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Localization and Surveillance under Wireless Sensor Network

In this thesis, our goal is to consider different issues in developing localization and surveillance for wireless sensor networks (WSNs) in common uses with the help of Wi-Fi technology. Localization is broadly used in WSNs to identify the current location of the wireless devices. A WSN consists of thousands of devices, and they are connected to each other wirelessly. The wireless connection reduces not only the cost of installation but also maintenance overhead. In wireless technology, Wi-Fi is popular due to its inherent features. Even in the currently appearing Internet of Things (IoT) technology, it is very much suitable. However, due to noise, shadowing, and fading effects on the signal in the environment, it is not easy to estimate the exact location of the wireless device in an environment, specifically in the indoor environment. In addition, the environmental effects repeatedly change from time to time. Therefore, the location of a wireless device using signal strength is important because the data rate and sensing capability entirely depend on it. In particular, manually finding the location of a device is very difficult in a dense network topology. The signal strength-based localization techniques make the process simple and economical. Therefore, researchers currently focus on the received signal strength indicator (RSSI)-based localization approach. To mitigate the influence of environmental effects in the RSSI technique, different methods have been proposed in the literature. However, the existing methods fail to achieve the desired level of performance in several environments. To overcome such drawbacks, this thesis has proposed some robust localization techniques using Wi-Fi signals under different environments. In different real applications, the messages may scatter due to various reasons, such as external noise, effects of electronic gadgets, signal blockage, etc. The position-based wireless communication using Wi-Fi is one of the most compelling and demanding techniques to address such issues. In position-based communication establishment between wireless devices, the knowledge of their positions is essential. Communication to the devices with their positions reduces various external effects in communicating signals, including scattering, which not only increases communication efficiency but also reduces processing overhead. By the RSSI-based tracking applications, the trajectory of a moving device can be easily identified. For the long ranges between these devices, the exchange of data may be significantly distracted. Therefore in WSN, a proper communication strategy needs to be developed to limit the scattering of messages. Typically, a common Wi-Fi router provides service through a one-hop network topology. When communication is required in a particular direction, the coverage increment of a single-hop connection increases power consumption. It restricts the applicability of single-hop networks. Developing a sensing-capable network to cover a large area, multi-hop communications can be used. It decreases power consumption.

This thesis first proposed some improved localization techniques to find sensor locations. Then, with these sensors, a multi-hop network is developed to deal with the surveillance system. This thesis also has provided efficient and robust tracking techniques in the same specific environments. In chapter 3, the distance between the rotating object and the wall is estimated with the help of at most two stations inside a room. In chapter 4, linear distances between the station and access point are estimated using the RSSI technique, where the different experimental environment is considered. In chapter 5, the RSSI-based smartphone localization system has been developed for indoor environments, where the smartphone location is determined by the distances of noisy environments. In chapter 6, the received signal strength (RSS)-based real-time on-road vehicle tracking infrastructure has been developed using the RSS from a vehicle to different base stations (BSs). In chapter 7, an surveillance system has been developed with the strongly connected multi-hop network, where the routers are sensing capable.

The proposed work can be used in various fields of applications like transportation, communication, positioning, etc. In the near future, IoT will become an essential part of our daily life. Such localization and surveillance can be an essential application of the IoT framework.

Our next goal is to develop human activity recognition system using the framework of localization and the path-following infrastructure for autonomous robots in warehouse scenarios.

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