute the variables in the integrated positioning method that has been developed in this study to see if the area where the node was located could be identified correctly. The outcome of the inspection (that was done in reverse) has further reflected the method to be reliable in being accurate even when there were discrepancies' making the RSSI values collected unreliable.

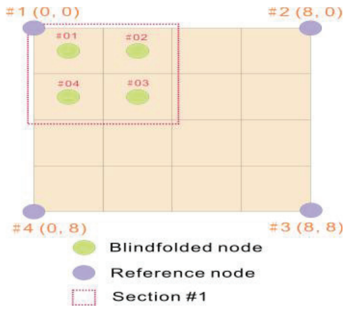

Figure 4.1 The reference points were arranged in a manner that was identical to the actual positioning

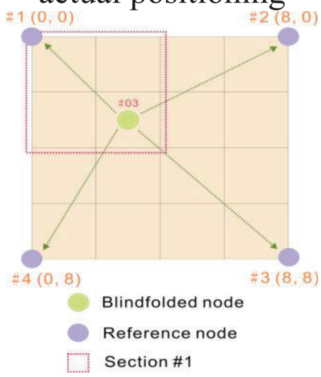

Figure 4.2 diagram displaying node #03 collecting the RSSI values of the four reference points.

4.2 The positioning test

A demonstration was carried out to put the integrated positioning method to the test. Four locating points located 1.2 meter above the ground were motioned at the constant speed of one meter per second, alternating with 5-minute intervals in between. Ten pairs of statistics were recorded and taken the average of to make an illustration of the error comparison, where spots plotted on the horizontal axis represent where motioning took place. The coordinates of (2, 0) would represent the starting point of "1", while the coordinates of (4, 0) would represent the finish point of "12" and so on and so forth.

The average location error rate produced by the demonstration ultimately indicated surpassing efficiency delivered by the method than if only MLE was applied (Figure 4.3), or than if only SBL was applied (Figure 4.4), or still, than if only CC2431 was applied (Figure 4.5). In Figure 4.6, the different comparisons made against the integrated positioning method were combined.

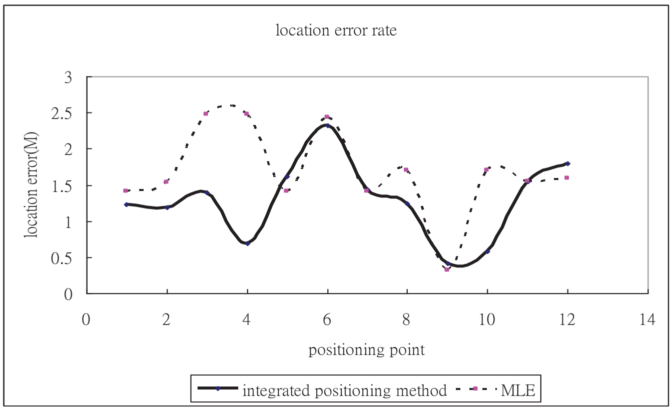

Figure 4.3 Comparing the IPM and the MLE

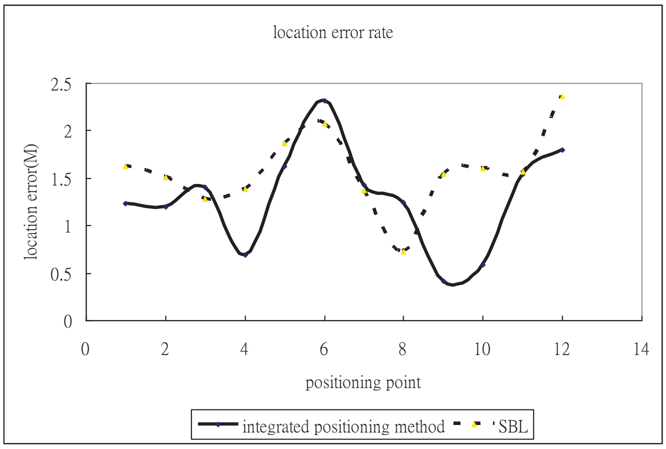

Figure 4.4 Comparing the IPM and the SBL

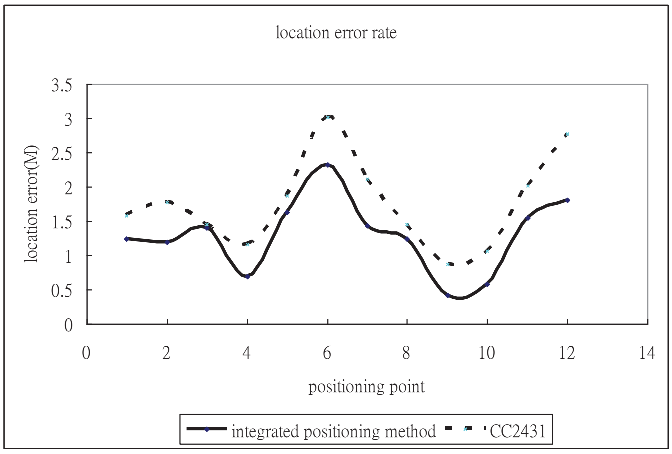

Figure 4.5 Comparing the IPM and the CC2431 (positioning engine)

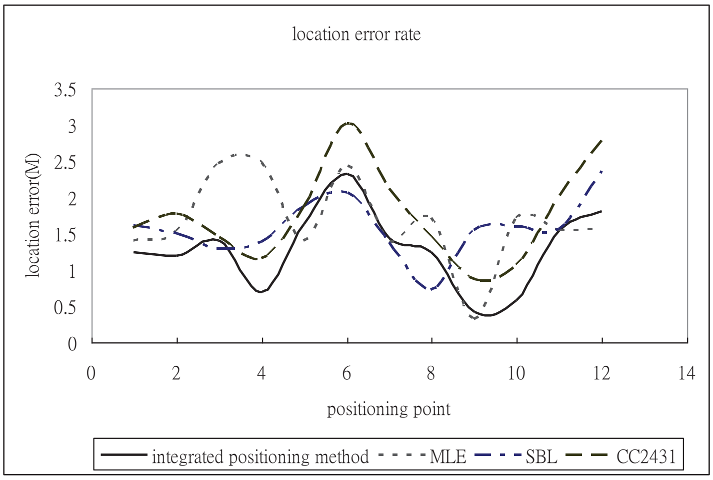

Figure 4.6 Comparing the IPM and the various methods combined

5. Conclusion

This study has proposed the adequate solution of solving positioning issues in particular by suggesting the use of the "integrated positioning method", which can be characterized as follows:

1). By referring to the path loss index the reference points used were determined by the sensibility of the RSSI values collected to be legitimate, which is then followed by the application of the EWMA flip-flop filter for smoothing.

2). The pass loss index need not be calculated beforehand, since such information is automatically obtained with ongoing communication being carried out throughout the reference points.

3). Because the integrated positioning method determines the section in which the reference point is located through the collection of the RSSI values, the signal strength values need not be converted into units in distance, and this avoids erroneous information from being produced in second operations.

The results of the research has indicated of a productive outcome that was delivered by the utilization of the integrated positioning method, which achieved a positioning error range of 1.3 meter that is sufficient for practical applications inside indoors settings that are enormous, such as classrooms or offices. The concept of zoning helped to limit other possibilities in the positioning ranges.

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