Mobile Indoor Positioning Using Wi-fi Localization and Image Processing

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Abstract. At present, there has been an increased interest in indoor positioning systems that propelled researchers to come up with various solutions. A number of these research either use Wi-fi Localization or image processing; each having problems with either accuracy or speed. In this paper, we propose a framework which will use both Wi-fi Localization and image processing to address this problem. The framework used Wi-fi Localization to calculate the estimated position of the user then refine the accuracy through image processing. The designed framework was able to surpass the performance of Wi-fi Localization algorithms in accuracy, and image processing in speed. Different techniques were also applied that improved accuracy and made the system calculate for the location faster.

Keywords: Wi-fi Localization, Image Processing, SIFT Algorithm.

1 Introduction

Numerous mobile applications currently make use of positioning technologies such as Global Positioning System (GPS) in determining the position of the user. These positioning technologies are fairly reliable in an outdoor setting, but are unreliable in an indoor setting due to physical obstructions. GPS, for instance, cannot provide a reliable position indoors because it requires direct line of sight from satellites. There are other approaches that can be used to address this such as Wi-fi Localization and image processing. Although Wi-fi Localization can be more accurate in indoor positioning than GPS, it still provides a large margin of error and are not accurate enough. Inside a building, a few meters of discrepancy may already point to a different room. Image processing can find an image from the database that will match the image captured by the user. This may work well but it requires high computing power and a large storage space, and speed will be compromised. Thus, the researchers proposed the use of both Wi-fi Localization and image processing. The two technologies when combined is intended to address the problems and limitations of each approach.

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2 Review of Related Literature

2.1 Wi-fi Localization

Wi-fi Trilateration. Spherical Trilateration makes use of at least three routers to calculate the location of the user. It needs the position of the routers and distances between the device and the routers. The distance would be used to generate a circle around each router, and the estimated position of the user will be where the circles intersect [1]. Another kind of Trilateration is the Gauss-Newton spherical Trilateration. Based on the same constraints as spherical Trilateration, the only difference is that it uses a random initial position to calculate the final position. It then increases the value of the initial position until it becomes acceptable to the system. These two Trilateration techniques still have a large distance error. The former has a mean error of 9.7 meters and a maximum error of 23.48 meters while the latter has a mean error of 6.26 meters and a maximum error of 22.13 meters [5].

Wi-fi Fingerprinting. Another method to solve these problems is by using Fingerprinting. The Fingerprinting method has two phases: an online phase, and an offline phase. The signal strength of the various access points are collected at various reference points and stored in a database for the first phase. These signal information includes the interference and multipath patterns of the Wi-fi signal which will help in identifying two spatially close points. In the next phase, the signals obtained from the location of the user will be compared and matched with the training data in the database. A location estimation algorithm will be used to find the best match, such as the k-Nearest Neighbour algorithm. The position of the best match will be the estimated location of the user [6].

2.2 Gyroscope

A gyroscope is a device used to calculate the orientation of a device. The type used in mobile phones is the mechanical gyroscope or Micro-electromechanical (MEMS) gyroscope, which was created with the goal of creating smaller and more sensitive devices. The operating principle used in this gyroscope is that a vibrating object tends to continue vibrating in the same plane as its support rotates. Today, the MEMS gyroscope is found in electronic devices in various devices [8]. By calculating the change in angle of the carrying device to a fixed reference point, the yaw, pitch, and roll of the phone can be determined. The data gathered from the gyroscope will be used to minimize the candidate images when searching the database [4].

2.3 Image Processing

Finding similarities in images involves 3 basic steps. The first step involves finding unique and robust points in an image. To be considered robust, they must be able to withstand different changes which may be in terms of 3D perspective,