Research on cooperative localization algorithm for multi user

Jianqiang Wang and Peini Shang

College of Information Engineering, Yulin University, Yulin, Shanxi, China

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ABSTRACT

Considering the scenario that multiple users require localization services in the same area, this thesis proposes a centralized location algorithm based on the information exchange between users. Users measure the signal strength from base station and other users, and then send the measurement result to a localization server, the server estimates the distance between users based on these measurements, and use MDS algorithm to calculate the relative position between users, the fingerprint localization result can be revised by this relative position information iteratively. With the distance estimation between users, the algorithm can combat the influence on wireless signal strength measurements introduced by a plurality of users, the localization precision can be effectively improved.

Key words: Indoor localization, wireless fingerprint localization, MDS, data fusion
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INTRODUCTION

In the densely populated area, often there are multiple user location service. On the one hand, because of human disturbance, the indoor multipath environment constantly changes, will cause the positioning accuracy decline; on the other hand, if the location service provided separately to each user, can achieve the positioning purposes, but there is no effective use of measurement results for multiple users, is a waste of resources. Considering such application scenarios, this chapter proposes a Co located multi-user algorithm, comprehensive utilization of multiple users to the base station signal measurement results of RSSI(Received Signal Strength Indication), the user's location to calculate, to achieve the objective of improving the positioning accuracy.

In the shopping center, exhibition hall and other personnel intensive place, users often have a greater demand for services based on the position of the guide, introduction. In such applications, due to the randomness of personnel movement, resulting in the wireless environment changes greatly, the variance of the RSSI value at the same point increases, the positioning accuracy and steep decline. So we need a new location algorithm is proposed to meet the complex application scenarios such demand.

In the distributed location fingerprint of traditional, each user in advance the fingerprint map location area, measuring signal from each base station in the positioning of the RSSI, inside the receiver to complete the calculation of the position. Positioning such to have the independence, the advantage of real-time, measurement to complete fingerprint can immediately calculate the location of the user, in addition, because it does not need the information sent to the outside, but also can greatly reduce energy consumption, radio signals from the base stations exist only location system, therefore not due to the increase in the number of users caused by network congestion, network strong expansion. However, in the positioning method of this, users are relatively independent, not through the collaboration between users to deal with the environment, when the user more location within the region, users will spread to the wireless signal caused by occlusion, reflection, the positioning accuracy of each user sharply.

In the application of multiple user positioning, more suitable for the centralized positioning method. Each user can listen for other users to send the signal intensity of the fingerprint information to complete the information

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interaction and relative distance estimation, and the auxiliary information is sent to the location server. Using this method, the fingerprint data server not only can obtain the user, also can be the relative position between users is estimated. With this information, the server can correct the error location positioning on individual users, the number of users increases offset due to the performance degradation. Many users are put forward in this chapter cooperative localization algorithm is based on this idea, the user interaction between measured RSSI results to correct fingerprint orientation alone, to achieve the objective of improving the positioning accuracy.

1. COOPERATIVE LOCALIZATION ALGORITHM FOR MULTI USER

MDS technology can achieve a series of node mapping in a multidimensional space to another in the multi-dimensional space, while maintaining the distance between the nodes of the same. MDS technology uses a dissimilarity matrix classical, namely matrix distance between nodes of a record in the multi-dimensional space, to calculate a multidimensional space (usually two-dimensional or three-dimensional coordinates of the nodes

The dissimilarity data in MDS algorithm is obtained by measurement, usually use the Euclidean distance to dissimilarity representation between nodes. The idea of this algorithm is the matrix transformation, re construct the topology of the network in a multidimensional space in the new. In new network topology construction, mutual distance between nodes in the network topology and the corresponding node before the dissimilarity between information.

In the multi user cooperative localization, the user through measuring RSSI information to estimate the relative distance between users, the location server can be corrected by the result of fingerprint orientation relative distance between users. Because each user can obtain between user and near distance information, the server can use MDS (Multi-Dimensional Scaling, multidimensional scaling) method to the relative distance information into the relative position information of user on a two-dimensional plane. Using this relative position information, combined with the fingerprint orientation for each user individually results, will be able to revise the results obtained positioning, positioning more accurate results.

MDS algorithm on RSSI measurement between the user value to use, estimate the relative position between the various users; on the other hand, the server using fingerprint localization algorithm to locate for each user, estimates can be obtained for each user location value. The use of these two kinds of location information, location precision of each user can use iterative method to improve the.

Combined the fingerprint localization algorithm for single user, can put forward cooperative localization algorithm is as follows:
● Users measure each base station signal RSSI values.
● User measurements from other user signal RSSI values, calculate the path loss transmit power based on the packet data.
● The path loss signal users will be measured fingerprint information and other users to the location server.
● The location server according to the rough location of P base station fingerprint user measured to estimate user.
● The location server using the path loss between the MDS algorithm and the user, calculating the relative position relationship between users.
● Select the K user as the anchor node localization algorithm, using WKNN results of their position relative to other users, will be converted to absolute position.
● For all A combinations, repeat the previous step of calculation.
● The A MDS location algorithm and WKNN algorithm results averaging the results, get the final positioning result.

RESULTS AND DISCUSSION

In order to cooperative localization algorithm for multi user authentication is proposed, combined with the distribution by measuring the collection to RSSI, the multi user scenarios for cooperative localization algorithm simulation.

3.1 Performance comparison of cooperative localization algorithm and WKNN algorithm for multi user
We first in the different user number case, comparing properties of the multi user cooperative location algorithm and WKNN algorithm. The simulation area is 20m * 20m region, the stochastic distribution of each user, select the number of cooperative users value of K is 4, based on the above two kinds of fusion method under different simulation on the number of users, as shown in Figure 1 results:
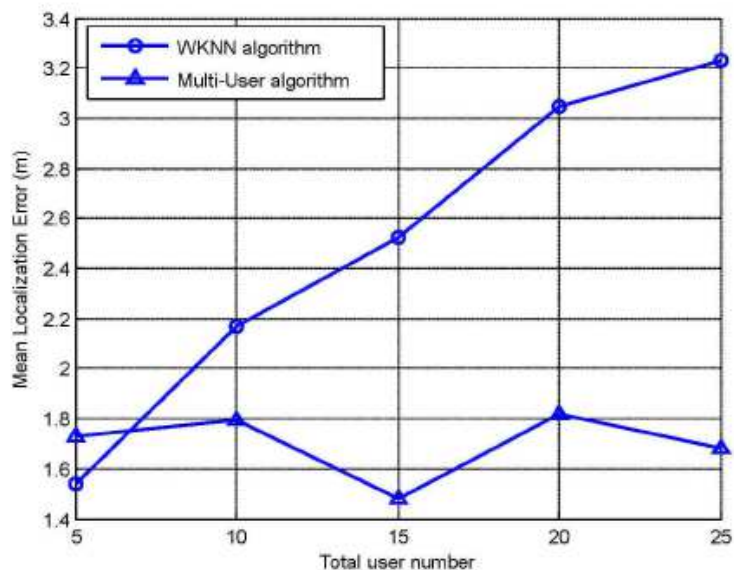
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Fig.1 Mean localization error comparison between multi-user cooperative algorithm and WKNN

As can be seen from the graph, multi user cooperative localization algorithm in the number of users is large, the positioning accuracy compared with the WKNN algorithm improved algorithm, positioning accuracy and relatively stable. This shows that the multi user cooperative localization algorithm can make full use of location information between users, by positioning the information on the WKNN algorithm results of correction, finally get the results more accurate positioning. And in the number of users, although the increase of interference users themselves, but also more accurate location information, so as to maintain the stability of the positioning accuracy.

3.2Effect of the reference point density

In the cooperative localization algorithm for multi user, the user can use the mutual location information, so the results of fingerprint positioning accuracy requirements can be reduced. Considering the fingerprint reference point location algorithm in this parameter range, if the reduced reference point number, increase the reference point of the distance, fingerprint orientation error will increase, but the error correction can be the result of MDS positioning. In order to investigate the impact of performance of cooperative localization algorithm reference point density for multiple users, we conducted simulations on different density reference point, the results as shown in figure 2:
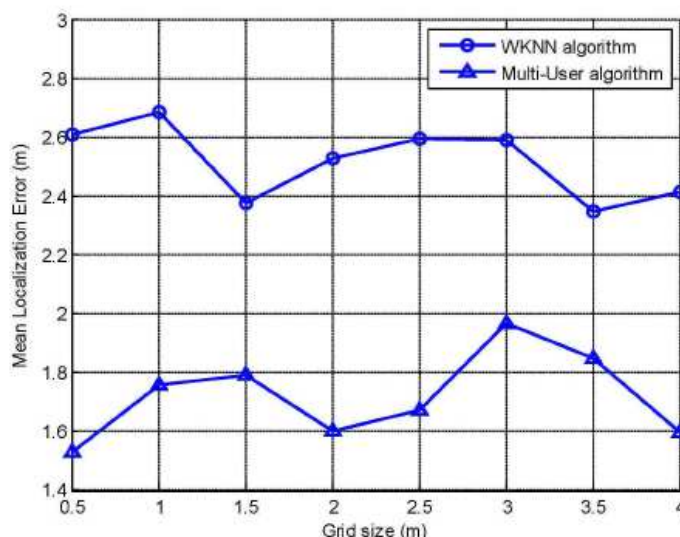

Fig.2Mean localization error of multi-user cooperative algorithm with different grid size

As can be seen from the graph, with the increase of reference point spacing, positioning error WKNN algorithm increases, and the positioning error of multi user cooperative localization algorithm for smaller increases. This is due to the multi user cooperative localization algorithm using the distance information between users is used to correct the positioning results, but such a correction in the case of sparse reference point effect more obvious, so, in the

application scenario more number of users, can increase the distance between reference points, so, the positioning accuracy will not have too much damage, but the system construction and maintenance workload can be greatly reduced. It is also one of the multi user cooperative localization algorithms in the application of the greater advantage.

3.3Multiple user random distribution
Next consider the more close to the practical application scenarios, namely the distribution of users in locating randomly within a region, which is consistent with the user to walk around to the actual situations. In Figure 1 can be seen, in the user the random distribution, positioning accuracy of cooperative localization algorithm for multiple users affected by the number of users. Through the analysis of a certain location results, the actual results to observe multi user cooperative localization algorithm in random distribution of user location. Figure 3 shows a typical localization results of 25 distribution of users in localization random graph, the simulation contains multiple users gather together and a single user alone, can position error analysis under different conditions in.
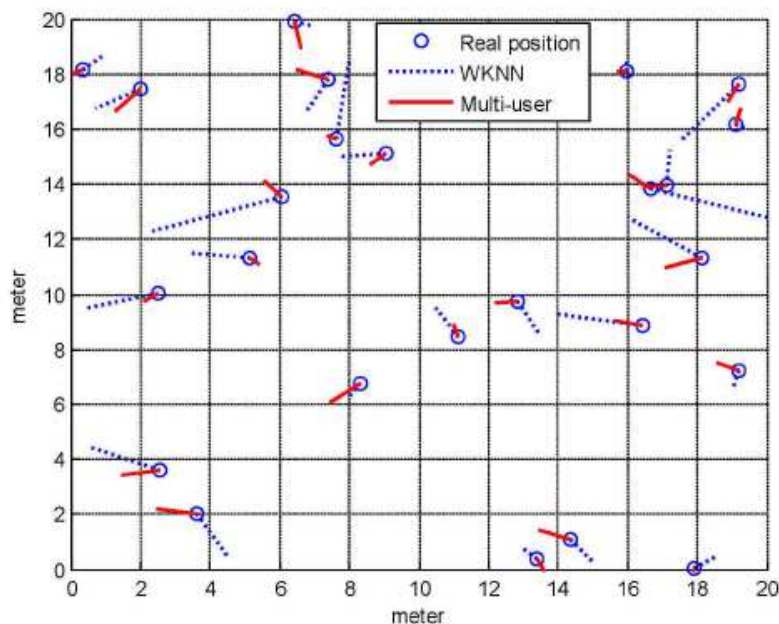

Fig.3 Localization result of randomly distributed users

In Figure 3 can be seen in the location of the user, the random distribution of location error, cooperative localization algorithm for multi user can still obtain smaller WKNN algorithm. In the simulation region below and to the right and lower left, the distance between the user far, though it has little effect on the measurement of RSSI user base station signal by other users, but the multi user cooperative error location information location algorithm can obtain the user between the large, so the location results of modified limited, the improvement of the positioning accuracy is not obvious. In the top right of the user area, close, although RSSI measuring user interference by users, but users can obtain more accurate distance meter position error, although individual users directly use the fingerprint localization algorithm to calculate the larger, but through the use of the adjacent users more accurate location information, relative to the WKNN algorithm, positioning accuracy of cooperative localization algorithm for multiple users get bigger promotion.

CONCLUSION

Aiming at the application scene in the location of the user more, this paper proposes a Co located multi-user algorithm, through the use of interactive information between users is extracted, the distance between the user information, carried out iteratively by location and single user results, achieve the objective of improving the positioning accuracy. Finally, the chapter on the cooperative localization systems is simulated and analyzed, the simulation results show that with the distance estimation between users, the algorithm can combat the influence on wireless signal strength measurements introduced by a plurality of users, the localization precision can be effectively improved.

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