Localization strategies in ultra-dense networks

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***Abstract*—WRITE THIS LAST!**

I. Introduction

The demand for high performance wireless communication has increased during the past decades all over the world. The connectivity in the world is continually increasing and it is going toward connectivity in cars and other appliances and is called the Internet of Things(IoT). Simultaneously there is an increase of communication between Device to Device (D2D). As more and more devices are connected these devices results in denser networks with more connections within a smaller area and especially in areas with higher population. This development of connectivity can increase the possibilities of data information from different devices with their positioning. The problem however is that all devices are not equipped with GPS sensors since it is both a cost in hardware and power consumption, which increases the desire for other localisation strategies. If more devices is becoming connected the information of these devices can also serve basically as sensors and creates a large Wireless Sensor Network(WSN).

II. Background

Depending on the situation different types of localization strategies are needed and in this section concepts of localization strategies are presented along with some concepts to explain the need of these strategies.

A. Wireless Sensor Network

A Wireless Sensor Network (WSN) is a network of sensor nodes used to monitor a certain object or factor. It could be everything from the weather and environment, military surveillance or in medical use [1], [2]. In WSN the information is useless unless the location of the sensor is known [3]. Since there often is a large number of nodes in the network there is a cost, both from financial aspects and energy consumption, to equip each node with a GPS-tracker, [4]. Techniques for localization often involve nodes to relate the position to the other nodes and as a combination the position is derived. To optimize this is to have as a reliable localization as possible, [4]. Improvement in localization strategy will yield not only more reliable information but a increase in capacity of the network.

B. Cooperative Localisation

As more complex networks are being used, such as the expansion of IoT and WSN, the need for a efficient localization strategy is growing. With Cooperative Localization the complexity of the localization is reduced. This is a way of determine the position of a node relative to the neighbour or a anchor node with a known position, [1]. In this manner there is no need to equip each node with a GPS tracker.

C. Ultra-Dense Network

Ultra-Dense Network (UDN) is a new technology in 5G communication. In UDNs, access entities are densely distributed in the coverage areas of base stations. The density of the access entities may exceed the density of users, [5], in which case lead to high data rate transmission in the networks. On the other hand, the UDNs may also introduce issues which are different from previous wireless networks in several aspects, including interference, mobility and resource management, etc, [6]. In this case the localization approaches and methods introduced in UDNs should consider the difference in order to adapt the new communication environment and enjoy the advantage introduced by UDNs.

D. Automotive V2V

One aspect that is important with the current development of 5G is the ability of having a less time consuming and more reliable communication with a larger number of nodes. When the location is known this information could be used to improve the performance of the communication. This information can be used for example to improve the estimation of the wireless channel and decrease the time when communicating which leads to a larger data rate, [7] [8]. This could be applicable in for example communication in vehicles where a fast and reliable localization and communication is crucial, [8]. Another application is to use the location information to improve the routing in a cluster of nodes to save time and to reduce the complexity, [9], [10].

E. Guidance

III. Analysis of Localization methods in Ultra-Dense Networks

Have not included references in this section

This section will analyse how localisation is performed between users and access points. The basic concept builds on the cooperative localization technique presented in section

II-B and this section will go more in depth to how it is implemented.

A. Distance measurements

This section describes the most common methods of estimating distance between users and access points. The methods presented below is all used depending on the specific implementation.

The estimation of users location can be obtained in different ways. Some approaches is more about approximation of the distance between the user and the antenna or the access point. Here for example there is the Received Signal Strength (RSS) that determine the distance between the user and the access point by sending a pilot with a known power and then calculate the distance through the path loss. Another way is to calculate the Time of Arrival (ToA) which is a method that calculate the distance by using the propagation time of the transmission. This however is a sensitive method due to the synchronization between clocks and is therefore hard to implement and not viable enough. Although, there are similar methods called Round trip Time of Arrival (RToA) and Time Difference of Arrival (TDoA) where the synchronization is not as vital. The RToA is performed by sending the pilot both up-link and down-link and this makes it more robust against synchronization errors. The TDoA is executed by calculating the time difference between access point when a up-link pilot is sent and that way locate the user. Another approach is to use the direction information is sent and is called Direction of Arrival (DoA). This requires that the user has some kind of smart antennas which is increased hardware cost.

B. Location tracking and prediction

(This section will be more in depth in the final report and include references.) The localisation methods in previous section creates a estimation of the users position by using different access points or one access point and using different methods. In order to be more efficient and not having to redo the localizing at each time instance the method of tracking is implemented. It is done by using a Extended Kalman filter (EKF) to predict the trajectory. By not doing the update step in the EKF but only the prediction step a trajectory is predicted for several time instances ahead. This step is not based on new measurements but information received for previous time instances.

C. Contrast with provious strategies before UDNs

D. Potential improvement for future localization strategies in ultra-dense networks

(This part will include more technical details in the final report.)
The potential research on localization strategies in UDNs is to achieve best positioning accuracy. ToA-based methods started with time of arrival for localization. Several relative methods are derived such as RToA, TDoA mentioned below. ToA-based methods still have potential in the future for improve the positioning accuracy. Another aspect is Connectivity-Based localization, one of the examples is Cramer-Rao lower bound (CRLB), which provides a benchmark to evaluate the performance of any unbiased range-free localization algorithms.

E. V2V localization

IV. Location aided communication

(Add more sources and more specific examples, and more detail.) Knowing the location of the users in the network has a lot of potential to improve performance on the communication. This section will discuss e few potential advantages an implementation of location aided communication.

A. Channel estimation

A possible way to improve the wireless communication is to utilize the location data sent in order to get an estimate of the channel. This is a time saving method that minimizes the number of transmissions while still getting an accurate estimation. Since the wireless communication is greatly affected and dependent on the environment it is vital to get an accurate estimation of the channel properties in order to guarantee a reliable communication. This method is highly useful in for autonomous systems that requires real time awareness such as self driving. In this systems speed, accuracy and robustness of the communication is in focus and these aspects could be improved by location aided communication.

B. Predicting demand

By using the location of the users and the possibility of predicting the movement some advantages can be gained and result in a more adaptive and dynamic network. The demand can be anticipated by knowing the location, prediction and demand of each user. The entrance of a user with a larger demand in a cell would normally result in a poor quality of service to the current users but by predicting this event the network could adapt before and reduce the affect of the new user.

V. Conclusion

The conclusion has not been completed since we haven't finish all of the works. The increasing of communication between devices results in denser networks. In 5G communication, the networks will be denser and denser. Under this circumstance, ultra dense network appear with more and more connections within a small area with high population. This article proposes different localization strategies specifically in ultra-dense network. Start with current localization strategies, some example methods are illustrated separately for solving specific problem, including distance measurements and location tracking and prediction. In order to answer the question that how localization strategies improved in ultra-dense networks, contrast of between previous and current strategies is addressed. The analysis of potential improvement for future localization strategies in UDNs proposes the prediction of the further development. Finally, some specific application are explained for further understanding.

VI. Discussion

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