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High-Speed Human Body Communication System

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1. Introduction

A review of research about human body communication was begun from a proposal [1] by Zinmerman of MIT (Massachusetts Institute of Technology) in 1995. Specifically, over the past few years, a considerable number of studies have examined human body communication. Practical use was researched about a wearable key [2] and the POS (point of sale) system [3]. In addition, a project called RedTacton [4] was begun. On the other hand, a detailed electromagnetic analysis about the propagation structure of the human body was reported [5]. However, only a few attempts have been made to accelerate the human body communication system. This paper investigates the acceleration of the human body communication system.

First of all, we examined the already known method of the human body communication system. Next, we investigated the electromagnetic characteristics of the human body for use as a transmission line.

2. The human body communication method

Human body communication can be classified into two main groups. The first method uses slight radio waves, and the second method uses a slight current. In this paper, the former is called the propagation method and latter is called the current method.

2.1 The propagation method

The propagation method realizes communication by transmitting weak radio waves at the human body. The schematic is shown in Fig. 1 [6]. This advantage of this method is that a pole touching the human body is not necessary. In other words, it is possible to use the top of the clothing.

However, there is a problem of common mode noise. Common mode noise degrades the quality of communication for the transmitter and the receiver worn by the human body. The signal detection method, which used photonic technology to address this problem, was proposed [4]. An electric insulation effect is achieved with photonic technology, and the signal can be efficiently detected.

2.2 The current method

This is a method of realizing human body communication by impressing a weak electric current about the human body. The schematic is shown in Fig. 2. The electric current, which was output from the sending pole, reaches the receiver via the human body. The feedback current is transmitted via the capacitive combination that occurs between the receiver and the transmitter.

The composition of the transmission line by capacitive combination is able to make the factor shown below in the objection. The disarranger is the size of equipment, distance and material and so on.

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3. The electrical characteristics of the human body

To realize a high speed human body communication method, detailed characteristics of the transmission line must be known. First, the frequency response of the transmission loss, which is a characteristic of the human body, is shown. Next, the frequency response of the capacitive combination, which is the return path for the current system, is shown.

Fig. 3 shows the poles used for the experiment. The poles are arranged as follows: length of 10 cm, calibre of 1.3 cm, distance between the poles of 10 cm, and the use of copper material. The human body send-line was created by grasping two poles with a hand on either side, and the frequency response of the transmission loss was measured using a network analyzer. The measuring results are shown in Fig. 4. The characteristics of the combination of poles, which the person does not grasp, is shown at the same time for comparison.

For frequencies above 40 MHz, the frequency response in human body transmission and space shows the same tendency. This result appears to be directly propagated by the poles regardless of the human body. For frequencies below 40 MHz, the human body has a transmission loss about 20 dB. And then, in space, it has a transmission loss equal to or more than 40 dB.

Fig. 5 shows an example of the frequency response of the capacitive combination. At this time, the transmitter is a PC and the receiver is a measuring instrument. The results change depending on the position and the size of the equipment. However, there are few transmission losses.

We may say that the high speed human body communication can be realized for frequencies less than 40 MHz.

4. Experiment result

One of the modulation techniques that tolerate changes in frequency response includes the OFDM method. This method was adopted by WiFi and digital broadcasting, and the effectiveness is sufficiently confirmed.

This evaluation experiment employed the OFDM method for digital broadcasting. The block diagram of the evaluation experiment equipment is shown in Fig. 6. Human body communication was realized in passing the signal from digital broadcasting, which changed into the IF band (3MHz) on the human body using the total recorder system [7]. Here, the electric current to impress on the human body is equal to or less than 500 uA. Continuously, we evaluated the transmission performance. The evaluation item is MER (Modulation error ratio). In human body communication, MER is 3 dB worse than transmission by cable but the signal could be sufficiently transmitted. Incidentally, in this experiment, a speed of 17 Mbps was attained.

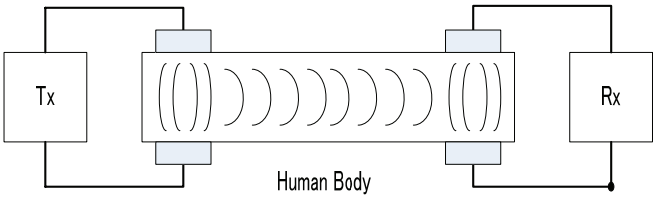

Figure 1: Propagation method

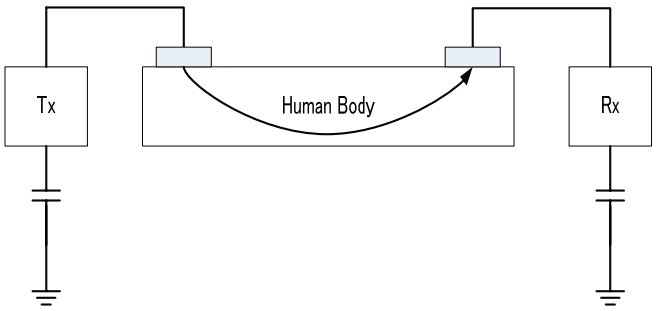

Figure 2: Current method (Monopole to monopole)

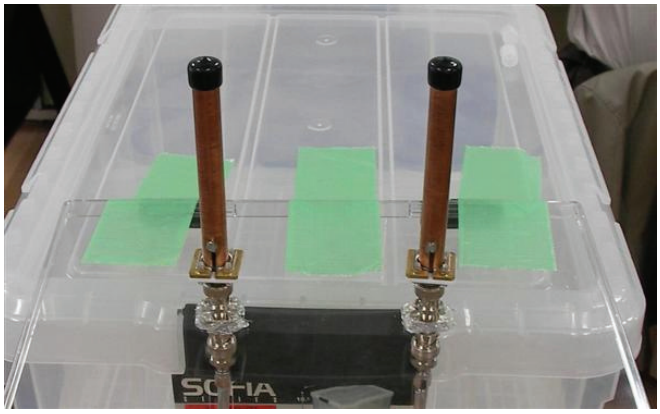

Figure 3: The photograph of the poles

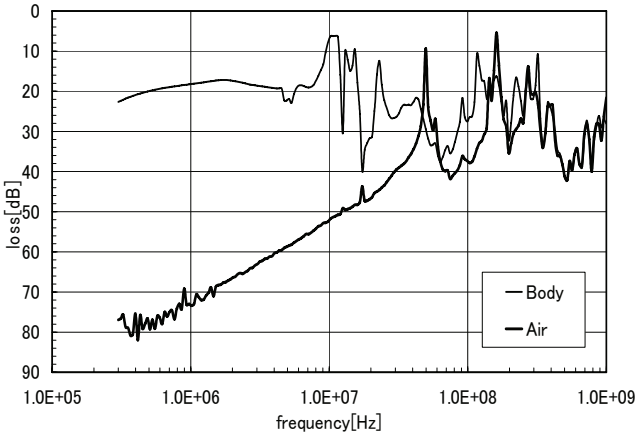

Figure 4: The frequency response of the human body

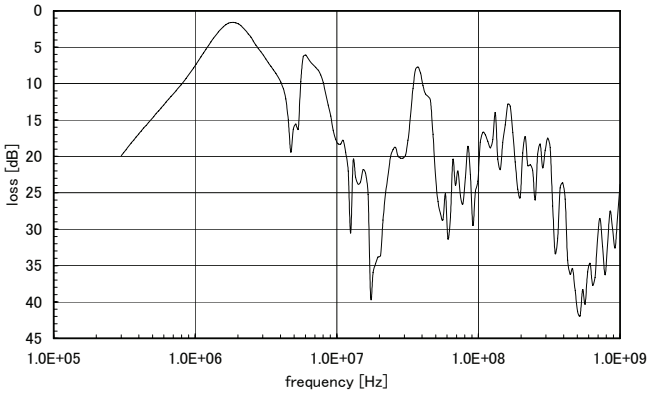

Figure 5: The frequency response of the capacitive combination

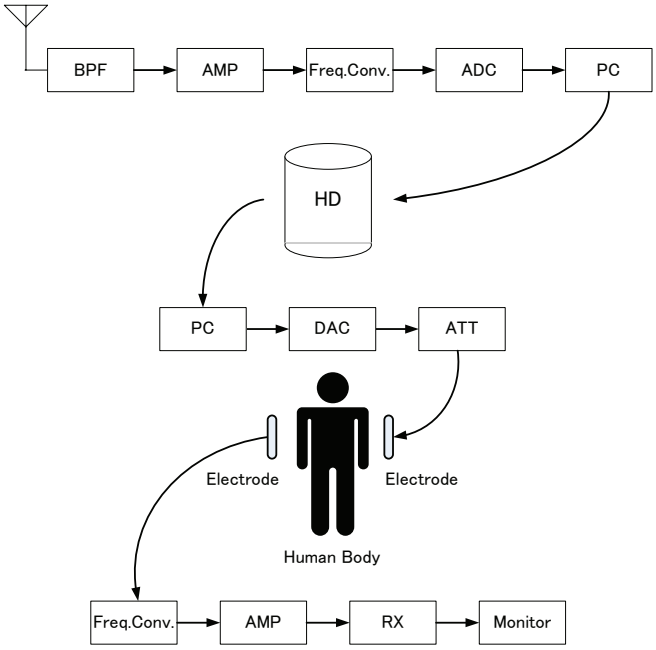

Figure 6: Block diagram of measurement system

5. Conclusion

We proceeded with the investigation of the technology trend in human body communication and measured the electrical characteristics of the human body. In conclusion, high-speed human body communication ca be realized as follows: (1) use the current transfer method (current is 500 uA or less); (2) use a frequency equal to or less than 40 MHz; (3) use a modulation technique that is strong in the change of the frequency response (OFDM etc). The result of the experiment was that the high speed transmission of 17 Mbps could be achieved with our system.

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