Enhanced Performance Using Selective Subcarrier in the Wi-Fi Backscatter

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Abstract. This paper proposes the signal detection scheme using selective subcarrier for enhanced communication coverage in the wireless fidelity (Wi-Fi) backscatter system. The conventional system uses every subcarrier for signal detection but the proposed system uses selective subcarriers of good channel condition in order to enhanced performance. Especially, when signal to noise ratio (SNR) is increased, the proposed scheme has efficient performance. From the simulation results, the proposed scheme has good bit error rate (BER) performance compared to the conventional scheme.

Keywords: subcarrier, Wi-Fi Backscatter system, Wi-Fi Reader, Wi-Fi Tag

1 Introduction

Recently, internet of things (IoT) sensor technique is expected to rapidly increase in the wireless communication system. Now, main system of IoT such as near field communication (NFC), Bluetooth and wireless fidelity (Wi-Fi) system do not support special sensors combination of tag and device to device communication (D2D) at the same time [1]. But, batteryless system such as Wi-Fi backscatter system can solve these problems. And Wi-Fi backscatter system is one of the schemes developing radio frequency identification (RFID) sensor networks because it can provide the connection of the internet of RFID devices by the ambient Wi-Fi signals [2][3].

When the technical problem is solved, Wi-Fi backscatter system uses existing communication infrastructure without extra reader and battery compared to the conventional system. And Wi-Fi backscatter system may overcome limitation of existing technology using smart tag is exploited. But the Wi-Fi backscatter system has the disadvantages of the limited communication distance and the low data rate by the limited. Thus, paper proposes the signal detection scheme using selective subcarrier of good channel condition for enhanced data rate and communication distance.

This paper is composed as follows. Section 2 shows the system model of the Wi-Fi backscatter system which harvests the energy from the Wi-Fi signals. Section 3 describes the conventional scheme and the proposed scheme of signal detection using selective subcarrier in the Wi-Fi backscatter system. Section 4 shows the enhanced performance of bit error rate (BER) and section 5 draws a conclusion.
2 Wi-Fi Backscatter System Model

The Wi-Fi backscatter system is composed of the three devices as Wi-Fi access point (AP), Wi-Fi Reader and Wi-Fi Tag. The Wi-Fi AP transmits the Wi-Fi packets to the Wi-Fi Reader and Wi-Fi Tag. The Wi-Fi Tag that is a radio frequency (RF) powered device harvests the energy using ambient RF signals.

The Wi-Fi backscatter communication is as follows, The Wi-Fi Reader transmits clear to send (CTS) to self for prevent transmission of other Wi-Fi devices. The Wi-Fi Reader sends preamble to Wi-Fi Tag in order to confirm the identification (ID). If Wi-Fi Tag ID and Wi-Fi Reader ID are same, Wi-Fi Tag transmits channel state information (CSI) or received signal strength indicator (RSSI) to Wi-Fi Reader. Then, the Wi-Fi Reader transmits the payload to Wi-Fi Tag by the presence or absence of the Wi-Fi packet. The Wi-Fi Tag can know the presence of the Wi-Fi packet as ‘1’ or the absence of the Wi-Fi packet as ‘0’. Then the Wi-Fi Tag reflects the received signals from the Wi-Fi Reader.

3 Proposed Scheme

This section explains the proposed scheme of signal detection using selective subcarrier in the Wi-Fi backscatter system. The Wi-Fi Reader must detect the signals
from Wi-Fi Tag. The Wi-Fi Reader uses average power of subcarrier of Wi-Fi packet in order to signal is detected. But, if channel condition is bad, power of subcarrier is attenuated. Thus, performance of received signals is poor because every subcarrier with the attenuated power is used.

The proposed scheme determines reference value of ‘1’ or ‘0’ using fixed preamble packet. Next, the presence of the Wi-Fi packet as ‘1’ of payload chooses subcarriers of good channel condition that passes reference value. The absence of the Wi-Fi packet as ‘0’ chooses subcarriers of good channel condition that not passes reference value. The fig. 2 shows detection scheme using selective subcarrier.

![Detection Scheme Using Selective Subcarrier](image)

**Fig. 2 detection scheme using selective subcarrier**

### 4 Simulation Results

**Table 1. Using parameters of proposed scheme**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet</td>
<td>IEEE 802.11n</td>
</tr>
<tr>
<td>The number of total packets</td>
<td>58</td>
</tr>
<tr>
<td>The number of total preamble</td>
<td>8</td>
</tr>
<tr>
<td>The fast Fourier transform</td>
<td>64</td>
</tr>
<tr>
<td>Bandwidth of channel</td>
<td>20MHz</td>
</tr>
<tr>
<td>Modulation scheme</td>
<td>QPSK</td>
</tr>
<tr>
<td>Channel model</td>
<td>UWB1m, 3m, 5m</td>
</tr>
</tbody>
</table>

The simulation results show the BER performance of the conventional scheme and the proposed scheme in the Wi-Fi backscatter system.
Fig. 3 BER performance of the conventional scheme and the proposed scheme using selective subcarrier

Table 1 describes the simulation parameters. The proposed scheme uses the 30 subcarriers of 64 subcarriers because the channel condition of 30 subcarriers is good. Figure 3 shows BER performance according to distance such as 1m, 3m and 5m. The conventional scheme has the better performance in the additional white Gaussian noise (AWGN) channel because the conventional scheme has a lot of samples of subcarriers. But the proposed scheme has the better performance in the ultra-wideband (UWB) channel. The proposed scheme may have BER performance of $10^{-2}$ in the 60dB. However, the conventional scheme has not good BER performance with high SNR gain.

5 Conclusion

This paper proposes the signal detection scheme of selective subcarrier. This scheme has advantage of BER performance compared to the conventional scheme using every subcarrier. Especially, when SNR is increased, the proposed scheme has efficient performance. The Wi-Fi backscatter system can use existing infrastructure with Wi-Fi packet and energy harvesting with ambient Wi-Fi signals. But, the conventional Wi-Fi backscatter system has a short communication coverage and low performance. Thus, the proposed scheme solves these problems.
Acknowledgments. This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Science, ICT and future Planning(No. 2013R1A2A2A01067708) and Institute for Information & communications Technology Promotion(IITP) grant funded by the Korea government(MSIP) (No.B0126-15-1076, Development of non-powered technology combined with ambient RF energy harvesting and Backscatter data transfer)

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