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ENHANCING INDOOR POSITIONING ACCURACY: IMPACT OF MOBILE DEVICE SIGNAL STRENGTH INDICATION ON WLAN FINGERPRINTING FOR IMPROVED LOCALIZATION

Nicholaus Minga

Department of Information and Communication Technology, Mbeya University of Science and Technology, Mbeya, Tanzania

Abstract: Indoor positioning systems have gained significant attention due to their vital role in various applications such as navigation and location-based services. Wi-Fi fingerprinting is a prevalent technique for indoor localization, relying on signal strength measurements from mobile devices to create location fingerprints. This study explores the impact of mobile device signal strength indication on Wi-Fi fingerprinting accuracy for indoor positioning. By conducting a comprehensive analysis of signal strength variations and their effect on localization performance, we demonstrate how incorporating signal strength data enhances the accuracy of Wi-Fi fingerprinting-based localization. Through experimentation and comparison with traditional methods, we highlight the improvements achieved in terms of positioning accuracy and reliability. Our findings underscore the significance of signal strength indication in refining indoor positioning systems and provide valuable insights for future advancements in this domain.

Keywords: Indoor Positioning, Wi-Fi Fingerprinting, Mobile Device, Signal Strength Indication, Localization Accuracy, Location-Based Services.

INTRODUCTION

Indoor positioning systems have emerged as a crucial technology for a wide range of applications, including navigation, asset tracking, and location-based services. As GPS signals are often unreliable or unavailable indoors, alternative methods such as Wi-Fi fingerprinting have gained prominence. Wi-Fi fingerprinting leverages the unique signal strength patterns of wireless access points to determine the location of a mobile device within an indoor environment. However, the accuracy of Wi-Fi fingerprinting is influenced by various factors, including signal strength variations caused by obstructions, interference, and the dynamic nature of indoor environments.

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One critical aspect of Wi-Fi fingerprinting is the utilization of mobile device signal strength indication. Mobile devices continuously measure and report the signal strength of nearby access points. Incorporating this signal strength data into the positioning algorithm can potentially enhance the accuracy and reliability of indoor localization. This study aims to investigate the impact of mobile device signal strength indication on Wi-Fi fingerprinting-based indoor positioning accuracy. By systematically analyzing the relationship between signal strength variations and localization performance, we aim to provide insights into how signal strength data can be effectively utilized to improve indoor positioning systems.

METHOD

In this research, we conducted a series of experiments to assess the impact of mobile device signal strength indication on WLAN (Wireless Local Area Network) fingerprinting for indoor localization improvement. The methodology involved the following steps:

Data Collection: We collected extensive Wi-Fi signal strength measurements using mobile devices within a controlled indoor environment. These measurements were taken at various locations, capturing the diversity of signal strength patterns caused by different obstacles and interference sources.

Fingerprint Creation: Based on the collected signal strength measurements, we created Wi-Fi fingerprints for each location. A fingerprint consists of signal strength values from multiple access points, forming a unique identifier for that location.

Signal Strength Analysis: We analyzed the signal strength variations observed across different locations. This analysis included identifying common patterns, understanding the impact of obstructions on signal propagation, and quantifying the variability of signal strength measurements.

Localization Algorithm: We developed and implemented a localization algorithm that utilizes both signal strength indications and traditional fingerprint matching techniques. The algorithm was designed to integrate the dynamic nature of signal strength data and adapt to real-time changes in the environment.

Experimental Evaluation: We conducted extensive experiments to evaluate the performance of our localization algorithm compared to traditional Wi-Fi fingerprinting methods that do not consider signal strength data. We measured accuracy, precision, and robustness under various scenarios, including different levels of signal interference and dynamic movement of mobile devices.

Results and Analysis: The results were analyzed to assess the impact of incorporating signal strength indication on indoor positioning accuracy. We compared the performance metrics obtained from our algorithm with those from the traditional methods, highlighting the improvements achieved through signal strength integration.

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By combining comprehensive signal strength analysis with advanced localization algorithms, our study aimed to provide practical insights into enhancing indoor positioning accuracy through the effective utilization of mobile device signal strength indication in Wi-Fi fingerprinting-based systems.

RESULTS

The experimental results demonstrated the significant impact of incorporating mobile device signal strength indication on enhancing indoor positioning accuracy through WLAN fingerprinting. The localization algorithm that integrated signal strength data consistently outperformed traditional methods that relied solely on fingerprint matching without considering signal strength variations.

In scenarios with varying signal strengths caused by obstructions and interference, the signal strength-enhanced algorithm exhibited higher accuracy and precision. The localization errors were reduced, and the algorithm showcased improved robustness in dynamic environments where signal strengths fluctuated due to movement and changes in the environment.

DISCUSSION

The observed improvements in indoor positioning accuracy can be attributed to the valuable information provided by mobile device signal strength indication. By leveraging signal strength data, the algorithm could better adapt to the dynamic nature of indoor environments. It effectively compensated for fluctuations in signal strength caused by obstacles and interference, resulting in more reliable and accurate location estimates.

Furthermore, the signal strength analysis revealed insights into the behavior of Wi-Fi signals in indoor spaces. The impact of signal strength variations caused by walls, furniture, and other obstructions was quantified, shedding light on the complex propagation patterns within indoor environments. This understanding was crucial in designing an algorithm that harnessed signal strength information effectively.

CONCLUSION

In conclusion, this study highlights the substantial improvement in indoor positioning accuracy achieved by integrating mobile device signal strength indication into WLAN fingerprinting-based localization systems. The combination of signal strength data and traditional fingerprinting techniques offers a robust solution for accurate indoor positioning, addressing the limitations of conventional methods that solely rely on fingerprint matching.

The findings of this research underscore the importance of considering signal strength variations in indoor positioning algorithms. The utilization of signal strength information enhances the adaptability and reliability of the system, making it suitable for a wide range of applications, including navigation, location-based services, and asset tracking within indoor environments.

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Future work could explore advanced machine learning techniques to further optimize the utilization of signal strength data. Additionally, the integration of other sensor inputs, such as inertial sensors or Bluetooth beacons, could potentially lead to even more accurate and robust indoor positioning solutions. Overall, this study contributes to the ongoing development of indoor positioning technologies, bringing us closer to achieving seamless and accurate location awareness in indoor spaces.

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