Switching Based Cognitive Data Transmission Using Wi-Fi and ZigBee

Nalluri Sravani, P.Vijaya Kumar

Abstract— The project focuses on the development of wireless communication network providing more than one wireless interface with the help of wireless devices. As a primary wireless interface Wi-Fi module is used and ZigBee module as secondary wireless interface. This system is implemented using Arduino Ethernet Microcontroller with the help of Arduino platform. Co-existence of both Wi-Fi and ZigBee technologies in the same device is determined and developed and the switching mechanism is implemented between Wi-Fi and ZigBee modules in order to improve the communication performance and also to improve the quality of transmission by avoiding loss of connections and to achieve significantly high reliability and robustness than the communication network with only one wireless interface.

Index Terms— Prototyping platforms, embedded systems, wireless communications, switching mechanisms, Co-existence

1 Introduction

Now a day, wireless communication devices are very well advanced for better functioning with high bandwidth. Flow of information is very important for regulating and controlling systems for production. Disturbance in the data flow can leads to interruptions and process delays. Wired devices produce high quality data transfer. Mainly the manufacturing industries relay on wired communication for higher bandwidth and reliable data transmission [2]. However, it is having disadvantages like lower mobility, complex installation, expensive and time consuming maintenance. If a production system is covered partly, contact wear or cable breaks can interrupts individual processes or lead to production stops in the worst case. Additionally the lack of flexibility of wired solutions is often problematic. If a manufacturing or production facility needs to be rebuilt or expanded, all cables must be adjusted or tightened, causing a high level of complexity and additional costs evaluation of technologies has driven sensor networks consists of a collection of wirelessly interconnected sensors, each of which is embedded with sensing, computing and communication components [2]. Availability, reliability and security of wireless solutions in production environments are one reason for the hesitation of the industry to invest so far in wireless technologies. However, the advanced wireless technology can produce higher bandwidth, mobility, cost effective, easy installation and better functioning. So, the industries can invest in this technology for better results.

- *N. Sravani is currently pursuing masters degree program in Embedded systems in SRM University, India. E-mail: Sravani.nalluri1@gmail.com*

In this paper section I give a brief introduction of the paper and section II relates to the previous work done. System architecture and description is viewed in section III.Prototype and test results are described in section IV.

2 Previous Work

To improve the performance of communication in industrial environment, several approaches have been made. Few years before some research have been conducted to study co-located interfaces to assist Wi-Fi transmission. Blue-Fi uses the co-located Bluetooth only to predict the availability of Wi-Fi connectivity [3]. Similarly, ZiFi has been developed and utilizes ZigBee to identify the existence of Wi-Fi networks and to coordinate the communication activities of Wi-Fi to reduce contention and collision [4]. A new development of wireless communication devices providing more than one wireless interface is developed due to the fact that there is no co-existence [7][8] of multiple wireless interfaces in the same device.

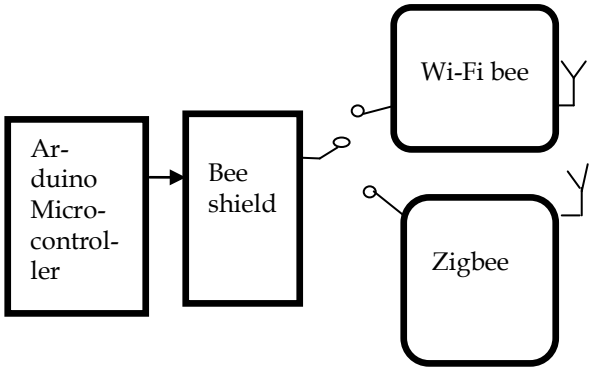
3 System Description

A. System Architecture

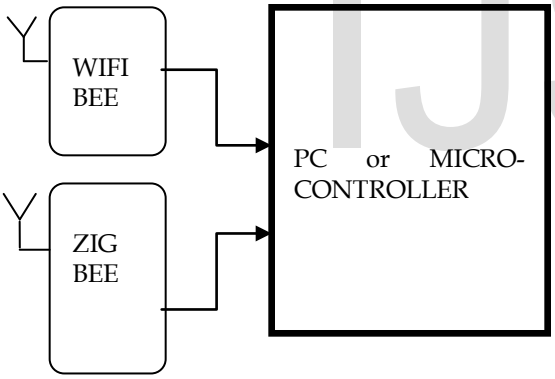
The architecture consists of a Arduino microcontroller, an extended interface bee shield and two different modules ZigBee and Wi-Fi to send and receive data [5]. The flow of data performs from one end to other end in different stages. When the data is ready in the microcontroller board then it transfers the data from microcontroller board to bee shield. Basing on the size of the data and depending upon the application the data will be redirected to either Wi-Fi bee module or ZigBee module. If the size of the data is higher than the data will be redirected to Wi-Fi module. If the size of the data is less, then the data will be redirected to ZigBee module. Quality of service is

also an important factor based on which switching mechanism can takes place. For specified data Wi-Fi module is better when compared to the ZigBee module and vice versa [5]. Each and every module will be discussed in detail in the form of flowchart. The flow chart explains the flow of data from one end to other end explaining the processes carrying out in between the networking devices.

The design and implemented communication interfaces serve the real time inspection of their connections and avoid a connection loss by using intelligent switching mechanisms between available wireless interfaces.



A) Transmitter Section



B) Receiver Section

Fig 1: System Description

The diagram of the proposed communication system is shown in fig 1 and consists of communication system which is composed of Arduino microcontroller and bees shield for extension purpose and two wireless interfaces Wi-Fi and ZigBee modules.

There are demanding requirements of communications in industrial environments. Designing objectives are

[1] Reliability: The designing must have a high reliability and the connectivity to ensure communication ability between all network devices despite the issues that the industrial space presents.

[2] Energy Efficiency: The design and installed modules should decrease the power consumption. Wireless devices Operate on batteries to guaranty the mobility and the energy must be saved.

[3] Throughput: The design should reduce the contention among the nodes there by the throughput [6] can be increased.

[4] Robustness: The system should have the capability to cope up with the errors during transmission as well as in the reception .It should operate continuously despite of any fluctuations in the transmission, abnormalities in the input side. All these factors has to be minimized in order to achieve quality of transmission without any errors [1].

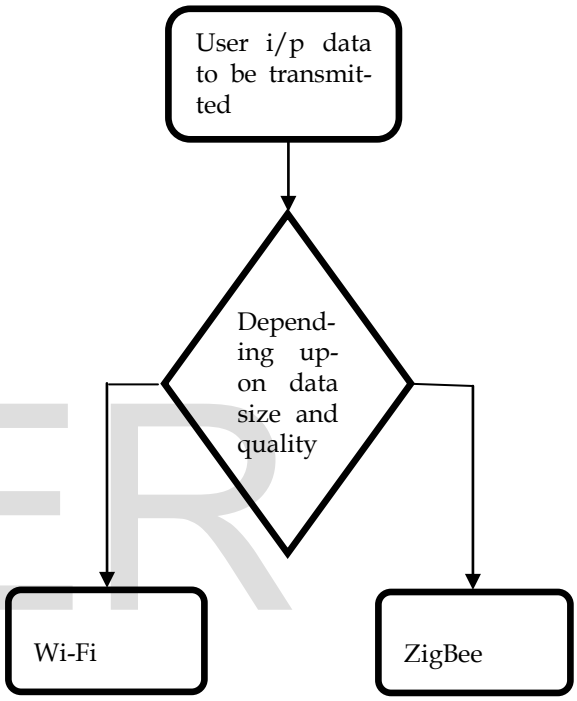


Fig.2: Transmission Flowchart

The above flowchart is a Transmission flowchart, which acts as the starting point and also as a sender that helps to transmit the data. In this flowchart, the data which will be in different formats transferred to the other end by using either Wi-Fi or ZigBee present in the transmission end. The module in the Transmission end will be selected depending upon the application and quality of service. If the size of the data is more then it will go to Wi-Fi otherwise the data will be transmitted using ZigBee.There by a coexisted [9] system is developed with two wireless interfaces. As a primary wireless technology small sizes Wi-Fi modules were used .Low cost, low power and long battery life are some of the reasons for using ZigBee modules as second wireless interface, which is suitable for building low power, low maintenance and self-organizing wireless networks [1]. The below flowchart is a Reception flowchart, which acts as the ending point and also as a receiver that helps to receive the data.

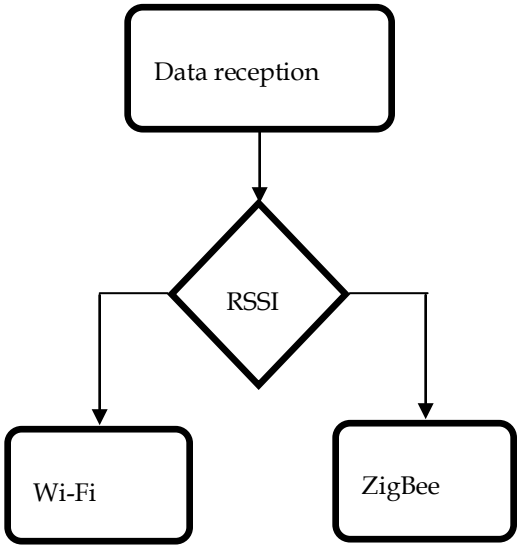


Fig.3: Receiver Flowchart

The data transmission in the Receiver flowchart explained above. In this flowchart, the data reception will transfer the data to either Wi-Fi or ZigBee with help of RSSI. By combining both the flowcharts, data transmission was clearly understandable.

4 PROTOTYPE AND TEST

A) System Prototype

To prove the concept, prototype was implemented. The prototype consists of hardware components described below for the development of communication system

1) Arduino Ethernet:

Arduino is an open-source physical computing platform based on a simple I/O board and a development environment that implements the processing/writing language.

i. Microcontroller (AT-mega 328) used for processing and calculations.
ii. It consists of an Ethernet interface (RJ-45) used for wired communications.
iii. Having a USB to serial converter which is used for programming the microcontroller.
iv. An on-board micro SD card reader, which can be used to store files for serving over the network, and is accessible through the SD Library.

2) Bee shield:

It is an interfacing device, acts as an extension for the Arduino platform. It is a multiple interfaces board and can be connected by two modules at a time; it has a large prototyping area and a customizable software serial port for easier prototyping

3) Wi-Fi module:

It acts as one of the wireless transmission interface to the prototype with a data transfer based on 802.11 a/b/g standard. It is an XBee Pro socket compatible outlook makes it very easy to integrate in the bees shield.

4) ZigBee module:

It is also a wireless data transfer interface and one of the module in the prototype based on 802.15.4 standard.

In the prototype we are using consists of two wireless interfacing devices. They are Wi-Fi and ZigBee. As a primary wireless technology small Wi-Fi modules were used. Low cost, low power and long battery life are some reasons for using ZigBee modules as a second wireless technology, which is suitable for building low power, low maintenance and self-organizing wireless networks. Following table 1 illustrates properties of selected wireless technologies.

TABLE 1[1]
Properties of Wi-Fi and ZigBee protocols

	WLAN	**ZigBee**
IEEE Specification	802.11 a/b/g/n	802.15.4
Bandwidth	11/54/150 Mbps	20, 40, 250 Kbps
Range	30-100 meters	70-300 meters
Network Topology	Ad-hoc, BSS, ESS	Ad-hoc, star, mesh cluster tree
No of nodes	2007	65000
Operating Frequency	2.4 and 5 GHz	868 MHz,900-928 MHz, 2.4 GHz
Complexity	Very high	Very low
Power Consumption (Battery life)	High	Very low
Autonomy	Hours	Years
Duty cycle	Device connection requires 3-5 sec	Devices can join an existing network in under 30ms
Typical Applications	Wireless LAN connectivity, broadband internet access	Industrial control and monitoring, sensor networks, building automation, home control and automation

B) TEST

By using all the components of the prototype, the results are generated for effective data transmission and reception by Wi-Fi and ZigBee. With the help of Arduino software, the program can be written in the interface of the software and can be complied from the pc.

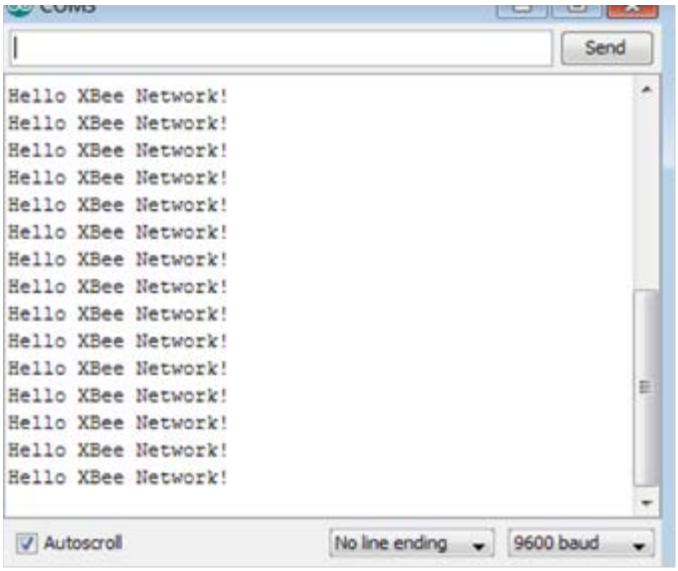


Fig.4: Arduino serial monitor

When ZigBee is selected as wireless interface for data transmission and reception over point to point is done by two xbees. It can be represented with the test results carried out.

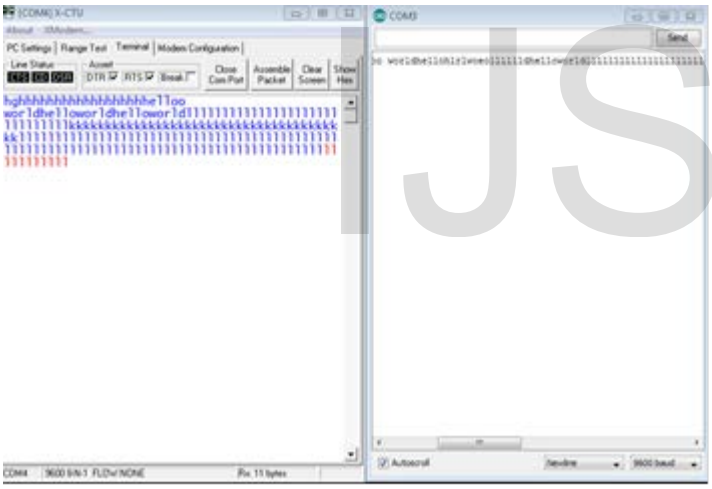


Fig.5: Data transmission with ZigBee

When WiFi is selected as a wireless interface then the data will be transmitted from the both sides and it can be represented as follows

Fig.6: Data Transmission with WiFi

5 REFERENCES

[1] Z.Ghraihn,A.Hribernik,"Intelligent wireless communication devices for efficient data transfer and machine control" EXPLORE.IEEE PROJECTS.COM,2012

[2] A.Hribernik, Z.Ghraihn, C.Hans,, K.D.Thoben, "Co-creating the Internet of Things -First Experiences in the Participatory Design of Intelligent Products with Arduino," in Proc. IEEE 17th International Conference on Concurrent Enterprising (ICE 2011), pp. 301-310

[3] G.Ananthanarayanan and I. Stoica, "Blue-Fi: Enhancing Wi-Fi

[4] Performance using Bluetooth signals," MobiSys, 2009.

[5] R. Zhou, Y.Xiong, G.Xing, L.Sun, and J.Ma, "ZiFi: Wireless LAN Discovery via ZigBee Interference Signatures," MobiCom '10

[6] J.Lee, Y.Su, and C.ShenA, "Comparative Study of WirelessProtocols: Bluetooth, UWB, ZigBee, and Wi-Fi," the 33rd AnnualConference of the IEEE Industrial Electronics Society (IECON), 2007

[7] Vehbi C.Gungor and Gerhard P.Hancke, ''Industrial Wireless Sensor Networks: Challenges,Design Principles, and Technical Approaches," IEEE Transactions on Industrial Electronics ,Vol.56,October 2009

[8] Federico Dominguez, Abdellah Touhafi, Jelmer Tiete and Kris Steenhaut, "Coexistence with Wi-Fi for a Home Automation Zigbee Product," © 2012 IEEE

[9] TingHan, BingjunHan, Ling Zhang, Xin ZhangDachengYang, "Coexistence Study for Zigbee and Wi-Fi under Smart Phone Scenarios," © 2012 IEEE.

[10] Yue Tao, Xiang-Yang Li, Cheng Bo, "Performance of Coexisted Wi-Fi and ZigBee Networks,"33rd International Conference on Distributed Computing Systems Workshops2013 IEEE