An Energy Efficient, Reduced Interference Interaction System using ZigBee

Allin Joe D[1], Karthikumar R[2], Pavithra P[3]

[1] *Assistant Professor, Department of ECE, Kumaraguru College of Technology, Coimbatore, India*
[2] *Assistant Professor, Department of ECE, Kumaraguru College of Technology, Coimbatore, India*
[3] *Assistant Professor, Department of ECE, Kumaraguru College of Technology, Coimbatore, India*

ABSTRACT

In this paper, an interaction system that is more energy efficient with reduced interference is designed. It visualizes the data entered in the touch screen and transfers it to the nodes and vice versa. Input is given by the user by using stylus in touch screen. A buffer is used in the touch screen to avoid loss of input data. The input data is processed by a personal computer which allows repossession of data and the processed data is allowed to pass through the ZigBee transceiver which transmits the data to a range of 100 meters. Addition and deletion of nodes is done by using their IP address which reduces the necessity for interference. ZigBee transceiver in the nodes receives the data transmitted by the personal computer and displays it. The nodes can interact with the personal computer which is very much suitable for the classroom environment. MATLAB programming is used to analyze the proposed system.

Keyword : - *touch screen, ZigBee, SC-FDMA, MATLAB, and PAPR.*

1. INTRODUCTION

Interaction technology is the imperative module in all the recent era of technologies. Human computer interaction involves efficient interaction between users and computers [1]. Li -Chien Huang, Hong Chan Chang, Cheng Chung Chen and Cheng Chien Kuob have proposed a ZigBee based monitoring and security system. In their work, they proposed that ZigBee could form huge networks which will be the efficient for monitoring and security system [2]. A ZigBee network can bond over 65,000 nodes at a time. K.Kawamoto, Y.Shimoda and M.Mizuno have analyzed the energy reduction potential of office utensils, power management, energy and buildings in their work [3]. They constructed a structure with a little cost and huge performance microcontroller, IC, ZigBee and GPRS. It avoids unforeseen trouble caused by overloading or overheating. This system will augment the safety of buildings. They concluded that the touch screen technology in accumulation with the ZigBee can be more energy effective and reduces interference. G.Song, F.Ding, W.Zhang and A.Song have anticipated a wireless power outlet scheme for smart homes [4]. In their work, they used ZigBee to improve the energy efficiency. In ZigBee, based on the transmission power the successful transmission distance between nodes is determined. At present, the transmission distance of ZigBee is about 100m under hindrance free circumstances. ZigBee can retain the network structure as tree or mesh which efficiently triumph over the issues of transmission along long distance.

The organization of this paper is as follows. The next section represents the proposed system model and involves in the description of each blocks in system model. The performance of the proposed system with a dialogue of the issues that needs to be addressed for recounting the energy efficiency and reduced interference of the design is noted in Section 3. Section 4 summarizes the foremost conclusions of this paper. The concluding section provides the future directions of exploration of this paper.

2. SYSTEM MODEL

The proposed system model of an improved energy efficient, reduced interference interaction technology using ZigBee is shown in Fig -1. It`s transmitter section is shown in the left side of the system model and its receiver section is shown in the right side of the system model.

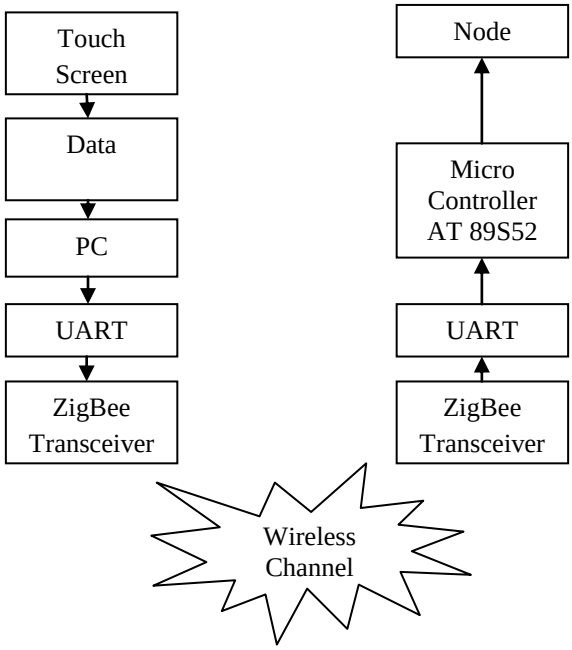

Fig -1: System Model

2.1 Touch Screen

The input of the proposed system is through a touch screen by a stylus [5]. A touch screen is an electronic visual display that can speck the place of a touch within the display area. It enables the user to interact directly with the display screen [6].

2.2 Data Buffer

Data buffer stores the input data in the touch screen and sends it to the PC for processing. It controls the movement of data from touch screen to PC. The data buffer must have the utmost capacity to store the entered data until it is processed and hence the loss of data will be avoided [7].

2.3 Personal Computer (PC)

PC is used for the assignment of nodes. It has memory storage for the recovery of data in future. The nodes are assigned according to their IP address. By opening the application in the PC, we need to enter the IP address of the node which needs to constitute the system. After entering the IP address of the node, it will be associated to the system. This improves the security of the system. The nodes can be disconnected by selecting the nodes and click "Delete".

2.4 Universal Asynchronous Receiver/Transmitter (UART)

Serial communication of digital data is more cost efficient than parallel transmission. UART is used to interface the peripheral devices in the system which will provide the intermediary data communication. It converts the transmitted digital data between its serial and parallel type as required by the consumer [8].

2.5 ZigBee Transceiver

ZigBee module forms the core of the proposed system. ZigBee is used for the small range and low power interaction technologies. The multiple access scheme used by ZigBee will require about half the power of ZigBee module. Hence a more energy efficient multiple access schemes should be used to drop off the power consumption. ZigBee design is suitable to create personal area networks and higher level protocols. ZigBee devices require low power but

it can be able to transmit the data over longer distances by creating a mesh network. Since it does not have need of any central node for the control of communication, it requires less power [9]. ZigBee transceiver is used in secure networking applications that have need of low data rate and long battery life. It has a distinct rate of 250 kbit/s, best suited for a single signal transmission from a sensor or input device. The ZigBee technology is simpler and less expensive. ZigBee networks are secured by a 128 bit encryption key [10]. ZigBee uses Direct Sequence Spread Spectrum (DSSS) to decrease the interference while propagation. In addition, it uses Carrier Sense Multiple Access Collision Avoidance/Channel Access mechanism (CSMA/CA), dynamic frequency selection and transmission power control to avoid channel collision. OFDMA and SC–FDMA multiple access schemes are used in ZigBee [11].

2.6 Subcarrier Mapping

The scalable bandwidth used in the ZigBee model is about 2.405-2.480 GHZ. In ZigBee, 16 channels are used for data communication. The data symbols from the N point DFT output are mapped into M number of subcarriers (M>N) after serial to parallel data switch. Power efficiency is crucial for ZigBee transceivers since they have a small number of energy resources. The maximum average amount of power required is designed by using PAPR value. The PAPR value is intended by demonstrating a CCDF (Complementary Cumulative Distribution Function) of PAPR. The CCDF of PAPR is defined as the probability that the PAPR is higher than a certain PAPR value (PAPR0) and it is denoted by the term Pr (PAPR>PAPR0).

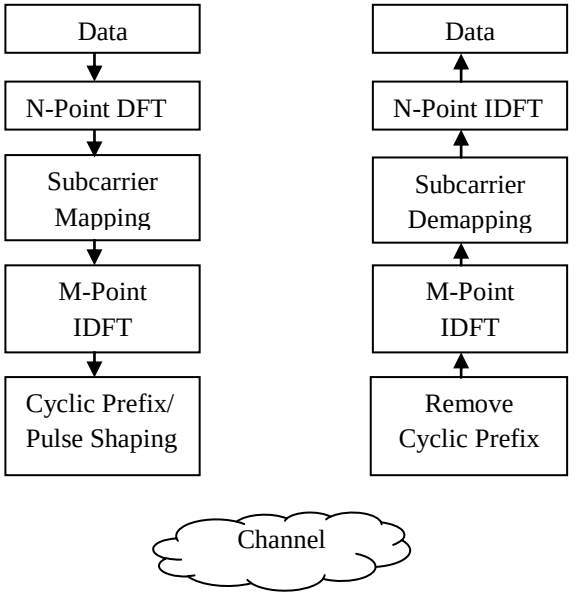

Fig -2: SC–FDMA Architecture

Without this subcarrier mapping, there will be no oversampling in the signal. If there is no oversampling, aliasing effect is introduced in the signal and distorts the signal, when it is passed through the digital to analog converter. Oversampling is introduced in the symbols by adding a number of zeros to the input data i.e. subcarrier mapping in SC–FDMA. In SC–FDMA, to minimize the PAPR value, the symbols are mapped to subcarriers, which mean that the power is spread along the subcarriers. The subcarrier mapping allocates N point DFT output complex values as the amplitude of some of the selected subcarriers based on the type of subcarrier mapping to increase the N length block to M length block. The SC-FDMA architecture is shown in Fig -2. There are three types of subcarrier mapping used in SC–FDMA.

2.6.1 Localized Mapping (LFDMA)

The DFT output complex values are mapped to a subset of successive subcarriers thereby comprising them to a fraction of the system bandwidth i.e. localized either at the beginning or middle or end of the bandwidth and allocating the other subcarriers as zero.

2.6.2 Distributed Mapping (DFDMA)

The DFT output complex values are mapped to the whole system bandwidth in an uneven approach. The length of the zeros added between each DFT output complex value is not equal. Hence a complex pulse shaping filter is required. Using distributed mapping, the power of the system is distributed to the subcarriers and so the PAPR value is decreased.

2.6.3 Interleaved Mapping (IFDMA)

IFDMA is considered as an exceptional class of DFDMA. The DFT output complex values are mapped to the whole system bandwidth in a equally spaced method. The length of the zeros added between each DFT output complex value is equal. This scheme combines the advantages of spread–spectrum and multicarrier transmission. It has high performance in wireless mobile communication due to its low PAPR value along with all the other subcarrier mapping schemes of SC–FDMA.

2.6.4 Orthogonal Frequency Division Multiple Access (OFDMA)

OFDM modulation of ZigBee addresses high PAPR and produces phase and carrier offset. OFDMA does not consist of the DFT processing unit of SC–FDMA. The data symbols N are divided into M subcarriers by passing through a serial to parallel converter and the data rate on each M subcarrier is N/M symbols. The input data stream on each carrier is then mapped by a modulation scheme. Then IDFT is used to find the corresponding time wave form. The output is M time samples.

After subcarrier mapping, cyclic prefix is added at the transmitted signal to avoid Inter Symbol Interference (ISI). It uses a frequency domain equalization and IDFT at the receiver. Data detection is performed in the time domain after IDFT operation [12].

2.7 MICROCONTROLLER

Microcontroller AT89S52 is used for automatically controlling the transmission and reception in nodes. It is a low power, high performance CMOS 8-bit microcontroller with 8 Kilobytes of programmable flash memory [13]. The microcontroller controls the duplex transmission in nodes.

3. PERFORMANCE ANALYSIS

The proposed system is implemented in hardware and analyzed using MATLAB software. The comparison of subcarrier mapping schemes is shown in Fig -3.

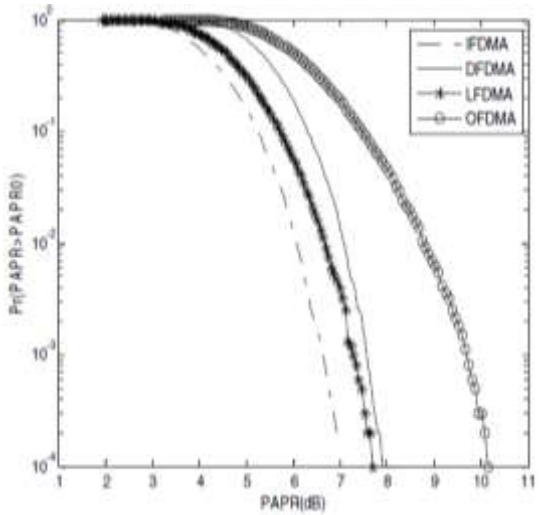

Fig -3: Comparison of Subcarrier Mapping Schemes

ZigBee module forms the central part of the system. The subcarrier mapping requires almost half of the total power. Hence the subcarrier mapping schemes used in ZigBee standard are compared to discover the more energy efficient subcarrier mapping scheme. OFDMA has the higher PAPR value and so it is not suitable for the ZigBee module since it must be more energy efficient for long-lasting battery life. Comparing to SC–FDMA, OFDMA has the higher PAPR value than all the SC–FDMA subcarrier mapping schemes. DFDMA has the higher PAPR value among all the subcarrier mapping schemes of SC–FDMA. LFDMA has closer PAPR value with DFDMA. IFDMA has the lower PAPR value among all the subcarrier mapping schemes. Hence IFDMA subcarrier mapping scheme is used in the ZigBee module to improve the energy efficiency.

The system is powered up and the data is entered in touch screen. The entered data is then stored in data buffer and then processed in PC. The node assignment is done in PC. Using PC the nodes are assigned by using their IP address and only the assigned nodes can be able to access the system. All the unassigned nodes are unable to access the system which improves the security of the system and also reduces the chance for interference from the adjacent systems. The system is made secure by using a 128 bit key for the encryption of data. The data is then transmitted to the receiver using a ZigBee transceiver. The ZigBee module is made energy efficient by using IFDMA subcarrier mapping in SC–FDMA. The power consumption of various subcarrier mapping schemes used in the ZigBee module is compared and it is inferred that using IFDMA subcarrier mapping scheme will enhance the energy efficiency of the system.

4. CONCLUSION

The improved energy efficient and reduced interference interaction technology is implemented using ZigBee module. Assignment of nodes improves the security of the system by reducing the interference from adjacent ZigBee modules. IFDMA subcarrier mapping scheme is used within the ZigBee module since it is more energy efficient. Microcontroller controls the transmission and reception to make duplex transmission in nodes a reality. ZigBee transceiver transmission is within a range of 100 meters. Hence it is used for short range applications.

5. REFERENCES

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BIOGRAPHIES

	Mr. D. Allin Joe was born in Kanyakumari, Tamilnadu, India, on May, 1990. His research interests include Antenna Design and Wireless Communication. He has published 6 research papers in International and National journals. He was awarded Amateur Wireless Station License, Grade-RESTRICTED issued by Ministry of Communications and IT, Government of INDIA, 2015. BEC Vantage certificate was awarded to him by University of Cambridge, United Kingdom. He was awarded Young Achiever Award 2016 by Institute for Exploring Advances in Science & Engineering (IEAE).
	Mr. R.Karthi Kumar was born in Paramakudi, Tamilnadu, India, on June, 1990. His research interests include Digital VLSI Circuit Design. He has published 6 research papers in International and National Conferences. He was awarded Amateur Wireless Station License, Grade-RESTRICTED issued by Ministry of Communications and IT, Government of INDIA, 2015. BEC Vantage certificate was awarded to him by University of Cambridge, United Kingdom.
	Ms. P. Pavithra was born in Tamilnadu, India, on June, 1988. Her research interests include RF, Microwave and Dispersion Compensation in fiber optic communication. She has published 7 research papers in International and National journals. She received Young Investigator Award from Interscience Research Network in 2013 and Best Paper Award from Anna University, Coimbatore campus in 2013 for her contribution towards dispersion compensation using delay line filter in fiber optic communication.