Contents

1. INTRODUCTION.....2-4
2. NARRATION 5-9
3. EXPERIMENTAL ANALYSIS AND HUMAN SAFETY 10-14
4. APPLICATIONS AND ADVANTAGE 1031-16
5. UNIQUE FEATURES AND LIMITATIONS.....17-19
6. CONCLUSION 20-21
7. REFERENCES.....22

CHAPTER 1 INTRODUCTION

Human Area Networking (HAN) is a technology that safely turns the surface of the human body into a data transmission path at speeds up to 10 Mbps between any two points on the body.

1.1 History of HAN

- The concept of intra-body communication was first proposed by IBM in 1996.
- This communication mechanism was later evaluated and reported by several research groups around the world.

All those reported technologies had two limitations.

1. The operating range through the body was limited to a few tens of centimeters.
2. The top communication speed was only 40 bit/s!!

These limitations were overcome by NTT (Nippon Telegraph and Telephone Corporation) located in Tokyo, Japan by using photonic electric field sensors and finally came up with a human area networking technology called 'REDTACTON'

.

1.2 Overview of HAN

- RedTacton is a new Human Area Networking technology that turns the surface of the human body as a safe, high speed network transmission path.
- Communication is possible using any body surfaces, such as the hands, fingers, arms, feet, face, legs or toes.
- RedTacton works through shoes and clothing as well.
- RedTacton uses the minute electric field emitted on the surface of the human body for data transmission.

NTT developed super sensitive Photonic electric field sensor for detecting minute electric field emitted on the surface of the human body.

The electro-optic sensor has three key features:

- ✓ It can measure electric fields from a device under test (DUT) without contacting it, which minimizes measurement disturbance.
- ✓ Ultra wide-band measurement is possible.
- ✓ 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 intrabody communication receiver For its human area networking technology, which is called RedTacton.

1.3 What is RedTacton?

TACTON: - "touch-act-on" Meaning "action triggered by touching".

RED: - It is an auspicious color according to Japanese culture

RedTacton transceiver :

- The transmitter consists of a transmitter circuit that induces electric fields toward the body and a data sense circuit, which distinguishes transmitting and receiving modes by detecting both transmission and reception data and outputs control signals corresponding to the two modes to enable two-way communication.
- Implementation of receive-first half-duplex communication scheme that sends only after checking to make sure that there is no data to receive in order to avoid packet collisions

CHAPTER 2 NARRATION

2.1 BASIC PRINCIPLE

There was an excellent success with an **electro-optic sensor** combining an **electro-optic crystal** with laser light. This sensor is applied for measuring high-frequency electronic devices. The electro-optic sensor has three **key features**:

- It can measure electric fields from a **device under test (DUT)** without contacting it, which minimizes measurement disturbance,
- **Ultra Wideband** measurement is possible, and
- It supports **one-point contact** measurement that is independent of the ground, which is the most significant feature in the present context. This third feature is utilized to fabricate an intrabody communication receiver for its Human Area Networking technology.

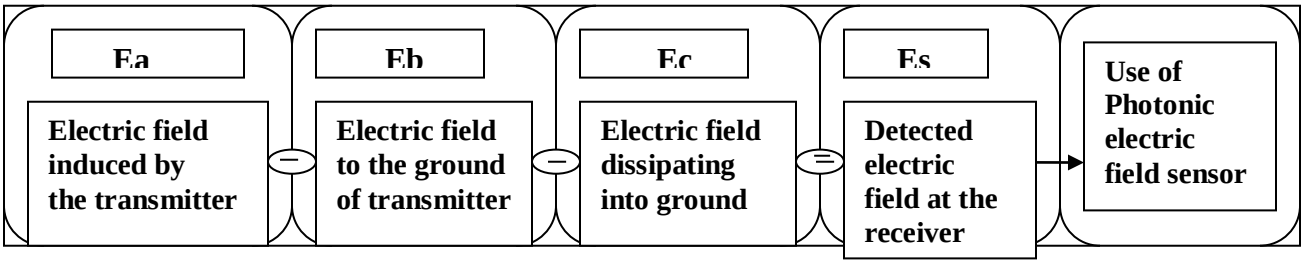

Fig2.1 (a) PHOTONIC ELECTRIC FIELD SENSOR

Ea represents the electric field induced towards the body by the **transmitter's signal** electrode. 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 thatreaches 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** and transformed into digital data by a **detector circuit**.

- **Ea** – Electric field induced by the transmitter.
- **Eb** – Electric field to the ground of the transmitter.
- **Ec** – Electric field dissipated into ground.
- **Es** – Detected electric field at the receiver.

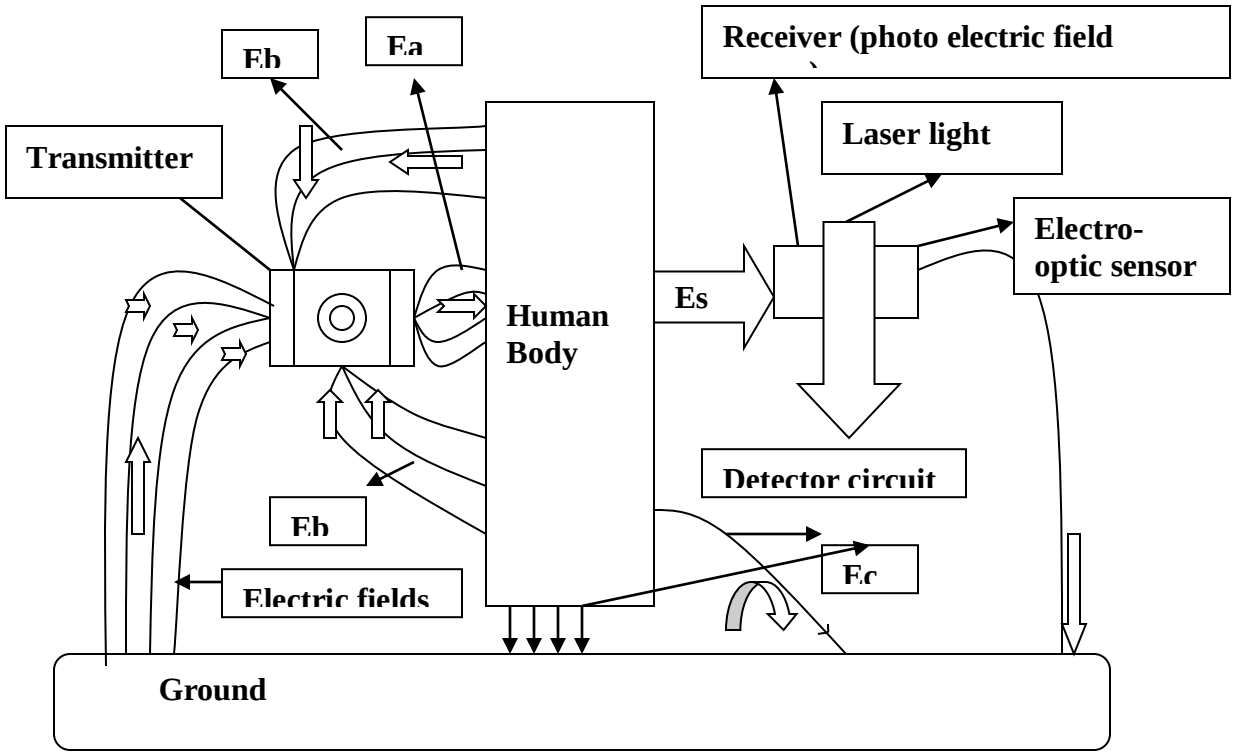

Fig2.1(b): MECHANISM OF COMMUNICATION

2.2 TRANSRECEIVER

Using a new **super-sensitive photonic electric field sensor**, we can achieve **duplex communication** over the human body at a maximum speed of **10 Mbps**. The transmitter used induces a weak electric field on the surface of the body, it receiver senses changes in the weak electric field on the surface of the body caused by the transmitter. This technology relies upon the principle that the optical properties of an **electro-optic crystal** can vary according to the changes of a weak electric field, it also detects changes in the optical properties of an electro-optic crystal using a laser and converts the result to an electrical signal in an optical receiver circuit.

The fig 2.3 block diagram of the RedTacton transceiver.

.

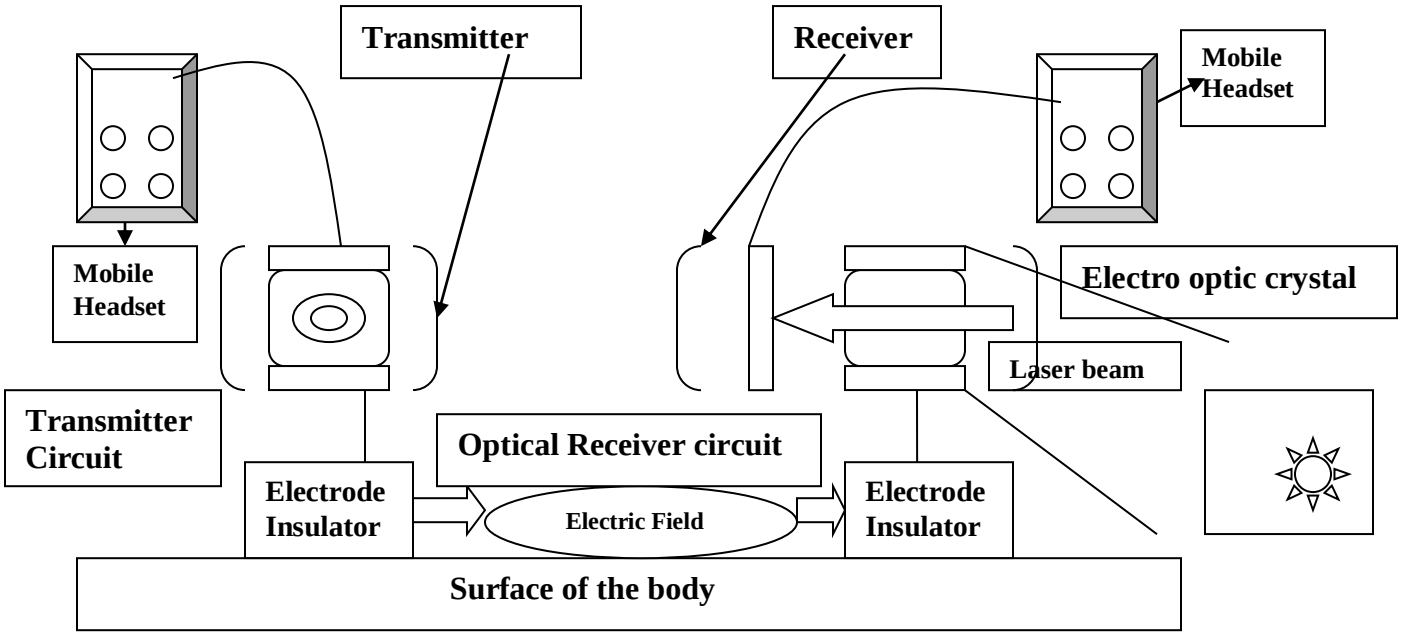

Fig 2.3 TRANSCEIVERS

Transmitter:

The **transmitter** consists of a **transmitter circuit** that induces electric fields toward the body and a data sense circuit, which distinguishes transmitting and receiving modes by detecting both transmission and reception data and outputs control signals corresponding to the two modes to enable two-way communication. We implemented a receive-first **half-duplex communication** scheme that sends only after checking to make sure that there is no data to receive in order to avoid packet collisions between terminals in compliance with the **IEEE 802.3 protocol**.

Receiver:

The **receiver** consists of an **electro-optic sensor** and a **detector circuit** that amplifies the minute incoming signal from the **electro optic sensor** [18] and converts it to electrical signal. We conducted a series of trials in which data was sent through human bodies using RedTacton transceivers.

CHAPTER 3

EXPERIMENTAL ANALYSIS AND HUMAN SAFETY

3.1 EXPERIMENTAL ANALYSIS

Setting up two sets of **transceivers**, each connected to a **PDA[19]** as shown in fig 3.1. The subject held one transmitting/-receiving electrode in each hand. The bit error rate of signals sent through the body was quantitatively measured.

The results showed that the system has no significant practical problems at a transmission speed of **10Mbit/s.** Besides communication between two hands, thereby communication between a foot and finger and between other parts on the person's body is also reliable and proved.

It has also been verified that good communication was achieved not only when the electrodes were in direct contact with the **person's skin [19]**, but also when the signals passed through clothing and shoes.

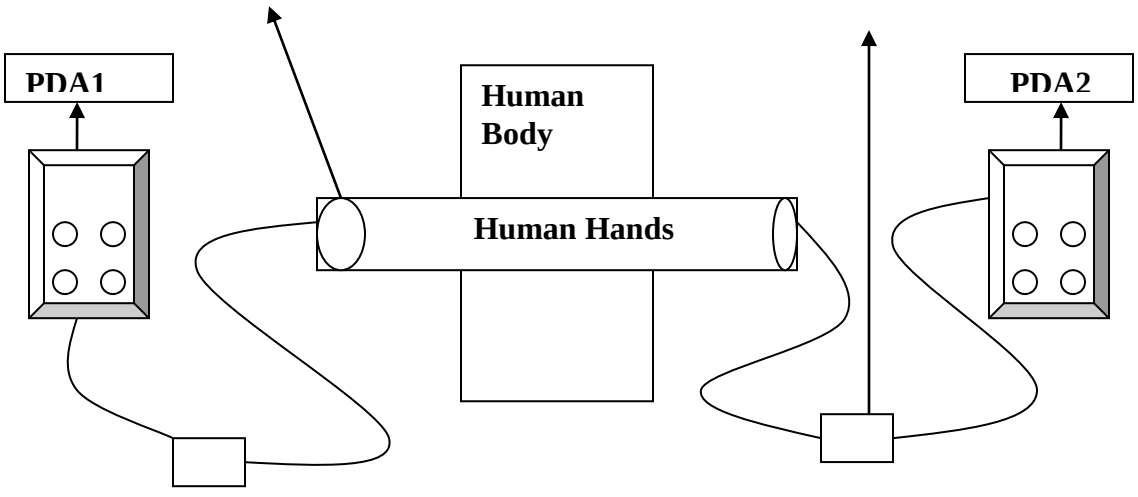

Fig 3.1 EXPERIMENTAL SETUP FOR INTRABODY COMMUNICATION

3.2 HUMAN SAFETY

We have to know the effects of this technology on human health, which is obviously an important issue. The transmitting and receiving electrodes of the **transceiver** are completely covered with insulating film, so the body of the person acting as the transmission medium is completely **insulated [22],[23].**This makes it impossible for current to flow into a person's body from the transceiver. When communication occurs, the electrons in the body generate displacement current because the body is subjected to minute electrical fields.

However, such displacement currents are very common in everyday occurrences to which we are all subjected to. Our Human Area Networking technology conforms to the **"Radio Frequency-Exposure Protection Standard (RCR STD-38)"** issued by the **Association of Radio Industries and Businesses (ARIB).** The levels produced by the transceivers are well below the safety limit specified by this standard.

CHAPTER 4

APPLICATIONS AND ADVANTAGES

4.1 APPLICATIONS:

- **ELIMINATION OF HUMAN ERRORS:**

It is used for the elimination of human errors, as our device embedded medicine bottles transmit information on the medicines' attributes. If the user touches the wrong medicine, an alarm will trigger on the terminal he is carrying. **[22]**

- **MARKETING APPLICATIONS:**

In touch advertising and receiving information as when a consumer stands in front of an advertising panel, advertising and information matching his or her attributes is automatically displayed.

- **INSTANT PRIVATE DATA EXCHANGE:**

By shaking hands, personal profile data can be exchanged between mobile terminals on the users. Communication can be kept private using authentication and **encryption technologies. [23]**

- **CONFERENCING SYSTEM:**

Various conductors and dielectrics can be used as communication media, and this has the potential to create new behavior patterns. An electrically conductive sheet is embedded in the table. A network connection is initiated simply by placing a laptop on the table. A conductive metal sheet is placed on top of a table, and simply placing devices on it creates a conferencing system.

- **WEARABLE:**

The Transceiver can carry music or video between headsets, mobile devices, mobile phones, etc. Users can listen to music from a player simply by putting on a headset or holding a viewer. In this case, the person is listening to music from a portable audio device through earphones.

- **SECURITY APPLICATION & PERSONALISATION:**

Automatic user authentication and log-in with just a touch. ID and privileges are recorded in a mobile transceiver device. Corresponding receivers are installed at security checkpoints. The system can provide authentication and record who touched the device, and when. The PC is configured to the user's specifications simply by touching the mouse.

- **COMMUNICATION IN NEW DOMAINS:**

The most significant of all the applications is communication in new domains that is potential for use as communication method in outer space and under water. Moreover potential for use as communication method with devices inside the human body itself is remarkable.

- **MEDICINE:**

A pacemaker inside the body if acquired takes a special radio frequency connector to interface to it. As more and more implants go into bodies, the need for a good Internet Protocol connection increases our human area network takes care of this interfacing. The most important application for body-based networking may well be for communications within, rather than on the surface of, or outside, the body. **[19].**

4.2 ADVANTAGES

An obvious question is why anyone would bother networking through their body, when proven radio-based personal area networking technologies, such as Bluetooth, already exist?

- The body-based networking is more **secure** than broadcast systems. With Bluetooth, it is difficult to rein in the signal and restrict it to the device you are trying to connect to.

- We usually want to communicate with one particular thing. But in a busy area, there could be hundreds of Bluetooth devices within range. As human beings are **ineffective aerials**, it is very hard to pick up stray electronic signals radiating from the body. This is good for security because even if you encrypt data, it is still possible that it could be decoded, but if you can't pick it up, it can't be cracked.

- Unlike infrared or Bluetooth phones and PDAs, which enable people to "beam" electronic business cards across a room without even formally meeting, **body-based networking** allows for more natural interchanges of information between humans.

- The transceivers can be treated as **standard network devices**, so software running over Ethernet or other TCP/IP protocol-based networks will run unmodified.

CHAPTER 5

UNIQUE FEATURES AND LIMAITATIONS

5.1 UNIQUE FEATURES

- A transmission path is formed and initiated automatically by body contact A device can be started, information can be obtained, or a wide range of natural human actions can trigger various services.

- The communication is interactive and broadband. Unlike RFID, HAN technology supports two-way exchange of large amounts of data between portable electronic devices.

- There is an independent transmission path for each individual person even in congested places. so it provides a duplex, interactive, very secure, fast communication without any interference at a maximum speed of 10Mbps.As transmission speed does not deteriorate in congested areas where many people are communicating at the same time.

- Almost anything that acts as a conductor and dielectrics can be used as transmission media. Conductors could be a human or animal body, water, metal, etc.—can serve as a transmission path. This means that there is no need for a dedicated cable or antenna.

5.2 **LIMITATIONS**

The Human Area Networking technology has subsequently been evaluated and reported by several research groups around the world. However, all those reported technologies had **two limitations**.

- The operating range through the body was limited to a **few tens** of centimeters.

- The top communication speed was only **40kbit/s**.

These limitations arise from the use of an **electrical sensor** for the receiver. An electrical sensor requires two lines (a signal line and a ground line), whereas in **intrabody** communication there is essentially only one signal line, i.e., the body itself, which leads to an unbalanced transmission line, so the signal is not transmitted correctly.

CHAPTER 6

CONCLUSION

By making Human Area Networks feasible, we can enable ubiquitous services based on human-centered interactions and therefore more intimate and easier for people to use. Human Area Networking has been used by technologies like **RedTacton.** As this technology is developing, we could all become individual networks that will exist individually but will interact on a daily basis with multiple other **individual networks** and larger networks. Our body and personal network will contain all the necessary **hardware** and **software** to connect to the greater network (whatever form our futuristic wi-fi clouds will take). In the near future, the most important application for body-based networking may well be for communications within, rather than on the surface of, or outside, the body. Of course this is dependent on this technology being adopted by the masses. An intriguing possibility is that the technology will be used as a sort of **secondary nervous system** to link large number of tiny implanted components placed beneath the skin to create powerful onboard -- or in-body – computers.

REFERENCES

1. E. Jovanov, A. Milenkovic, C. Otto, and P.C. de Groen, "A wireless body area network of intelligent motion sensors for computer assisted physical rehabilitation", *IEEE Transactions on Circuits and Systems-II: Express Briefs,* Vol. 56, No. 8, pp. 672-676, August 2006.

2. A.A. Lazar, "Time Encoding with an Integrate-and fire Neuron with a Refractory Period", [23] T. G. Zimmerman, "Personal Area Networks: Near-field intrabody communication",*IEEE Transactions on Circuits and Systems-II,*Vol. 44, No. 11, pp. 907-917, November 1997.

3. M. Shinagawa, M. Fukumoto, K. Ochiai, and H. Kyuragi, "A Near-Field-Sensing Transceiver for Intrabody Communication Based on the Electrooptic Effect", *IEEE Transactions on Instrumentation and Measurement,* Vol. 53, No. 6, December 2004, pp. 1533-1538

4. H.Y. Yang and R. Sarpeshkar, "A Bio-inspired ultra-energy-efficient analog-to-digital Converter for biomedical applications", *IEEE Transactions on Circuits and Systems, Regular Papers* , vol. 53, no. 11, November 2006, pp. 2349-2356.

5. E.V. Aksenov, Yu.M. Ljashenko, A.V. Plotnikov, D.A. Prilutskiy, S.V. Selishchev, E.V. Vetvetskiy, "Biomedical data acquisition systems based on sigma-delta analogue-to-digital converters" *in Proc. IEEE EMBS 23rd Annual International Conference,* Oct. 2001, vol. 4, pp. 3336-3337.