

# **Intra-body Communication using Personal Area Network**

Kirti Thosar<sup>1</sup>, Geetha Narayanan<sup>2</sup>

P.G. Student, Department of EXTC Engineering, VIT Engineering College, Wadala, Maharashtra, India<sup>1</sup>

Associate Professor, Department of Biomedical Engineering, VIT Engineering College, Wadala, Maharashtra, India<sup>2</sup>

**ABSTRACT:** Intra-body communication is a "wireless" communication technique that enables electronic devices on or near the human body to exchange the information. For this the characteristics of the human body are studied. The human body acts as a signal transmission medium and it uses the dielectric properties of human tissues for data exchange which covers frequency range from 100 KHz to 150MHz. Transmitting data directly through the skin can be much more beneficial than current wireless transmission technologies such as Blue-tooth and Wi-Fi as it will utilize less power. In this paper the concept of Personal Area Networks is presented to demonstrate how electronic devices which are on and near the human body can exchange digital information through the body as well various methods used for Intra-body communication are compared in this paper.

**KEYWORDS:** Human body communication, Intra-Body Communication, Personal Area Network..

## **I. INTRODUCTION**

Today's world is a wireless world. So majority of people uses wireless devices shown in Fig.1, through which a person can access multiple devices at same time. This increased propagation of devices necessitates a technique to communicate between these heterogeneous devices. In these wireless devices power consumption is a major issue. So many efforts have been taken to reduce power consumption. Various communication protocols are also developed for long rang and short range wireless communication such as Blue-tooth, Zig-bee, wireless LAN etc. Among these methods INTRABODY communication is a new method developed to connect mobile devices on and inside the human body. This technique uses the human body as a signal transmission medium.

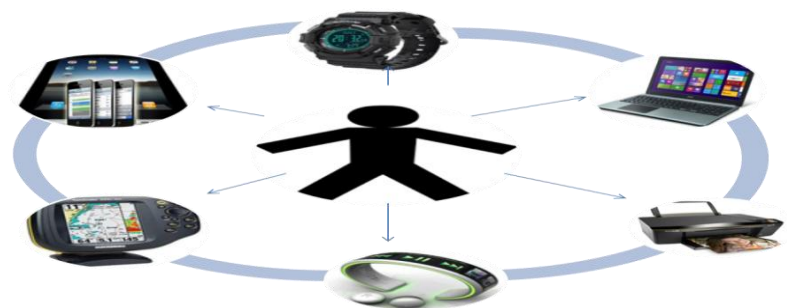


Fig.1 Wireless devises

Intra body communication has many useful characteristics like high data rate, high transmission quality, ease of network access, zero bandwidth problems. Electronic devices are evolving and becoming so small that one can carry them or even wear them on the body. With such advancement it is possible to communication between these devices which are on or around human body. For this purpose we can use body area network which is based on the IEEE

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

802.15.6 standard for transmission and it is type of wireless personal area network. The technique is still in very early phase but the results from some project implementation like RED TACTON show good results.

This paper discusses few types of intra-body communication namely

1) Simple circuit, 2) Electrostatic coupling, 3) Waveguide

This also discusses the challenges in this field and RED TACTON system that is developed based on IBC technology. A brief discussion about the working and applications of RED TACTON is also done.

## 1) Simple circuit:

This is a simple method in which human body is used as a conductor. This method requires an external wire to carry out the transmission.

## 2) Electrostatic coupling:

In this method as shown in the fig.2, devices are connected to the ground and it does not require any external wire. The transmission signal may differ depending on surrounding environment. Signal or data transmission is facilitated between transmitter and receiver by electrostatic coupling provided. There is suitable capacitance provided for earthing between input side and output side of the circuit. The signal is transmitted between the body channel transceivers by making a current loop, which is composed of the transmitter electrode, the body channel, the receiver electrode, and the capacitive return path through the external ground. In this method the human body is considered as perfect conductor and the electrostatic couplings between the transceiver, body, and environment are considered as capacitors. The signal is sent through encoder before sending them to body channel. They are then decoded using decoder at receiver end.

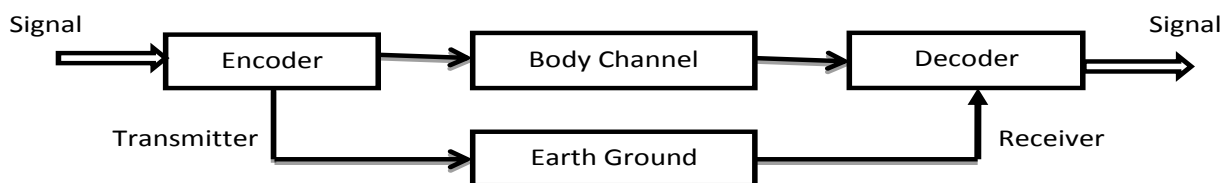


Fig.2 Electrostatic Coupling

## 3) Waveguide:

Other name for this method is galvanic coupling. In this method as shown in Fig.3, entire human body is treated as waveguide and it does not require grounding like electrostatic coupling. In This method high-frequency electromagnetic waves are used as input signal and are passed through the body. The waves are then received by output terminal. This method does not require external wires and transmission is unaffected by surrounding environment. In wave guide, a pair of transmitter electrodes passes differential signals into the body and the body acts like waveguide propagating the signal to the receiver. At the receiver end, the signal is detected by the receiver electrode pair. By shortening the transmitter electrodes this method achieves low data rates usually in kbps range. There are few subtypes of this method depending on the position of the electrodes which are either on the body surface or implanted inside the body.

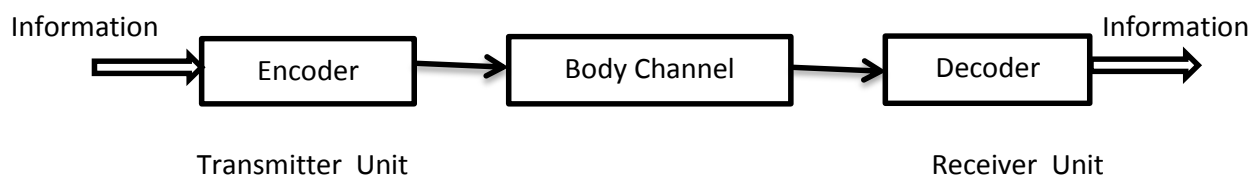


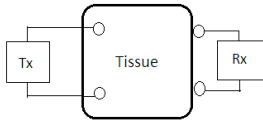
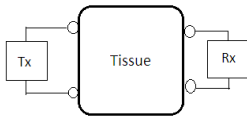
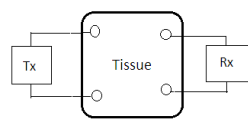
Fig.3 Waveguide Coupling

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

Three types of communications can be done by implanting waveguide on the surface or in the body in intra-body communication. The comparison between three types is as below:-

Sr. No.	Implant to surface communication	Surface to surface communication	Implant to implant communication
1.			
2	In implant-to-surface communication, galvanic coupling is used to send signals from a device implanted in the body to electrodes on the skin	In Surface to surface communication, devices are mounted on the skin.	In implant-to-implant communication, both the transmitter and the receiver are implanted inside the body.
3	Signal quality improvement is done through easy placement and repositioning of skin electrodes	Sensors are not implanted and thus can result in signal distortion as sensors are away from signal source	Implanted receiver can be connected to outside equipment using wired or wireless communication
4	More signal attenuation occurs as signal travels through skin which is less conductive than many human tissues	They can be used to create sensor network thus improving quality of signal	They cannot be easily repositioned but require less power

In galvanic coupling alternating current is fed into the human body with the help of two electrodes. The flow of the current is controlled by AC current flow and human body is considered as transmission medium[5].

Comparison between electrostatic and galvanic coupling is as below[1]:-

Electrostatic Coupling	Galvanic Coupling
Electrical signal is applied to control induced signal (Applying static charged electrode).	Alternating current flowing over multiple electrode is used to control the induced signal
Here only one electrode of both transmitter and receiver is attached to the human body and the other electrode is floating	It is necessary to attach both the electrodes of transmitter and receiver to the body
Ground is necessary as a reference	Ground is not necessary as a reference
The signal transmission is done through environment(dominantly) only	Human body tissues are used for signal transmission
Higher transmission data rate and channel gain (Higher operation frequency compared to galvanic coupling)	Lower transmission data rate
Environmental conditions around body has effects on signal quality	Here dielectric properties of human tissues affect the signal quality
Interference from surrounding devices that could capacitive couple directly to the IBC device.	Sensitive to the body location because of the dependence on inter-electrode distance and orientation along the body.
Direct contact to the human body is not required. It can work even if device is in the proximity of human body.	Direct contact with body tissue is necessary. Capable of both onbody and in-body (implanted) device communication

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

## Advantages of IBC:-

- 1) As signal passes through human body there is less influence of electromagnetic noise and obstacles on signal transmission.
- 2) It is more secure as signal starts falling as distance from transmitter or person increases. This is because in such case it is difficult to intercept the incoming signals.
- 3) It requires less power and devices also can be made smaller.
- 4) Private data can be shared instantly

## Disadvantages of IBC:-

- 1) Bandwidths are low
- 2) Signal attenuation is more as signal strength gets attenuated to nanovolt or even picovolt range thus reception becomes difficult.
- 3) It can have effects on human health as electromagnetic and electrical fields may lead to health problems

## Applications of IBC:-

There are different fields which can use IBC for better communication between devices.

Some of these applications are as follows:

1. **Wearable devices:** With the use of IBC data can be transmitted between different devices just by touching them. Thus it can eliminate usage of Blue-tooth or WIFI which are more power consuming and have some issues in transmission.
2. **Security Applications** Automatic user authentication and log-in with just a touch. ID and privileges are recorded in a mobile IBC device. Corresponding IBC receivers are installed at security check points. The system can provide authentication and record who touched the device, and when.
3. **Personalization of Mobile Phones:** Your own phone number is allocated and billing commences. Automatic importing of personal address book and call history. The PC is configured to the user's specifications simply by touching the mouse.

## Future Work:-

1. New techniques to improve data rates in low frequency ranges required.
2. Theoretical models to understand the body channel characteristics and constraints. Human channel modelling will be necessary while the body is in motion.
3. Studies on tissue effects for IBC use in the long term, e.g. Cancer.
4. The specification of WBAN needs to be considered in future IBC transceiver design.
5. New transceiver design based on high security, low power consumption, enhanced data rate, and small form factor for ease of use compared to current IBC systems.

Since the concept of Intrabody communication is a novel approach about transmission of data, lots of work have been done in this field. Many authors have tried different coding scheme and coupling methods for the implementation of IBC idea. This concept has found its applications in both Personal area network (PAN) and Body area network (BAN). Under Personal Area Networks (PANs) concept on-body IBC is used for the data exchange among electrical devices which are worn on the body. While under BAN implant IBC is used for the communication among implantable electrical devices. IBC technique potentially offers a more power efficient and naturally secure short range communication method for body sensor networks, compared to wireless RF.

## II. RELATED WORK

There are many groups working on the concept of intra body communication for wearable electronics products. There are different methods of IBC which are divided into two categories depending on the modulation scheme. First is continuous frequency modulation which uses FSK, ASK. In these methods researchers are trying to find optimum frequency to transfer signal through human body having low power consumption with low voltage and weak current. But such systems have very short range and low speed. Range is only about 30cm and speed is 38.4kbps. Second

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

method transfers digital data directly through human body without any frequency modulation. It uses electric field sensor with high input impedance and wide electron band width.

The human body communication can have its interferences. Few of them like noises from cathode ray tube monitor, drier, mobile phone and so on were taken into consideration by Keisuke and others. There are new papers which propose new measures to overcome these interferences from electronic and wireless devices such as PC devices, cordless phone, radio broadcasting towers and so on.

To overcome problems arising due to the induced strong electromagnetic waves to the human body emitted from household appliances and different devices particularly below 5MHz. The information is spread into selected frequencies by using Walsh code without continuous frequency modulation using carrier frequency.

There are several approaches with implanted devices communicating through human body as communication channel has been proposed and tested. These methods provide information on how intra body communication can be realized. There are many advantages of intra body communication over wired and RF communication for communicating with implanted devices.

However intra body communication is very new technology and has many challenges like power delivery, data speed, and safety measures. These challenges are need to be addressed and with improvements in intra body communication technologies it can be used for different application like psychological monitoring.

## III. RED TACTON

The research in this technology is going on since 1996 after it was first proposed by IBM. Some earlier efforts were promising but had some issues. These difficulties were overcome to certain extent by NTT (NIPPON TELEGRAPH AND TELEPHONE CORPORATION), Japan by using photonic electric field sensors and it came up with the Human Area Network Technology called Red Tacton.

This system uses touch of human body to start the communication and can result in wide range of responses from the different devices. This technology uses human body surface as a high speed transmission medium. In this technology, communication starts when terminals carried by user or placed in devices are linked in different combination depending on the user's natural movements. The transmission is done using weak electric field present on human body surface. Thus it is not depending on the electromagnetic waves or light waves.

The communication is possible using any body parts of the body such as fingers, legs, feet, arms, face or toes. It can also work through shoes and cloths.

In this system the communication starts as soon as any body part comes in contact with the Red Tacton transceiver. When this contact ends the communication also ends. The minute electric fields on the surface of the human body are passed to the receiver. At the receiver these electric field affects optical properties of the electro-optical crystal. The extent of change in properties of electro-optical crystal is detected by the laser light and then detected signal is converted into the electrical signals by detector circuit.

NTT has done good work in developing a sensitive photoelectric sensor for detecting minute electric fields on the surface of the human body [10].

### Mechanism of Communication:

A brief working mechanism of Red Tacton is shown in below Fig.4. It includes electrodes, insulators, electro optic crystal & transmitter/receiver circuits. Photonic electric field sensor is used with an electro-optic crystal and laser light to detect changes in minute electric field. The naturally occurring electric field is induced on the surface of human body which then get dissipated into earth. Thus this electric field is very weak and unstable. NTT developed photonic electric field sensor is used to detect this weak electric field by detecting changes in optical properties of electro-optic crystal with laser beam.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

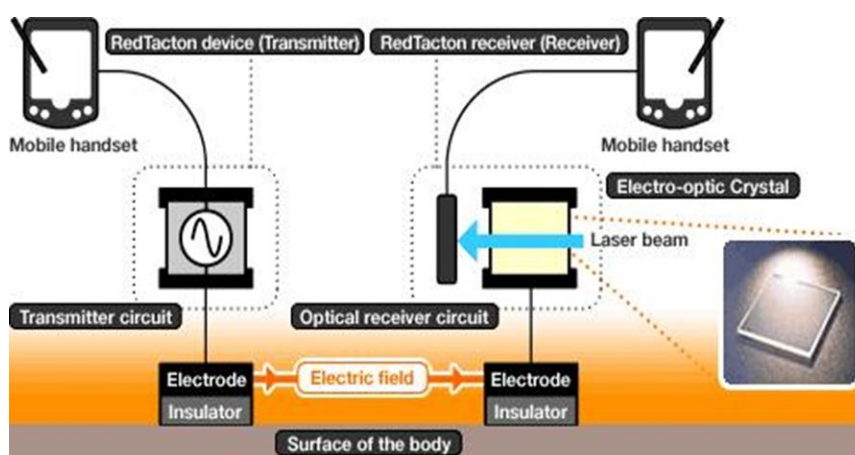


Fig.4 Working mechanism of Red Tacton

## Working of RED TACTON:

This system uses the above mentioned mechanism with red tacton transmitter inducing electric field onto the human body surface and receiver then senses the changes in this electric field by detecting output of electro-optic crystal with laser beam. These optical changes are then converted to electric field by receiver unit.

## Red Tacton Transceiver:

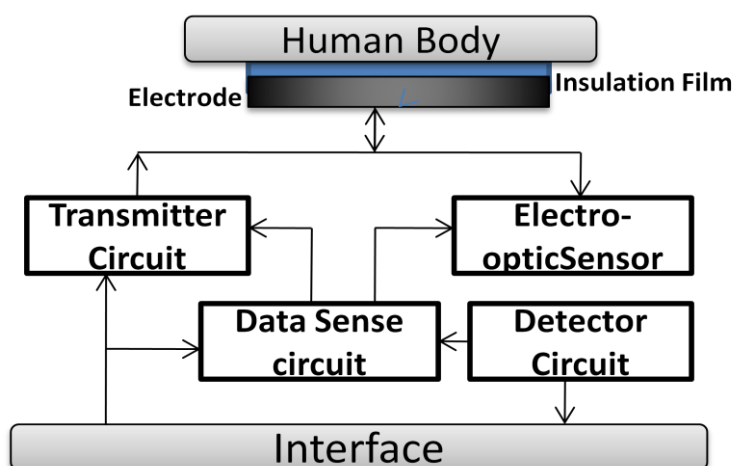


Fig.5 Red Tacton Transceiver

The above Fig.5 shows red tacton transceiver [10]. The data sense circuit and transmitter both receive data from the interface. The data sense circuit gives control signal to transmitter when it detects data in the sensed signal. This control signal then activates the transmitter circuit. Transmitter varies signal induced on human body. This change is then detected by electro-optic sensor. The output from this sensor then given to detector circuit. Detector circuit gives output to interface on the receiving red tacton device[10].



# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

## IV. EXPERIMENTAL RESULTS

Two sets of Red Tacton transceivers and electrodes are used one at transmitting end and other at receiving end, each connected to a PDA as shown in Fig.6. By this, BER of the signal sent through body and signal drop is measured.



Fig.6 Experimental setup of Red Tacton

The expected result is that the data should pass from human body at the speed 10 Mbps without any significant problem.

### Advantages of RED TACTON:

- 1) It is very fast and easy to operate
- 2) Data loss is minimum
- 3) Low power consumption
- 4) It provides more security

### Disadvantages of RED TACTON:

- 1) The operating range is limited to few centimetres.
- 2) Its effects on human health is still not fully known.

### Application of RED TACTON:

- 1) This technology can be use for marketing purpose where customer gets all information just by touching to or standing in front of the advertisement display.
- 2) Furniture or walls can be use as transmission medium with the help of this technology. For example internet access through desktop
- 3) Security application can be made using this technology. One can authenticate secure access just by touching the system. This can also be used in secure transactions where one can get all relevant details through touch of the customer.
- 4) As the transmission starts with simple human actions we can avoid usual electronic components such as smart cards, cables, frequency tuner required for today's electronic devices.

### Future Work:-

- 1) Wired connection can be replaced.
- 2) In the crowded areas such as meeting room due to many users throughput can be reduced by packet collision in case of Bluetooth and wireless LAN using RED TACTON this problem can be solved.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

## V. CONCLUSION

This elaborate study is carried out about Intra-Body Communication, IBC. This communication uses human body as a medium. Two techniques namely electrostatic coupling and galvanic coupling or waveguide are discussed here. IBC has many advantages over current short distance wireless communications protocols like Zigbee, WIFI and Bluetooth etc. We studied that IBC allows several wearable devices carried by one person to exchange information and share I/O hardware resources. IBC technology can be used for personal area network (PAN), computer network access, implant biomedical monitoring, human energy transmission etc. The practical system which is Red Tacton is discussed which is developed by NTT.

## REFERENCES

- [1] MirHojjatSeyedi, "A Survey on Intrabody Communications for Body Area Network Applications", IEEE2013.
- [2] Maria Callejon, David Hernandez," A Comprehensive Study into Intra-Body Communication Measurements", IEEE,2013.
- [3] Namjun Cho, Jerald Yoo, Seong-JunSong, "The Human Body Characteristics as a Signal Transmission Medium for Intra-body Communication" IEEE,2007.
- [4] Chang Hee Hyoung, Jin Bong Sung, Jung Hwan Hwang, Jin Kyung Kim "A novel system for Intrabody communication- Touch• And-Play", IEEE 2006.
- [5] T.lotkar," Comparison of approaches to Intra-body Communication", IJSC,2012.
- [6] T.G. Zimmerman, "Personal Area Networks: Near-field intra-body communication," IBM systems journal, Vol. 35, Nos. 3&4, pp.609-617, 1996.
- [7] T. Nagatsuma and M. Shinagawa, "Photonic measurement technologies for high frequency electronics," NTT REVIEW, Vol.14, No.6.pp. 12-24, 2002.
- [8] M. Shinagawa, "Development of Electro-optic sensors for Intra-body Communication," NTT Technical Review, Vol. 2, No. 2, pp. 6-11, 2004.
- [9] M.Shinagawa, M. Fukumoto, K. Ochiai, and H. Kyuragi, "A near-field-sensing transceiver for intra-body communication based on the electro-optic effect," IEEE Trans.IM, Vol.53,No.6, pp. 1533-1538,2004.
- [10] NTT (February 2005). "Red Tacton: An innovative Human Area Networking Technology"