Interference detection performance using asynchronous MU-MIMO and self-interference cancellation technique

Kazuma Ando, Kentaro Nishimori, Takefumi Hiraguri*, Yoshiaki Morino*, Hideo Makino
Graduate School of Science and Technology, Niigata University, * Nippon Institute of Technology
Ikarashi 2-nocho 8050, Nishi-ku Niigata-shi, 950-2181 Japan
Email : ando@gis.ie.niigata-u.ac.jp, nishimori@ie.niigata-u.ac.jp

***Abstract* –This paper proposes a collision detection scheme in *asynchronous* multiuser-multiple input multiple- output (MU-MIMO) transmission and self-interference cancellation. We assume that *asynchronous* MU-MIMO which realizes the efficient transmission and other antennas can receive preamble signals while the transmission is employed with antennas which are used in *asynchronous* MU-MIMO. The self-interference can be cancelled by subtracting the short preamble signal which is multiplied by the estimated channel response using the received signal after FFT processing. The effectiveness of proposed method is shown by computer simulation. In addition, interfering power from the *interfering* user terminal (IT) at the access point (AP) and *desired* user terminal (DT) is verified in an actual indoor environment.**

***Index Terms* — *asynchronous* MU-MIMO, collision detection, interference to noise power ratio, short preamble**

1. Introduction

Recently, access points (APs) of wireless LAN are deployed at many places to meet an offload for cellular systems. Because cell size of AP is very small, a lot of APs must be located at heavy traffic area. However, because the frequency channel which one AP uses is limited, the collision between the user terminals (UTs) occurs when many UTs try to connect with the AP [1]. Therefore, collision detection like wired communication system is essential and a collision detection method using *single-user* MIMO transmission has been proposed [2]. The method utilizes the fact that the second antenna is idle when the first antenna transmit the short preamble signals which are used for timing synchronization with the UT.

In this paper, a novel collision detection method in *asynchronous* MU-MIMO transmission [3] is proposed. When considering *asynchronous* MU-MIMO, other antennas can receive preamble signals while the transmission is employed with antennas which are used in *asynchronous* MU-MIMO. The self-interference can be detected by subtracting the short preamble signal which is multiplied by the estimated channel response using the received signal after FFT processing. In this paper, interfering power from the interfering user terminal (IT) at the access point (AP) and desired user terminal (DT) is verified when assuming the packet collision in an actual indoor environment. By analyzing the interfering signal from IT to AP and DT, it is shown that possibility by the collision detection when using the proposed method.

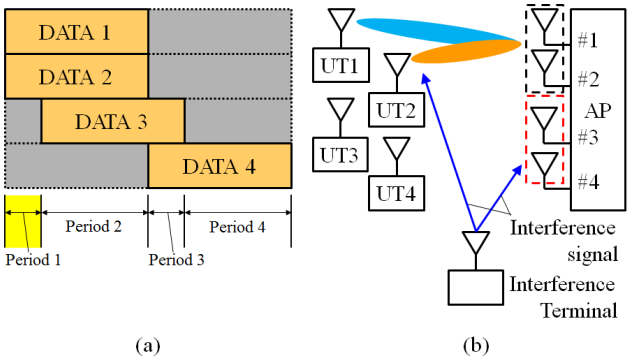

Fig. 1. Basic idea of proposed method.

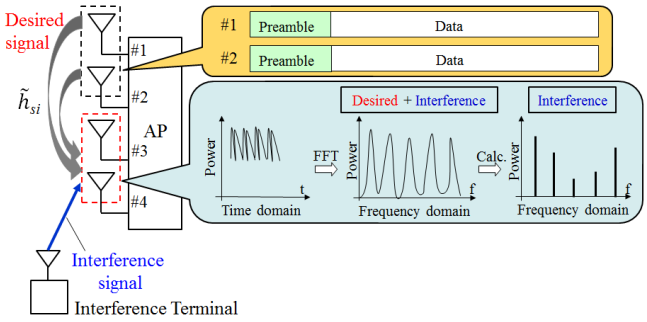

Fig. 2. Concept of proposed method.

2. Proposed method and basic performance

Fig.1 (a) and (b) show an example of data sequence in asynchronous MU-MIMO transmission and basic idea of proposed method. As can be seen in Fig.1 (a), the transmission for each user is instantaneously employed after gathering downlink signals in asynchronous MU-MIMO transmission [3]. The proposed method focuses on this feature and *unused* antennas are prepared for the detection on self-interference cancellation by the AP. When considering the case in Fig.1 (b) (Period 1 in Fig.1 (a)), only Data 1 and 2 for UT1 and 2 are transmitted. Hence, only two antennas are required for the data transmission. In the proposed method, the antennas #3 and #4 at the AP are used for the collision detection.

Fig. 2 shows the method for self-interference cancellation

between AP antennas and signal detection from IT. As shown in Fig.2, the self-interference and signal from IT are received at *unused* antennas. Because the self-interference is *known* short preamble signal at AP [2], the self-interference is cancelled by subtracting the short preamble signal which is multiplied by the estimated channel response using the received signal after FFT processing. After this processing, only signals from IT can be estimated.

Fig. 3 shows the basic performance of proposed method and estimation error versus signal to interference power (SIR) is plotted in Fig. 3. The average SNR is set to be 45dB from the previous measurement [2]. The number of trials is 10,000 and median values are plotted for each SIR. As can be seen in Fig.3, the estimation error is less than 1 dB, when the SIR is less than 30dB. Hence, the proposed method can successfully cancel the self-interference between AP antennas and estimate interference with small power.

3. Characteristics of interference to noise power ratio

Fig.4 shows measurement environment. In this measurement, interfering power is verified from IT to AP and DTs, when assumed the packet collision in an actual indoor environment. The size of room is 6.24x7.5m and AP and DTs are located inside the room in Fig. 4. On the other hand, IT is located at a corridor (outside the room). Center frequency and transmit power are 2.55GHz and 21dBm, respectively. The other basic measurement parameters are the same with IEEE802.11ac standard signal format. The short preamble signals are obtained by sliding correlation at each measurement point. In order to avoid specific characteristics in the measurement, the transmitter is moved with the interval of 0.5 wavelengths by using a position controller and 17 measurement points are obtained per each transmit location.

Fig.5 shows interference to noise power ratio (INR) versus the distance from IT to AP. INR is obtained by averaging 17 measurement points. A broken line denotes the threshold value, which is obtained by estimation error with 1dB in Fig.3, because the INR is 15 dB when SIR and SNR are 30 and 45 dB, respectively. When INR is greater than the threshold value, the proposed method can detect the interference while cancelling the self-interference between AP antennas.

As can be seen in Fig.5, the interference can be detected at the distance of 16 m at the AP. Because tendency regarding INR among AP and DTs are similar, the AP instead of DTs can successfully estimate the interfering power from IT when considering a room with small size. On the other hand, DT receives the interference but AP cannot receive interference when the distance is greater than 16 m. In such a scenario, collision cannot be detected at AP but the received power from AP to DT is much higher than that from IT and DT, the communication between DT and AP is not so serious problem.

4. Conclusion

This paper has proposed a collision detection scheme in asynchronous MU-MIMO transmission and self-interference cancellation. It is shown that the proposed method accurately estimates the interference power even if the interference power is small and the collision detection at AP is realized from the measurement.

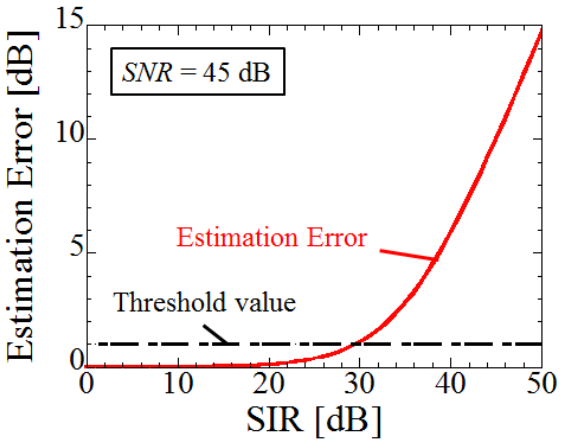

Fig. 3. Estimation Error versus SIR.

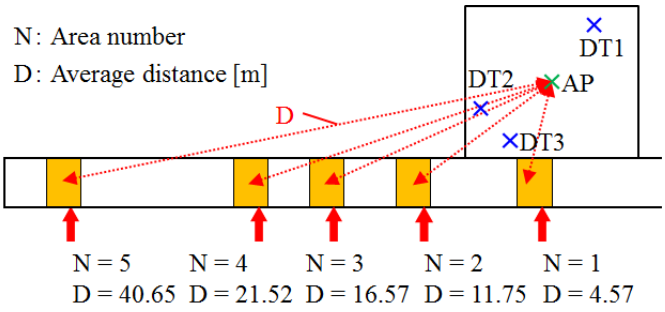

Fig. 4 Measurement environment.

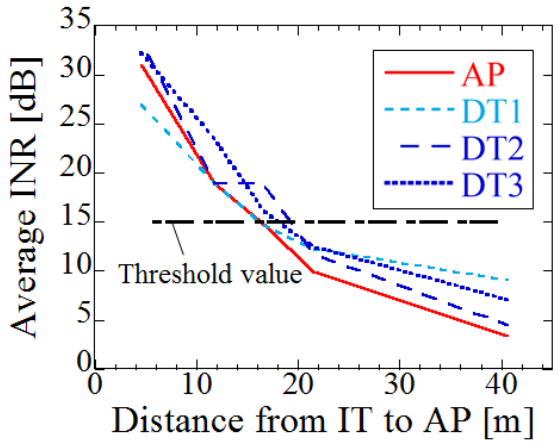

Fig. 5 INR versus distance from IT to AP.

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