

Study on Calculating 2D Location using WSN in Multipath Environment

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I. INTRODUCTION

Research on location-aware applications is really booming. Guiding you to your favourite restaurant in an unknown city is just one example. Outdoors these systems can rely on GPS-based positioning, but for indoor applications these systems simply don't work. Indoors wireless sensor networks (WSN) are the only affordable alternative. These systems can only be successful if they incorporate all the underlying physical phenomena in a powerful localization model in order to give accurate results in the complex and dynamic real-life indoor wireless environments. In this paper we attack this problem and present a positioning method based on the received signal strength, developed with the help of our testbed.

II. PRINCIPLE OF OPERATION

In a previous paper [1] we already mentioned that the WSN IEEE802.15.4 standard itself suggests a linear relation between the measured received signal strength (RSSI) and the logarithm of the distance between sender and receiver. Emulating that relationship with attenuators, we were able to present graphs of packet error rate versus the separation of a Wifi-interferer and a WSN receiver. Also earlier we showed that some WiFi interferer modes are worse than others. It is clear that a good localization protocol can still work with other interferers like

microwave ovens, Bluetooth and wireless USB.

In this paper the WSN testbed in our IBBT office premises in Ghent is used to further explore the RSSI-distance relationship in a real-life indoor environment full of multipath fading. One node is sending the one after the other and the others report the RSSI to a central server. Here a best linear fit for that node between the RSSI and the logarithm of the separation between sender and receiver is calculated, using standard regression analysis tools. This provides intercept point, slope factor and r-squared (RSQ) values for each sender. We suggest to use these RSQ values for the selection of good anchors. Nodes with a high RSQ will be able to locate the other nodes better. In our building these nodes are found in the extremes of the building, not in the centre and especially not in the corridors, where a lot of multipath fading is encountered, giving a much too strong measured signal. The intercept point and slope factor are used to calibrate the sending node.

A second step is to select anchors with a low standard error (which is actually an estimate of the standard deviation of the frequency distribution of the logarithmic distance graph). Any standard linear regression tool can calculate this standard error. In our building we found a good correlation between the RSQ and the standard error, resulting in two additional good anchors in the center of our building. With +/- 2 times the standard error on the logarithmic distance we can construct 95%

confidence intervals on the distance between the sender and the receiver.

A final step is the construction of minimum, average and maximum circles based on the previous steps. Starting from points lying on the regression line, the minimum and maximum circles form a ring, with the exact distance in the (logarithmic) average. If a single node is exactly on the regression line, keeping the averages, but reducing the spacing between all minimum and maximum circles results in the exact position. Unfortunately in real-life there will be no single node exactly on the regression line. Having a negative regression slope, a measured RSSI that is too high (too much constructive multipath fading) will result in a circle that is too small and a measured RSSI that is too small (too much destructive multipath fading or too much attenuation from the walls) will have too large circles. As long as the rings contain the exact distance, the error on the position will be acceptable. Our 5% outliers can still cause enormous problems demanding an additional step before the reduction of the thickness of the rings.

There are two kind of outliers. The first category comes from RSSI reports that are too low. These are also encountered in other localization protocols. There the problems are solved using a maximum likelihood algorithm in combination with a min-max criterion [2]. Sending power is reduced and a maximum distance for that power level is set. Some authors try to compensate the minimum RSSI by selecting the top maximum RSSI reports. We think this will not work in our heavily multipath faded indoor environment because this will lead to the second category of outliers: the bad anchors with too much constructive multipath fading, resulting in too small minimum and maximum circles. The presence of both kind of outliers results in the reduction of the ring thickness process failing to converge.

III. Future work

A very first step will eliminate the outliers of the first category, described in the previous section using the maximum likelihood algorithm and larger circles than the building. A too large maximum circle is not the main problem, but this circle will also be accompanied with a minimum circle that is too large, overlapping a maximum circle of another anchor.

Outliers of the second category will also be detected using overlapping minimum circles of neighboring anchors.

IV. CONCLUSIONS

In this paper we presented a new approach for localization based on standard linear regression tools. Up to now the selection of good anchor nodes based on a high RSQ and a low standard error was not encountered. Furthermore it is not a good idea to base localization protocols on selection of anchors reporting maximum RSSI readings, because these probably are heavily multipath faded nodes.

REFERENCES

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