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Hybrid Communication System using Ultrasonic Waves and Electric Field thorough the Human Body

超音波と電界を用いたハイブリッド生体通信システムの基礎開発

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1. Introduction

Recently, the almost wireless communication is used the electromagnetic waves. However, the electromagnetic radiation has a problem on the information leakage and the limitation of the service area, such as medical institution and an airplane. We consider that all communication isn't needed to use electromagnetic waves, particularly short range communication. Then, we have proposed alternative communication system for the inappropriate situations using electromagnetic communication. The system is using the human body as the transmission path, and modulated electric field and ultrasonic waves are transmitted hybridly through the body. In this system, both energies are generated by one device. The system can be utilized several application, such as high speed and security communication, by using two kinds of energies.

In this time, we set up the prototype using personal computers and succeeded that the hybrid signal is transmitted and demodulated, respectively.

2. System Configuration

Figure 1 shows the system configuration. This system is applied a wearable device which is electronic hardware installed computing and wireless communication functions with wearable size, such as wrist watches. The system communicates interactive information using a single path with half-duplex communication in the human body. The path is consisting of a pair of piezoelectric ceramic oscillators. One oscillator is mounted in the wearable device (WD), and the other is in the stationary terminal type data reader-writer (R/W) or the other WD. The piezo oscillator can output the electric field (EF) and the ultrasonic waves (UW) respectively or simultaneously, depending on the input signal waveform. The communication is performed that the user touches the R/W or shake hands with other person, since the electric field and the ultrasonic waves can run through the human body.

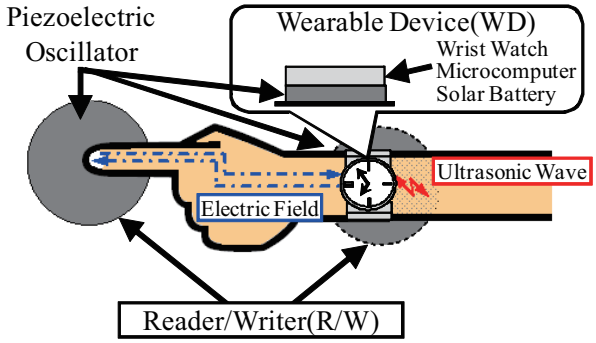

Fig.1 System Configuration of Hybrid

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3. Hybrid Communication System

On the beginning of this study, this system was only utilizing ultrasonic waves for protecting of information leakage in the air[1),2)]. However, the EF is also output from the oscillator, when the UW is output. Then we have considered utilizing both energies and built up the hybrid communication system. On the EF communication, the prototype using one chip microcomputer was developed and can communicate the digital data with the speed of 250 kbps between the arbitrary points in a human body. Additionally, the multiplexing communication is succeeded using the system based on personal computers (PCs) and the software. On the UW communication, the communication conditions are verified and the experimental communication using the prototypes is implemented with 115.2 kbps.

The hybrid communication is consisted of combining those characteristics, and can realize the high usability and security communication. The experimental system is controlled totally by the software "LabVIEW" (National Instruments). This software is easy to control several function generators and measurement equipments through the general port on PC, but the real-time processing is impossible. The oscillators in this experiment are [Pb (Zr, Ti) O3: PZT] with a resonance frequency of 1 MHz, a diameter of 20 mm, and a thickness of 2 mm. In this time, the EF transmission path is the

everywhere in the human and the UW path is the upper and lower forefinger. Transmission data is several textual information on the EF, and 3bit data on the UW. As a result, the mixed signal of the EF and the UW can be communicated, respectively.

The detail procedure is explained as follows referred on Fig. 2 to Fig. 4. First, the transmit signal of the EF is prepared on the transmitter side PC (upper of Fig. 2). Second, the transmit signal of the UW is prepared according to ASK (middle of Fig. 2), and the both signals are mixed (lower of Fig. 2). The signal data is sent to the function generator and input to the transmitter side PZT, the PZT emits hybrid energy consisted of the EF and the UW. The transmitted energy run through the body and received each part of PZTs. The PZTs transform the energies to the voltage and sends to the oscilloscope. The oscilloscope exchanges the signal to the digital data and inputs to the PC. The EF data is processed FFT and demodulated, the result is indicated the monitor shown in Fig. 3. Meanwhile, the UW data is amplified, filtered, envelop demodulated, digitalized, coded and indicated to the monitor shown in Fig. 4. The estimated transmission speed is 800 kbps (= 8 bit / (5 cycle * 2 μs)) at the EF and 200 kbps (= 1 bit / 5 μs) at the UW.

4. Conclusion

In this paper, we have proposed the novel communication system for the wearable device and the alternative system of the conventional electromagnetic communication. This system is using the human body as a transmission path, and two kinds of energies, electric field and the ultrasonic wave is using hybridly. The experimental system is constructed and the mixed signal can be communicated, respectively. According to the results, the availability and possibility of this system has been demonstrated.

Next step, we try to establish the real-time processing system instead of the LabVIEW. Additionally, in order to improve the ultrasonic communication, it is considered that the oscillator shape and the modulation method.

Acknowledgment

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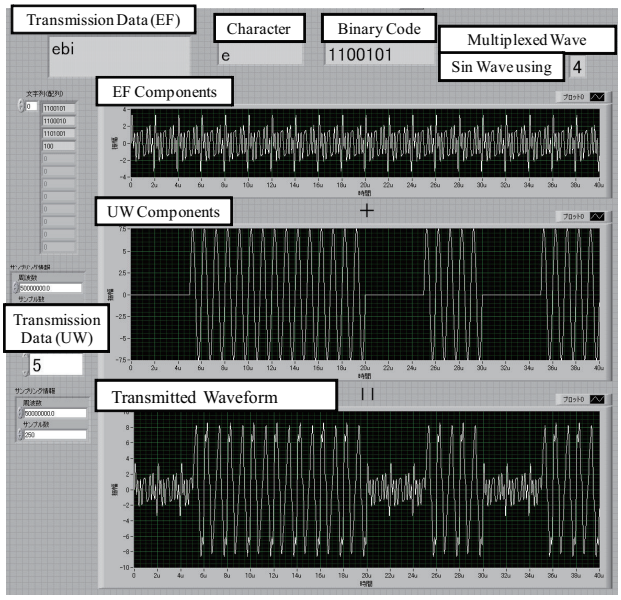

Fig. 2 Screen Image of "LabVIEW" on the Hybrid communication experiment (Transmitter Side PC)

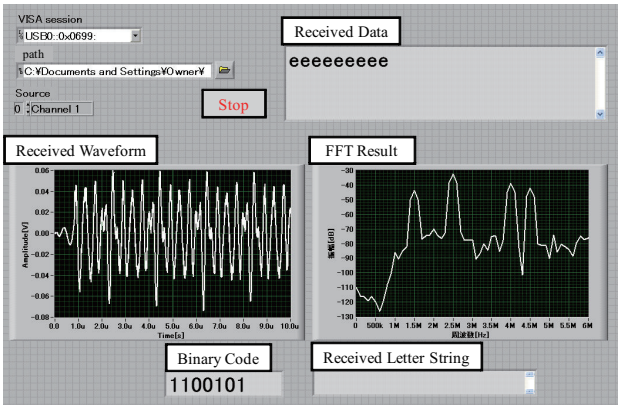

Fig. 3 Screen Image of "LabVIEW" on the EF Receiver Side PC.

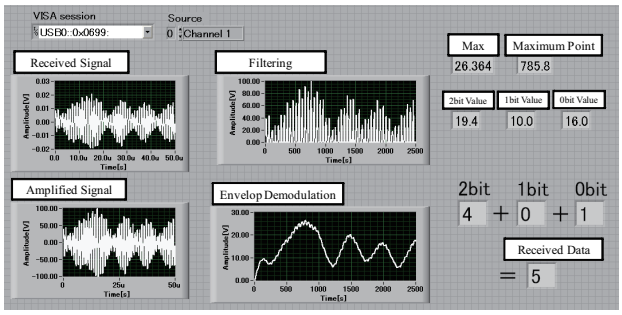

Fig. 4 Screen Image of "LabVIEW" on the UW Receiver Side PC.

References

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