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Communication in Human Area Networks Using PDAs

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***Abstract*— Human society is entering an era of ubiquitous computing or pervasive computing, when networks are seamlessly interconnected and information is always accessible at our fingertips.**

When very weak radio signals are used for the communication, data speeds are reduced by packet collision and other such problems in crowded places such as exhibition sites and security risk from unwanted signal interception is another problem. Technology for solving such problems includes the use of the person body as a signal path for communication. A transmission path is formed automatically when a person comes into contact with a device and communication between mobile terminals begins.

This paper describes a near-field-sensing transceiver for intrabody communication, in which the human body is the transmission medium. The key component of the transceiver is an electric-field sensor implemented with an electrooptic crystal and laser light. This sensor is suitable for detection of the small and unstable electric fields produced by the human body because it has extremely high input impedance. This transceiver enables IEEE 802.3 half-duplex communication of 10 Mb/s through a person's body in an operating range of about 150 cm between the hands.

Index Terms*—*Electrooptic crystal, laysor light, Personal area network, ubiquitous computing, Red Tacton, Human Area Networking

I. Introduction

AS CELLULAR phones, personal digital assistants (PDAs),digital video cameras, and other information and communication devices become smaller and more widespread, there are increasing opportunities for people to come in contact with small computers in their everyday lives. There is no question that the process of miniaturization will continue, and we will soon see the emergence of the so-called ubiquitous computing environment (Fig. 1), where, ideally, many computers serve each person everywhere in the world . For ubiquitous computing to be implemented in a comfortable and useful way, it is essential that we are able to share data not only among our own personal computers but also among peripheral computers. Wire connections are clearly impractical because they so easily become tangled, so some sort of short-range wireless communications technology is required. A number of short-range wireless schemes have been considered, including the Bluetooth and IEEE 802.11 standards. However, these radio wave-based methods are susceptible to interference and cannot connect between many computers without decreasing speed.One solution is intrabody communication,, which uses the human body as the transmission medium and is an entirely new concept for communications systems. The unique feature

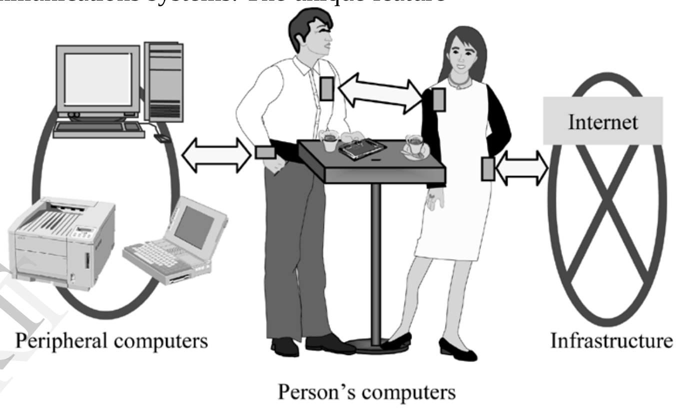


Fig. 1. Ubiquitous computing environment.

of intrabody communication are that data can be exchanged by unconscious actions, such as touching or stepping, and the person is clearly aware of connection. In addition, data transmitted through the human body eventually escapes through the feet into the ground, thus minimizing the chance of intercept and, thereby, providing secure transmissions. Some intrabody communications systems using very small voltages and currents applied and detected on the human body have been reported. Drawbacks in all recent systems are a short operating range and low speed because the systems employ electrical sensors. The input impedance of the sensors is not very high, making it difficult to accurately detect signals through the human body. As a consequence,the typical operating range is only about 30 cm, and speed is limited to about 40 kb/s. We have been researching electric-field sensors using electrooptic (EO) crystals and laser light, which we have applied in the development of various probing systems for measurement of ultrafast electronics. Because our EO sensor has extremely high input impedance and ultrawide detection bandwidth,it is especially useful for accurate detection of small and high-speed electric fields. Recently, we have developed a nearfield-sensing transceiver for intrabody communication using an EO sensor. We have achieved the first successful 10-Mb/s halfduplex communications in accordance with IEEE 802.3 through the human body at an operating range of about 150 cm between the hands. Moreover, this transceiver enables intrabody communication through clothes and interbody communication between two persons by a handshake. In this paper, we describe the configuration of the transceiver and the electric-field sensor unit in detail and present results of a communication test.

A. Configuration of Transceiver

The configuration of the transceiver is shown in Fig 2 The transmitter board consists of a transmitter circuit and a data

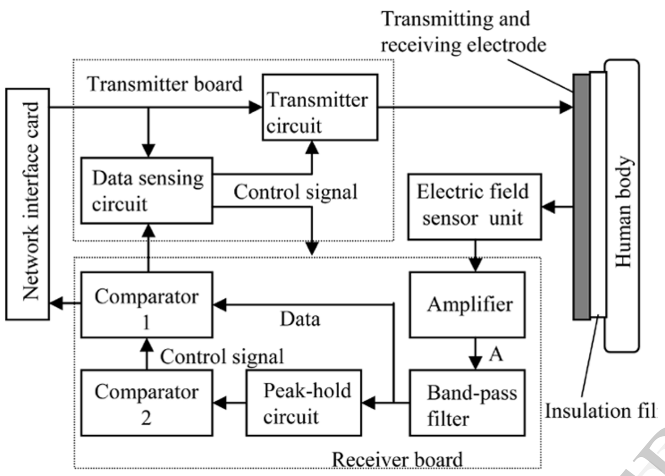


Fig 2: Configuration of the transceiver

sensing circuit. The data sensing circuit detects transmitted data and outputs the control signals needed for half-duplex communication.The receiver board consists of an amplifier, a bandpass filter, a peak-hold circuit, and two comparators. The signal from the electric-field sensor unit is amplified, and the bandpass filter eliminates noise outside the detection bandwidth. The output signal from the bandpass filter is divided into two signals. One is input to comparator 1 as data. The other is converted into control signal for packet extraction by the peak-hold circuit and comparator 2.

B. Intrabody Communication

Each transceiver was connected to a PDA. All components were battery powered. One person touched the TR electrodes of these two transceivers with his right and left hand.As mentioned before, the transceivers and PDAs were suspended in the air by insulated wires. The TR electrode was covered with the insulating film so that the electrode could not be touched directly. We confirmed 10-Mb/s (10BASE) half-duplex communication in accordance with IEEE 802.3 by sending a connection confirmation command. In addition, we also verified that intrabody communication can be performed through clothes without direct contact with the skin, and that interbody communication can be performed as well by having two persons shake hands while each touches the TR electrode of his transceiver with the free hand.

The transmitter circuit generated a signal of 25 V. However, the voltage actually induced on the human body was less than 100 mV, because the electrical load of the human body is so large that the transmitter circuit cannot drive it efficiently.

II. HUMAN AREA NETWORK

NTT has had excellent success with an electro-optic sensor combining an electro-optic crystal with laser light and recently reported an application of this sensor for measuring high frequency electronic devices. The electro–optic sensor has three key features: 1) It can measure electric fields from a device under test (DUT) without contacting it, which minimizes measurement disturbance, 2) Ultra wide band measurement is possible, and 3) It supports one point contact measurement that is independent of the ground, which is the most significant feature in the present context. NTT utilized this third feature to fabricate an intra body communication receiver for its human area networking technology, which is called Red Tacton. The operating principle of Red Tacton is illustrated in the figure below:

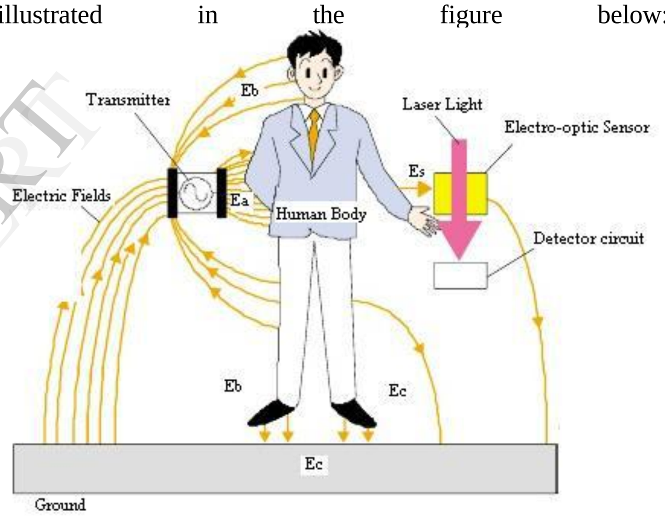


Fig : 3 Operating Principle

The electric field induced towards the body by the transmitter's signal electrode is represented by Ea. The system requires a ground close to the transmitter signal electrode, so electric field Eb induced from the body can follow a return path to the transmitter ground. Moreover, since people are usually standing on a floor or the ground, electric field Ec escapes from the body to ground, mainly from the feet. The electric field Es that reaches the receiver is Es= Ea-(Eb +Ec). It couples to the electro-optic crystal and changes the crystal's optical properties. This change is detected by laser light and transformed into digital data by a detector circuit.

III. PERVASIVE COMPUTING MODEL

The technological advances necessary to build a pervasive computing environment fall into four broad areas: devices, networking, middleware, and applications.

A. Devices

An intelligent environment it contain many different device such as :
• traditional input devices, such as mice or keyboards,and output devices, such as speakers or light-emitting diodes; • wireless mobile devices, such as pagers, per- sonal digital assistants, cell phones, palmtops, and so on; and
• smart devices, such as intelligent appliances,floor tiles with embedded sensors, and biosensors.

Ideally, pervasive computing should encompass every device worldwide that has built-in active and passive intelligence. The University of Karlsruhe's MediaCup project5 is an experimental deployment of everyday objects activated in this sense. The project's guiding principle is to augment objects with a digital presence while preserving their original appearance, purpose, and use.Sensors that automatically gather information,transfer it, and take actions based on it represent an important subset of pervasive devices. For example,sensors based on the Global Positioning System provide location data that a device can translate into an internal representation of latitude, longitude, and elevation. Stereo camera vision is another effective sensor for tracking location and identity in a pervasive environment. These fast-processing, two-lens digital cameras can record both background images and background shapes. The results are much more robust for tracking motion such as gestures.

B. Pervasive networking

The number of pervasive devices is expected to multiply rapidly over the next few years. IDC, a market analysis firm, has predicted that, by the end of 2003, the number of pervasive devices will exceed the estimated worldwide population of 6 billion people. Specifically, there will be more than 300 million PDAs; two billion consumer electronic devices, such as wireless phones, pagers, and settop boxes; and five billion additional everyday devices, such as vending machines, refrigerators, and washing machines embedded with chips and connected to a pervasive network.As a consequence of this proliferation, many current technologies must be revamped. In addition to extending the backbone infrastructure to meet the anticipated demand, global networks like the Internet also must modify existing applications to completely integrate these pervasive computing devices into existing social systems.

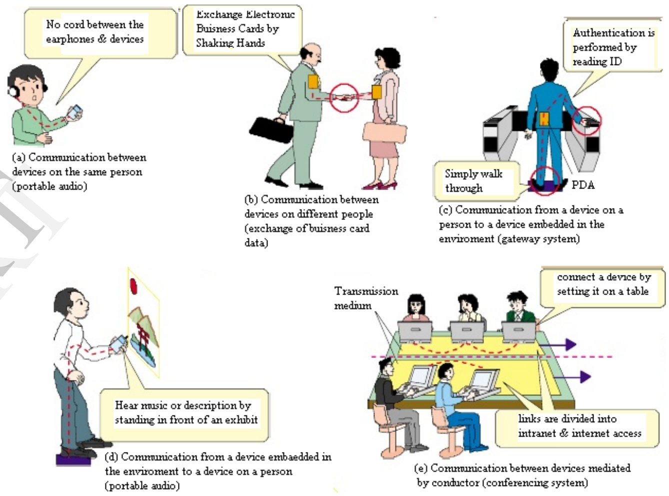
IV. HUMAN SAFETY

We investigated the effects of Red Tacton technology on human health, which is obviously an important issue. First as shown in figure on the previous page, the transmitting and receiving electrodes of the Red Tacton receiver are completely covered with insulating film, so the body of the person acting as a transmission medium is completely insulated. This makes it possible for current to flow into a person's body from a transceiver. When communication occurs, displacement current is generated by the electrons in the body because the body is subjected to minute electrical fields. However such displacement currents are very common everyday occurrences to which we are all subjected.

Red Tacton conforms to the "Radio Frequency- Exposure Protection Standard (RCR STD-38)" issued by the association of Radio industries and business.

(ARIB). The levels produced by Red Tacton are well below the safety limit specified by this standard.

V. APPLICATIONS OF RED TACTON



VI. PROPOSED WORK

Though pervasive computing components are already deployed in many environments, integrating them into a single platform is still a research problem.The problem is similar to what researchers in distributed computing face, but the scale is bigger. Integrating pervasive computing components has severe reliability, quality of service, invisibility, and security implications for pervasive networking. The need for useful coordination between confederation components is obvious.So the proposed idea behind that to use RFID technology with the REDTACTON device so that the users can communicate with there sofistcation. The uncomfortable users restricts access to the services by touching.As the area of redtacton device is limited that might be increased by using high electro optic sensors and lasor diodes.so the user can either use REDTACTON or RFID for the communication.

VII. CONCLUSION

We have developed a transceiver that uses a human body as a data transmission medium based on electric field sensor that uses an electro-optic crystal and laser light. Using this transceiver, we succeeded in achieving 10BASE communication in accordance with IEEE 802.3 through a human body from one hand to other hand. Our longer term plans include developing a mass market transceiver interface supporting PDA's.Using this transceiver, we succeeded, for the first time, in 10BASE communication in accordance with IEEE 802.3 through the human body at an operating range of about 150 cm between the hands. This transceiver will open the way to intrabody communication in a comfortable and useful ubiquitous computing environment.

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