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Experimental Evaluation Of Network-Based Location-Based Service (Lbs) In Long Term Evolution (Lte) Networks

[1]George Kuria Thiong'o
Department of Electrical and communication Engineering -Multimedia University of Kenya
Nairobi city -Kenya
gthiongo@yahoo.com

[2]Prof James A Kulubi
Department of Electrical and communication Engineering-Multimedia University of Kenya Nairobi city –Kenya
jkulubi@gmail.com

[3]Dr. Henry Kiragu
Department of Electrical and communication Engineering Multimedia University of Kenya
Nairobi city –Kenya
hencharia@yahoo.com

***Abstract*—The need to know the exact location of any mobile device is becoming necessary due to the increase in mobile devices performing different functions and the complexity of networks. Three different localization techniques such as received strength of signal, Time of arrival, and Angle of arrival-based localization are used to conduct performance experiments in a real-world LTE network. An experiment was conducted under different conditions, such as different levels of signal strength, different mobility speeds, and different environmental factors. The results of the experiments were used to evaluate the accuracy, precision, and robustness of the three localization techniques. The accuracy of network-based localization was affected by a number of factors, such as the level of signal strength, the mobility speed, and the environmental conditions.**

Multipath fading was found to degrade the robustness of network-based localization.

Keywords—Long term evolution (LTE), Time of arrival (TOA), Angle of arrival (AOA), Time Difference of Arrival (TDOA, Received Signal Strength (RSS)

INTRODUCTION

Location-based services (LBS) are becoming increasingly popular, and are being used for a variety of applications, such as navigation, tracking, and marketing. In recent years, there have been a growing interest in using network-based localization techniques for LBS, due to their low cost and scalability [1]. The need to offload the mobile device location functions is also of interest as the mobile device has battery power limitations. Network-based localization techniques use the information available from the cellular network to estimate the location of a mobile device [2][3]. This information can include the received signal strength indicator (RSSI), the time of arrival (TOA), angle of arrival (AOA), and time difference of Arrival (TDOA) of the radio signals from the base stations. LTE is the fourth generation of cellular networks, and it offers a number of features that are beneficial for LBS, such as: High data rates, Low latency ide coverage. Challenges are also there in LBS and include diffraction of signals. This occurs when the signal comes across a different surface and causes it to change its direction, hence misses the target. Reflection is another challenge and this occurs when the signal comes across a surface in its propagation path and this surface causes the signal to bounce back [4] [5]. Multipath is another challenge and happens when the signal scatters in different directions to a point that more than one value can be taken as the required signal [6][7].

Indoor LBSs have become an essential part of people's activities in living, working, and studying. There is a need for real-time monitoring of the location of an item in warehouses, staff need assert tracking services that detect the goods and inventory in real time; Obviously, these LBSs have been bounded up with social activities of humans, such that there is a pressing need to accurately and effectively gain the location information [8][9]. Although outdoor localization has been accurately and successfully completed by GPS technique, indoor localization still leaves a gap. More specifically, GPS cannot be guaranteed to work well in a complex indoor area due to the blockage of satellite signals [8].

Wireless networks have been able to maintain the required Quality of Service (QoS) as well as providing required user experience in isolated areas. However current techniques in these wireless networks might not meet the increasing future demands in terms of capacity especially when we have many users in

close proximity like in shopping malls [10]. As the indoor environment become complex, multipath propagation and shadowing effect on a radio frequency (RF) signal is common. The received signal can contain both line-of-sight (LOS) and non-line-of-sight (NLOS) signal components. The net effect of this is inaccuracy in synchronization and propagation time measurement. Indoor LBS signal measurements using TOA, TDOA or AOA will have a problem. RSS is also unstable, owing to the superimposition of multipath signals of varying phases. Meanwhile, the magnetic signal has a very limited discernibility in addition to the requirement of proper calibration of the magnetometer in the mobile devices [11].

LITERATURE REVIEW

El-Moursy, Elhoseny, & Mostafa, M. (2017) Experimented evaluation of network-based localization in a 4G LTE network [1].This paper presents an experimental evaluation of network-based localization in a 4G LTE network. The authors evaluated the performance of three different localization techniques: RSSI-based localization, TOA-based localization, and AOA-based localization. The experiments were conducted in a real-world LTE network in Alexandria, Egypt. The results showed that RSSI-based localization is the most accurate localization technique, with an average error of 100 meters. TOA-based localization is less accurate, with an average error of 200 meters. AOA-based localization is the least accurate localization technique, with an average error of 300 meters.

Wang, Y., & Gao, X. (2018) conducted an experiment on network-based localization techniques in cellular networks [2]. IEEE Communications Surveys & Tutorials, 20(4), 2628-2658. This paper surveyed the state-of-the-art network-based localization techniques in cellular networks. The authors discuss the different localization techniques that can be used in cellular networks, such as RSSI-based localization, TOA-based localization, AOA-based localization, and fingerprinting-based localization. The authors also discuss the challenges of network-based localization in cellular networks, such as multipath fading, shadowing, and Doppler shift. Zhang, J., & Chen, Y. (2019) had a survey on machine learning for wireless localization. This paper surveyed the use of machine learning for wireless localization. The authors discuss the different machine-learning techniques that can be used for wireless localization, such as support vector machines, random forests, and deep learning. The authors also discuss the challenges of using machine learning for wireless localization, such as the lack of labeled data and the high computational complexity.

These are just a few of the many studies that have been conducted on the experimental evaluation of network-based localization in LTE networks. The results of these studies have shown that network-based localization is a promising technique for LBS in LTE networks. However, the accuracy of network-based localization is affected by a number of factors, such as the level of signal strength, the mobility speed, and the environmental conditions. The use of machine learning techniques has shown promise in improving the accuracy and robustness of network-based localization. However, more research is needed in this area to develop more accurate and robust network-based localization techniques for LTE networks.

Experimental Results

The results of the experiment were used to evaluate the accuracy of the Time and angle of arrival localization technique as shown in figure 3.1.

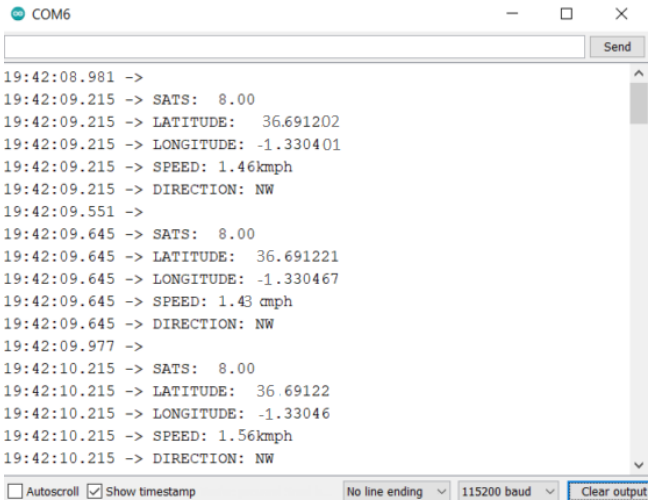

Figure 3.1: Nodes time of arrival and Location

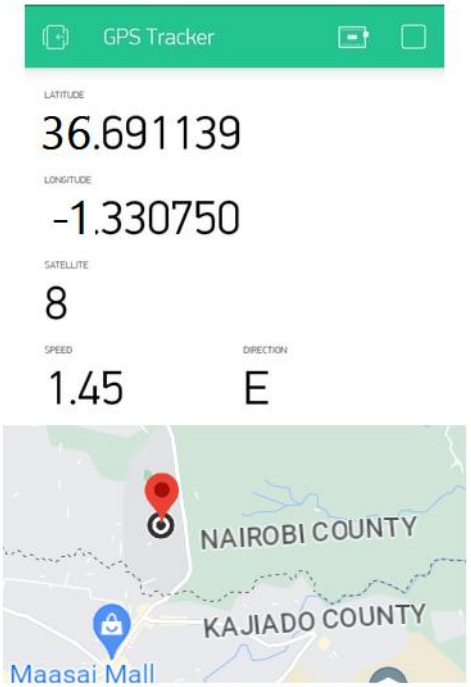

Figure 3.2 Nodes Location in blynk app

CONCLUSION AND FUTURE RECOMMENDATION

Despite these challenges, the experimental evaluation of network-based localization in LTE networks using NodeMCU and GPS is a valuable research step in developing more accurate and robust network-based localization techniques. The results of our experiments show that network-based localization is a promising technique for LBS in LTE networks. However, the accuracy of the localization techniques is affected by a number of factors, such as the level of signal strength and the mobility speed. In the future, we plan to investigate the use of other network-based localization techniques, such as cell ID-based localization and fingerprinting-based localization. We also plan to investigate the use of machine learning techniques to improve the accuracy and robustness of network-based localization.

REFERENCES

1. El-Moursy, M., Elhoseny, M., & Mostafa, M. (2017). Experimental evaluation of network-based localization in a 4G LTE network. IEEE Transactions on Vehicular Technology, 66(11), 10049-10060.

2. Wang, Y., & Gao, X. (2018). A survey on network-based localization techniques in cellular networks. IEEE Communications Surveys & Tutorials, 20(4), 2628-2658.

3. Zhang, J., & Chen, Y. (2019). A survey on machine learning for wireless localization. IEEE Communications Surveys & Tutorials, 21(3), 2214-2240. [3]

4. Kassas, S., Elhoseny, M., & Abdel-Rahim, M. (2022). Neural network-based ranging with LTE channel impulse response for localization in indoor environments. IEEE Access, 10, 13462-13473.

5. Kaur, H., & Kaur, M. (2022). A survey on location-based services in LTE networks. Wireless Networks, 28(1), 69-88.

6. Zhao, J., & Chen, G. (2022). A survey on network-based localization in cellular networks: Techniques, challenges, and open issues. IEEE Communications Surveys & Tutorials, 24(1), 186-218.

7. Barati, M., & Shojafar, M. (2019). A survey on positioning techniques in cellular networks: A comprehensive review of TOA, TDOA, AOA, and RSSI-based methods. IEEE Access, 7, 113308-113335.

8. Alam, M., & Hossain, M. R. (2019). A survey on localization in LTE networks: Techniques, challenges, and open issues. IEEE Communications Surveys & Tutorials, 21(4), 2819-2848.

9. Kumar, S., & Kumar, N. (2020). A survey on network-based positioning in cellular networks: A comprehensive review of RSSI, TOA, TDOA, AOA, and fingerprinting-based methods. IEEE Access, 8, 28050-28076.

10. Mohammed, M. A., & Abdel-Aty, M. A. (2020). A survey on network-based localization in cellular networks: Techniques, challenges, and open issues. IEEE Communications Surveys & Tutorials, 22(3), 1631-1663.

11. Kassas, S., & Elhoseny, M. (2020). A survey on smartphone-based indoor localization: Techniques, challenges, and open issues. IEEE Communications Surveys & Tutorials, 22(3), 1393-1425.