Intrabody Communication for Human Area Network Application

Chanakya Kumar
Department of Electronics and Telecommunication
Saradchandra Pawar COE, Otur, Pune, India
chanakya@ieee.org

Hiren R. Italia
Department of Electronics and Telecommunication
Saradchandra Pawar COE, Otur, Pune, India
hiren.italia@gmail.com

***Abstract*— Intrabody communication (IBC) is a novel data transmission method to transmit the data using human body as a transmission channel. In this paper we have taken efforts to develop a methodology for IBC. The IBC will play a vital role for the data transmission through the human body. The idea is driven from the vision of a cable free secure data transmission system. This paper examines the data transmission between the two mobile devices for the different conditions, different distances, different modes, IBC transceiver design and the practical uses in future.**

Keywords*— *Intrabody Communication, IBC, HAN, Mobile Communication, wireless communication, M2M communication.

I. INTRODUCTION

In today's world transmission of data is performed over a wired network or wireless network. The drawback of the wired network is the routing of the cable. The drawback of the wireless network is packet collision and security risk. But these drawbacks are eliminated by using the proposed system in this paper.

IBC was originally proposed by T. G. Zimmerman [1]. The concept is to use a human body as communication channel between mobile device terminals. The concept of Personal Area Networks (PAN) [2] - Near field IBC is demonstrated how mobile devices near the human body can exchange digital information by capacitive coupling in pico ampere currents through the human body.

In the year 2013 MirHojjat Seyedi [3] et al done a survey to examine the ongoing research in the area of Intrabody communication for body area network applications and gives IBC fundamentals, IBC mathematical models of the human body, IBC transceiver designs. It is found that IBC is a new short range non-RF wireless communication technique specified by the IEEE 802.15.6 using the human body as a transmission medium. As it stands, the IBC technique potentially provides a more power efficient and naturally secure short range communication method for body area networks, compared to wireless RF. Despite the tremendous benefits, the evolution of IBC is still in its infancy.

Zimmerman [1] said that, the near-field communication can operate at very low frequencies and low transmission power. The prototype of the PAN transmitter operates at 330 kHz, 30V, with a transmission power consumption of 1.5mW for charging the electrode capacitance. Direct coupling by Masaaki Fukumoto [2] et al is a modified version of the basic capacitive method. The system operates by analog frequency modulation at frequencies within 50 kHz to 90 kHz for transmitting a simple protocol of ID numbers. Sasaki [9] et al tried to illuminate the principles of intrabody communication, where the Electro Optic [EO] sensor is used to receive data signal. Maria Amparo Callej´on [4] et al implemented galvanic [5], [6] and capacitive coupling [7], [8] setups and carried out comprehensive set of measurements by analyzing fundamental IBC parameters such as optimum frequency range, maximum channel length and type of electrodes.

II. PROPOSED MODEL FOR INTRABODY COMMUNICATION

A. Hardware Model

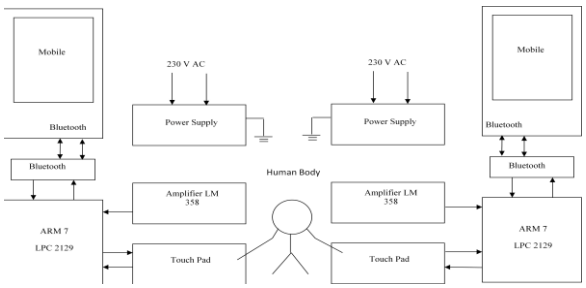

Fig. 1. Intrabody communication Transceiver

In the hardware model mobile devices used is based on the android operating system because now a day's android is the most adopted technology. In the mobile device we have created a graphical user interface (GUI). In this GUI there is facility to transmit the personal data and there is also an option for the file transmission from the SD card.

The transmission of the data takes place between mobile device and the hardware using the external bluetooth device. The bluetooth device used here is the RN-42 class-2.

The heart of the hardware system is the ARM7. The main purpose to use the ARM processor is it consists of two UART ports. One port is useful for the bluetooth to transmitter hardware and another is used for mobile device to receiver hardware.

Before transmission of the data we have used the amplifier LM358 to transmit the data over the long range. This component decides the distance of data transmission between two mobile devices. The main advantage to use the LM358 is it requires only positive power supply. OP-AMP Rx and Tx units are designed using LM358 as shown in fig. 2.

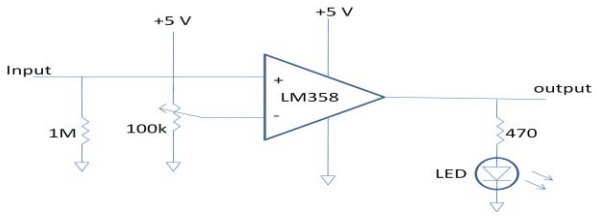

Fig. 2. LM358 Amplifier design

In the amplifier, the input is coming from the body in term of mA current. 1M resistor used for the current to voltage conversion makes it as high as possible for the higher possible voltage. 100k potentiometer is used for the adjustment of the reference voltage. LED is used for the indication of the output.

The ARM processor required +3.3 V power supply to provide the same we have used LM1117 which will convert the +5 V to +3.3 V.

In this hardware section we must have to take care about the proper earthing to complete the continuity of the current. Because the reference of all the circuit is not same so it requires the common earthing.

Here the hardware used in either side is transceiver. When we transmit the data from one side transmitter the same data will receive to the same receiver and another side receiver. To make it enable the reception of the data from the same side receiver we have used the diode as shown in fig. 3.

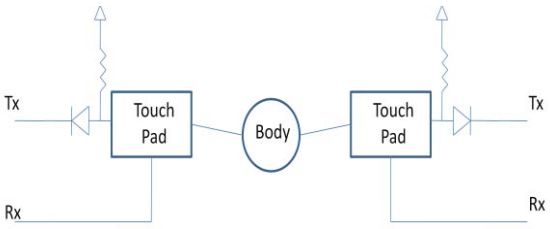

Fig. 3. Use of diode in the transceiver

B. Software Model

We have divided the software model into two parts; one is the mobile side and another is the processor side. For the mobile side we have used the java language with the ADT toolkit and eclipse software, whereas in the processor side we have used the embedded C in the keil software. We are operating software model into two modes, one is the GUI data or personal data transmission and another is the transmission of the file which is resides in the MMC.

a) Mobile side

Define all GUI elements which consist of the some edit text field, radio button for choosing personal data or file transmission, some simple buttons for the data transmission methods i.e. only transmission, only reception or transceiver. Create the GUI element which are defined and fill all the require data in the GUI.

Perform the operation to check whether the mobile device has a facility of the bluetooth. This checking can be performed by passing the MAC address of the device. If yes then establish the connection between mobile device and external bluetooth device. Define the input output stream for the bluetooth. Then click on the ActiveTx or DeactiveTx or ActiveRx or DeactiveRx for the data transmission methods. These are the simple buttons created on the GUI for the data transmission methods. For the file transmission write the file address in the provided text field. Create an object named as Active.

For the bluetooth transmission check for the BTTransmit Active is true or false. If it is true then check for the TxBusy if it is true then convert the data into one string with some specific format. If it is the personal data then make the string starting with starting with 'M' or if it is the file then make a string starting with the 'F'. Next field in data string is the message length and after that attach the actual personal data or file content. At the last flush the data from the buffer for the transmission.

For the Bluetooth reception check whether BTReceive Active is true or false. If it is true the start reception of the data. Check whether the data is personal or file by checking

the first field of the received string. Then check the length of the data form the next field. If it is the personal data then display it on to the GUI and if it is the file then store it into the MMC.

By making the data flow diagram shown in fig. 4, a user fills the information in the GUI form or read the file from the MMC through the file handling system in the mobile. Then the data or file is going to be converted in the packets. Those packets are transmitted to the receiver controller through the body. At the time of reception the receiver controller receives the data from the body. The received data is decoded and if the data is information then it will send to the GUI and it will display on it. If the data is file then it is given to the file handing system and stored into the MMC.

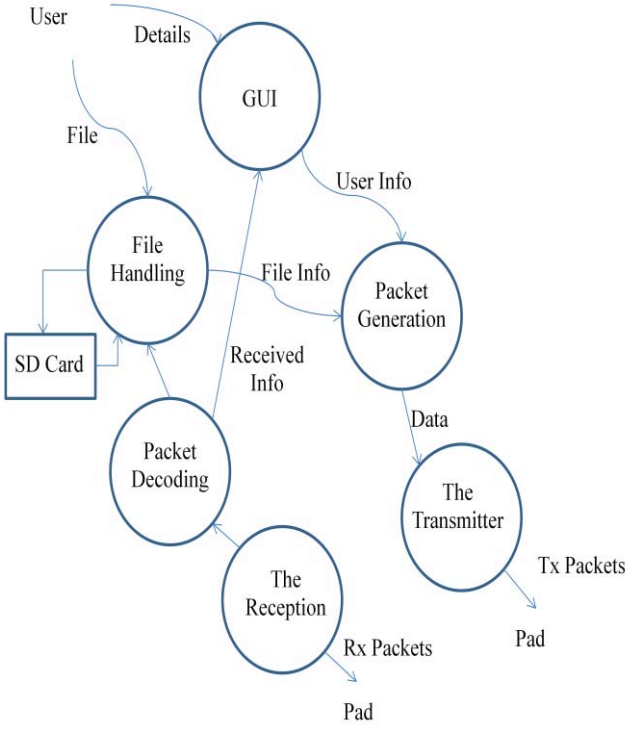

Fig. 4. Dataflow diagram for mobile side

b) Processor Side

Processor side the program is written into the embedded C language using keil software. In the processor side we have defined the data transmission from external bluetooth device to the touch pad and from touch pad to the external Bluetooth device. The mobile data will be received from UART 1 and the data transmitted to the touch pad from UART 0. The data will be transmitted using serial transmission protocol which is shown below in fig. 5.

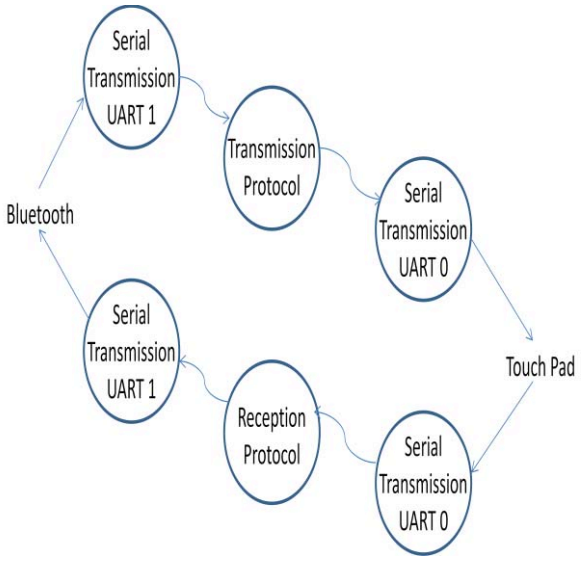

Fig. 5. Data flow diagram for Processor side

III. Result and Conclusion

By creating the GUI elements we can transmit the personal data or some file which is in the MMC. Give the data path of the file for the transmission of the file or fill the GUI data for the personal data transmission. First select the ConnectBT button to check for bluetooth availability if it is available then the connection is establish between the mobile device and the external hardware. Secondly select the ActiveTx, DeactiveTx, ActiveRX or DeactiveRX according to the data transmission mode whether you want Only reception or only transmission, or transceiver.

Here the data transmission is depends on the packet size of the data and the input output buffer size. Here we have developed the methodology f or the data of 255 byte. The probability of the reception of proper data is depends on the reference level of the amplifier. The distance between two mobile devices for the data transmission is depended on the amplification of the signal. We can transmit the data over the 9600 baud rate.

The main achievement of this methodology is by using only one wire (body) the full duplex transmission is possible. And the socking related problem is not possible because the whole system works on lower DC voltage.

IV. Future Abstraction

Here in this paper we have developed the external hardware to transmit the data from one mobile device to another mobile device. But in the future we can develop the mobile phone with this inbuilt facility. We can also provide some option for the data transmission and some security. The mobile devices will not transmit the data without user's prior permission. To transmit the data between two devices with the increase data rate and increased buffered size. This may also be expands to transmit the audio, video or image file.

REFERENCES

[1] T. G. Zimmerman, "Personal area network (PAN)," M.S. thesis, Media Lab., Massachusetts Inst. Technol., Cambridge, Mar. 1995.

[2] Mitsuru Shinagawa, Masaaki Fukumoto, Katsuyuki Ochiai, and Hakaru Kyuragi, "A Near-Field-Sensing Transceiver for Intrabody Communication Based on the Electro optic Effect," *IEEE Transactions On Instrumentation And Measurement*, vol. 53, no. 6, pp. 1533-1538, Dec. 2004.

[3] MirHojjat Seyedi,Behailu Kibret, Daniel T. H. Lai, and Michael Faulkner, Member, IEEE, "A Survey on Intrabody Communications for Body Area Network Applications," *IEEE Transactions On Biomedical Engineering*, vol. 60, no. 8, pp. 2067-2079, Aug. 2013.

[4] Maria Amparo Callej´on, David Naranjo-Hern´andez, Javier Reina-Tosina, and Laura M. Roa, "A Comprehensive Study into Intrabody Communication Measurements," *IEEE Transactions On Instrumentation And Measurement*, vol. 62, no. 9, pp. 2446-2455 Sep. 2013.

[5] M. S. Wegmueller, A. Kuhn, J. Froehlich, M. Oberle, N. Felber, N. Kuster, and W. Fichtner, " An attemp to model the human body as a communication channel," *IEEE Transactions On Instrumentation And Measurement*, vol. 54, no. 10, pp. 1851-1857, Oct. 2007.

[6] Y. Song, Q. Hao, K. Zhang, M. Wang, Y. Chu, and B. Kang, " The simmulation method of the galvanic intrabody communication with different signal transmission path," *IEEE Transactions On Instrumentation And Measurement*, vol. 60, no. 4, pp. 1257-1266, Apr. 2011.

[7] R. Xu, H. Zhu, and J. Yuan, "Electric-field intrabody communication channel modelling with finite element method," *IEEE Transactions on Instrumentation and Measurement*, vol. 58, no. 3, pp. 705-712, Mar. 2011.

[8] Z. Lucev, I. Krois, and M. Cifrek, "A capacitive intrabody communication channel from 100 kHz to 100 MHz," in Proc. *IEEE Instrum. Meas. Technol. Conf.*, May 2011, pp. 1-4.

[9] Ai-ichiro Sasaki, Mitsuru Shinagawa, Katsuyuki Ochiani, "Principles and Demostrastion of intrabody communication with a sensitive electro optic sensor," *IEEE Transactions on Instrumentation and Measurement*, vol. 58, no. 2, pp. 457-466, Feb. 2009.

[10] Brian W. Kernighan, Dennis M. Ritchie, The C programming Language, First Edition 1988, Prentice-Hall, ISBN 0-13-110370-9.

[11] http://www.cadsoftusa.coom/download-eagle/

[11] Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4thEdition, Prentice-Hall.

[12] Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 10thEdition, Prentice-Hall.