第Ⅳ部門

Feasibility Study of Bluetooth and Wi-Fi Communication Systems in Post-Disaster Management

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1. Introduction

With the rapid spread of mobile devices such as smartphones and wearable technologies, the use of Radio Frequency (RF) communication has become pervasive. RF communication technologies do not necessarily require line-of-sight for their operations and has also been widely used for localization purposes. Consequently, for post-disaster management, they can be effectively used to localize valuable assets and individuals that are buried under debris and rubble [1)]. The German Federal Agency for Technical Relief (THW) in a survey revealed that about 80% of buried victims in a disaster carry their phones with them [1)]. This study aims to assess the feasibility of using RF localization systems, such as Bluetooth and Wi-Fi, for localization purposes for post-disaster management. In this regard, it aims to examine the communication stability and signal loss for Wi-Fi and Bluetooth (2400MHz), between two Android devices, while one of them is buried under ruins.

2. Review of related literature

By the appearance of various RF technologies such as Wi-Fi, Bluetooth, RFID and Ultra-Wideband, the Real-Time Location Systems (RTLS) and methodologies have improved significantly. Consequently, so far, several methods were proposed based on different measurement principles such as Time of Arrival (TOA), Angle of Arrival (AOA), and Received Signal Strength Index (RSSI). In order to apply any of the aforementioned methods for localization in the response and recovery phases of disaster management, it is necessary to know the signal strength which is transmitted from a device that is buried under debris. In this regard, many researchers have focused on GSM 700-2000 MHz [2)] and Ultra-Wideband radar systems [3)]. However, direct communication between smartphones in 2400 MHz was less noticed.

3. Methodology

In order to measure the Bluetooth and Wi-Fi signal strength and signal loss, as it is shown in Figure 1, a smartphone device (Huawei Honor 6 Plus) was placed in the center of a cube, which was made by construction cement bricks, and the signal strength was measured in different distances. The test was performed in a sunny weather situations in 10^{0}C and 43% humidity. First, bricks were arranged to cover a range of 20cm from each side of the smartphone, and then, a range of 50cm from each side. For both 20cm and 50cm, the Received Signal Strength (RSS) were measured from 0, 2, 5, 10, 15 and 20 meters horizontal distance from the edge of obstacle, and 1 meter height (Figure 1). The RSSs in Figures 2 and 3 are measured by the Nexus9 tablet in the dBm unit using two Android applications named “WiFi Analyzer” and “BluetoothAnalyzer” from Google Play Store.

4. Discussion and Conclusion

Figures 2 and 3 show the signal loss caused by the obstacles and distance. The maximum measured RSS in direct line-of-sight was -18dBm for Wi-Fi and -30dBm for Bluetooth signal, and behind the

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obstacles, the *signal loss* for both Wi-Fi and Bluetooth was almost same in 0m distance. The R^2 values in Figures 2 and 3 show that the effect of distance on the signal strength is similar for both Wi-Fi and Bluetooth. The RSS has significantly reduced by increasing the thickness of obstacle. For instance, in Figure 3 the Bluetooth signal is completely lost after more than 10m distance. However, the Wi-Fi signal was still reliable for the range of 20m. In a disaster case such as an earthquake, the big blocks, walls, concrete and metals might fall over an RF device. However, in this test, cement bricks as a usual construction material were used, which is different from real situation, for future work the aim is to simulate the real situations and materials. While the production and use of Smartphones and wearable devices are increasing significantly, this initial test can prove the feasibility of RF localization by means of Wi-Fi and Bluetooth communication systems and ubiquitous devices.

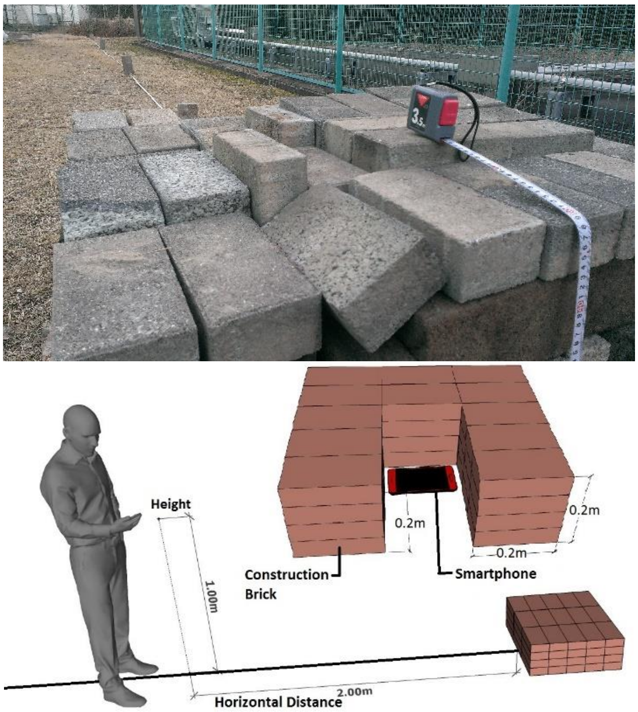

Figure 1. Smartphone surrounded by bricks and measurement situation

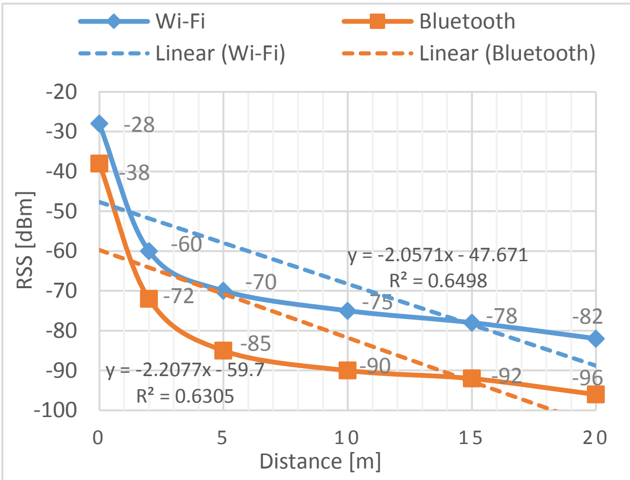

Figure 2. The measured RSS over 20cm of bricks

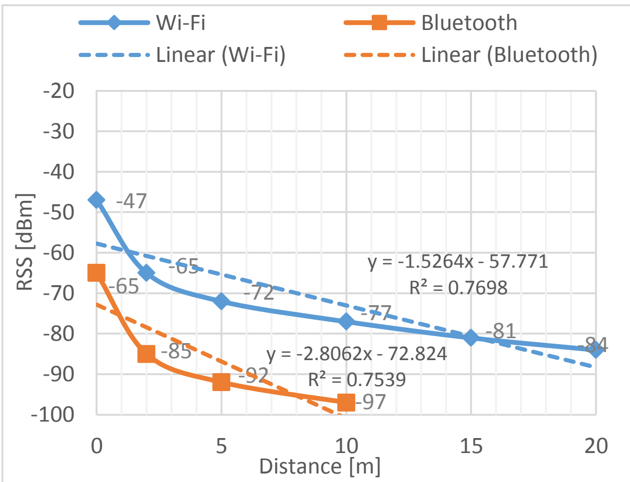

Figure 3. The measured RSS over 50cm of bricks

References

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