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Technical Note

A Tool to Calculate the Level of Occupancy in Indoor and Outdoor Spaces Using BLE and Open Data to Be Published in Real-Time

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Abstract: The ability to know the precise level of occupancy in an indoor or outdoor space in real time could have multiple applications. It is a well-known problem for which a number of technologies have been proposed over time. The recent emergence of BLE beacon technology has provided a solution to the problem. This study presents a tool that uses beacons and user smartphones to determine the level of occupancy in indoor and outdoor spaces, providing real-time information that can be published as open data and subsequently used by other applications. The tool was tested in a university environment in real-life situations and has produced promising results in obtaining an occupancy count.

Keywords: beacon; BLE; level of occupancy; open data; smartphone; localization; occupancy detection

1. Introduction

The ability to know the precise level of occupancy of a section of a building in real time could have multiple applications, ranging from energy management within a building to emergency response plans. In the case of a university environment, it could be extremely useful to manage public spaces, such as classrooms, laboratories, library rooms or outdoor activities.

Indoor occupancy detection is a well-known problem that has been studied since the 1990s with the use of, for example, infrared sensors [1]. Since then, many other technologies have emerged, some of which have been applied to solve this very problem. Recent solutions have used RFID [2] or NFC [3] based technologies, although the most commonly used technology by far to solve this problem is WIFI [4,5]. RFID requires the installation of building antennas, as well as receiving devices, while NFC requires not only the placement of NFC labels throughout the building, but a high level of proximity to function properly, since it is a short range technology (<20 cm). The advantage of WIFI technology is that it does not require the addition of supplementary devices to the building, due to the current widespread use of this technology. The drawback, however, is a high level of energy consumption on the user's device, usually a mobile phone, which is continuously scanning the WIFI. Moreover, the signal strength of a wireless device may also change over time, or an indoor environment may change. Recent studies are focusing on improving location accuracy of Wi-Fi fingerprinting localization from different approaches, with self-calibration time-reversal (TR) [6], using probabilistic [7] or Extreme Learning Machine (ELM) [8]. All of these technologies have certain drawbacks that can be solved, as explained below, with Bluetooth Low Energy (BLE).

Since the emergence of the new Bluetooth 4.0 Low Energy (BLE) [9], new applications of this technology appeared. This technology presents numerous advantages compared to previously