Zigbee-Based Generic Wireless Data Acquistion System

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***Abstract*—Through the past three decades, the world has seen major changes in the technologies. There has been some remarkable aspects to the rapid growth in wireless technologies and engineers across many disciplines are becoming interested in wireless communication, However, the introduction of Zigbee technology has made wireless technology more challenging for various use ranging from home automation to sensor networking such as lightning, heating etc.**

Keywords—Communication, Coordinator, End Device, Router, Wireless sensor Network, Zigbee

I. INTRODUCTION

Probably one of the most fascinating technologies in industry today is the wireless technology. Over the past few years the world is using more of wireless technology. Discovering of moving data wirelessly has been a major challenge in many industries around the world and there are a lot of developments in wireless technologies and most industries nowadays venture into this technology basically because of the reduced cost of hardware, low power supply, easy installation, simpler engineering, reduction in material needed and most importantly, good delivery of data.
There are some few wireless technology that can be used to achieve this, but the most recent low power supply, cheap and reliable wireless technology is called Zigbee. Zigbee is a next generation wireless technology and it provides two or more way communication link between devices[1],[2],[6]
Zigbee technology standard is built on IEEE 802.15.4 specification and IEEE is the world leading professional association for the advancement of technology. The Important features of zigbee wireless technology allow all the smart energy products based on zigbee to be easily installed, low energy consumption, in built intelligence and less expensive.
Zigbee improves the functionality of wireless technology by offering a very simple widen network topologies with an incorporated system and routing intelligence to make it possible for simple setting up and high flexibility to malfunction.
Other important characteristics of zigbee wireless technology also permit all the smart energy products based on zigbee to be in power saving mode when it is not used. That means, devices attached to zigbee like sensors can be powered and this make them self controlled and lessen the installation costs. [4]

Various wireless technologies emerged like WIFI, Bluetooth, Infrared, WiMaX and Zigbee. The reason why zigbee technology is more interesting when compared to other wireless technology is because zigbee was developed to serve set of industries, residential, medical, and general automation and control.

A. Research focus

This research focuses on generic wireless data acquisition system based on zigbee sensor and zigbee controllers which was built using jennic JN5121 IEEE802.15.4/Zigbee modules, JN5121-Z01-M00.

II. ZigBee Technology:

Zigbee technology is a low rate wireless connection developed to provide set of industrial, residential, and medical application with very low power consumption, low cost requirement, and comfortable needs for data rate and quality of service. Zigbee technology is designed to provide inexpensive and low power connectivity for devices that need battery life for months to years but does not require data transfer rates as high as those enabled by Bluetooth.
Zigbee wireless devices are likely to transmit between for about 12-75 minutes and this depend on the RF environment and output power consumption needed for a given function and it operates at 2.4GHz. [9]
Zigbee can be implemented in three ways of network topologies, viz

i. Mesh topology network.
ii. Star topology network, and
iii. Cluster tree topology

Zigbee frequently uses a simple master slave configuration appropriate for star, mesh and cluster tree network topologies. It allocates up to 250 nodes, when zigbee node is not used or in standby mode, it can power up or wake up and find packet in around 15msec [14] Zigbee architecture consist of different types of mechanisms. The most basic is the device. Zigbee devices can be in form of Full-Function Device (FFDs) which is capable of playing the role of a network coordinator or Reduced-Function Device (RFD). Full Function Device (FFDs) can talk to any other devices, while Reduced Function Device (RFD) can only talk to Full Function Device. (FFDs)
However, in a wireless network at least one of the Full-Function Device (FFDs) operating as the personal area network coordinator must be included. The Full Function Device (FFDs) can operate in three different ways: a central controller, a coordinator or a router. In case of Reduced Function Device (RFD) this is designed for applications that are very simple that do not required large amount of data.

III. Wireless Sensor Network:

Wired sensor networks have been around for quite a long time, but the recent development in science and technology especially in silicon radio chips have shown the way for the introduction of Wireless sensor network that produces low-cost effective chip consisting of transistors. The chips development around the world grows every time as technology advance and this led to the production of less expensive, low powered consumptio. In recent time, Wireless Sensor Networks have been boosted and received remarkable attention from both academia and industry because of its large range of possible applications for home automations, industrial automation, battlefield monitoring, and remotes systems.
Wireless sensor networks can be used with numerous different wireless technologies, such as Bluetooth, Zigbee and RF identification but Zigbee is the most recent technology with low data rate, short range wireless network whose radio mechanism could run several years on a single battery.
A wireless sensor network contains quite big figure of tiny sensor nodes that are closely positioned either within the phenomenon to be sensed or around it. Sensor nodes consist of sensing component, data processing and networking mechanism.
Usage of Wireless Sensor Networks: the primary areas in which wireless sensors are useful as follows.

i. Military Monitoring: sensor network is used for battlefield monitoring or surveillance. Sensor devices used to monitor the movement of vehicles, track down the enemy and to protect the equipments used in battlefield by attaching sensors to it.
ii. Building Monitoring: sensor networks used to monitor and control climate changes in buildings/industries. Thermostat and temperature sensor nodes are fixed inside the buildings vicinity and usually placed in strategic places. In addition, sensor can also used to observe quivering that can destroy building structure.
iii. Health Care: sensor used in biomedical application to improve the excellence health care being provided. Sensors are attached to part of human body in order to observe medical condition such as cancer and also help patients keep their health.
iv. Environment Monitoring: Wireless sensor used to observe environment changes. For instance, water pollution detection in a pond that is place close to factory that uses chemical substances. Sensor nodes are place in an unknown and hostile area. They also used for forest fire detection, rainfall surveillance in agriculture and air pollution.

IV. Experiment

The first step to establishing a wireless sensor network for simple automation using zigbee devices, is to have the hardware's and development software handy and using Mesh network topology.
The two boards (zigbee sensor boards) has in built temperature, humidity and light level sensors. The light level sensor act as a router.
In so doing the two operations are set up with one acting as a wireless End Device and the other as a wireless Coordinator.
With the help of a C code the End Device is able to read the measurement of the temperature/humidity and the light level in absolute values sensors and send them to the Coordinator wirelessly through RS232 link to a PC.
With the end device set up and able to send information there is need for the coordinator to be able to receive the data from it; calibrate them and send them to a local PC via the RS232 link.

V: Development tools:

The development consist of both hardware and software tools, of which the Hardware apparatus are Two zigbee sensor boards; a USB-to-Serial Converter; a 1.5volt Power supply and a personal computer/Laptop
The Fig 1–4 below shows the hardware equipments needed to establish a wireless sensor network for simple automation and The Fig 5 & 6 shows the software setup

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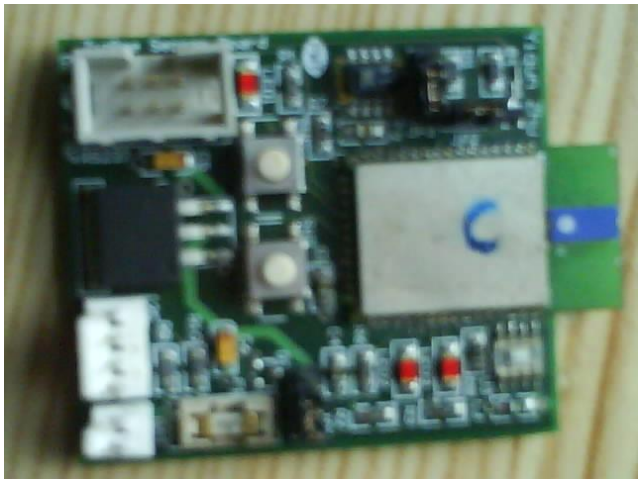

Fig 1 A zigbee sensor board Coordinator Device (Label C)

Fig 2 A zigbee sensor board Router Device (Label R)

The coordinator device can work as a controller or sensor board and the router device can be used to read data from the zigbee board which has a built in sensor and transmit the data to the coordinator device.

Fig 3 show the USB to serial converter to PC

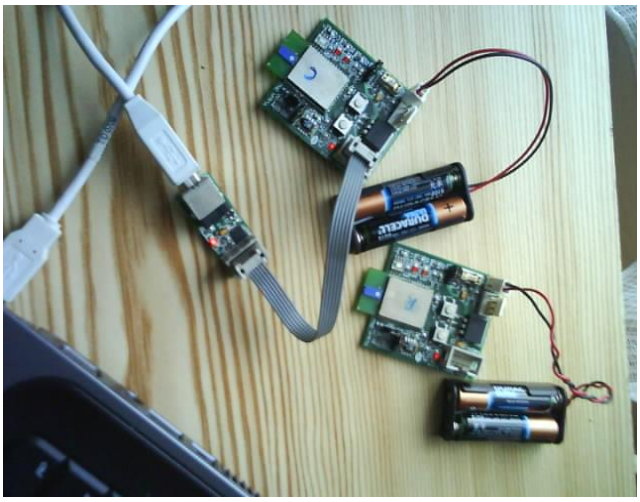

Fig 4 show the set up of component

The software used to achieve this tasks are Jennic JN-UG-3028 Code Block IDE and Jennic JN-UG 3007 Flash Programmer
The JN-AP 1015 Zigbee application sensor network for the software development is an all important software which helps in developing and modifying the C code .

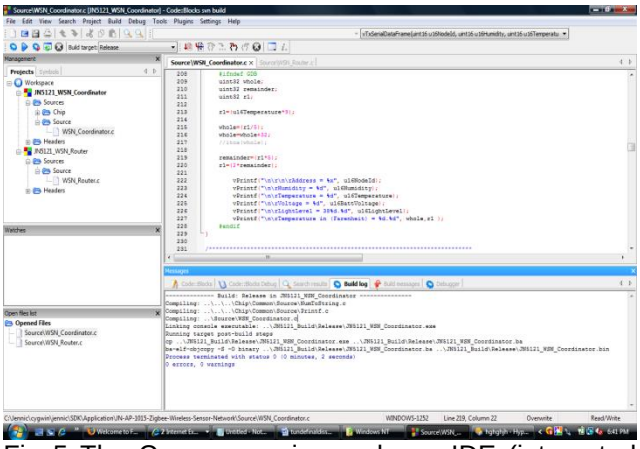

Fig 5 The C programming code on IDE (integrated development environment)

There are two programs needed, one for the coordinator and the other for the router. After the two C codes has been build and compile without any error, they will now be downloaded onto the two zigbee boards in order to see the output.
It will be observed that at the instance of Refresh the computer recognizes the type of device ready for download, the MAC address, device types and flash type will display down the bottom of the flash programmer. The following display for coordinator sensor board.

i. MAC address: 00 15 8d 00 00 00 47 b6
ii. Flash ST M25P 10-A (assumed)
iii. Device: JN5121r2
iv. COM Port (COM 4 used for this experiment)
v. Target (Detect Flash)

As soon as the display for the coordinator sensor is noted, then the progam can be downloaded unto the

zigbee boards, from the Fig 6 it can be seen that the green stream show the progress of the programs and the expected time to finish also display.

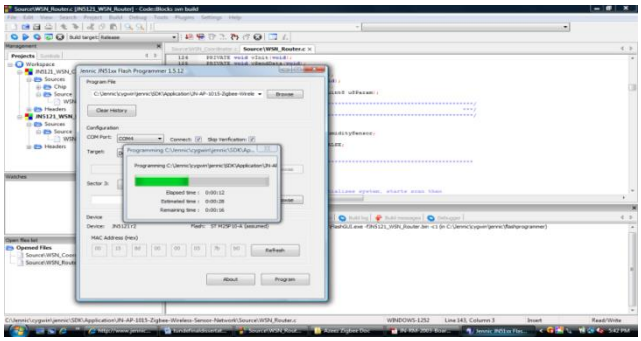

Fig 6: Progam downloaded unto the zigbee boards

The same method use for router sensor board is adapted, except for the MAC address that is changed.
The following display for router sensor board

i. MAC Address: 00 15 8d 00 00 05 7b b0
ii. Device JN5121r2
iii. Flash STM25P 10-A(assumed)

On completion of compilation and download, the whole apparatus needs to be disconnected before one can see the output of the programs downloaded on both coordinator sensor board and router sensor board using HyperTerminal. The HyperTerminal is set rolling by selecting a baud rate for this task is 19200 Bits per seconds. Fig 7 shows the port setting of the HyperTerminal

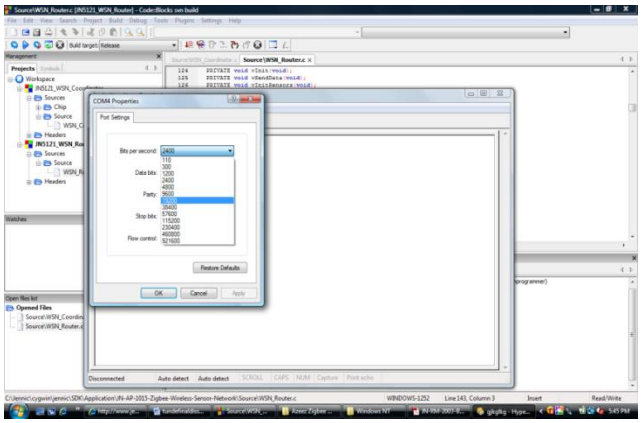

Fig 7 Port setting of the HyperTerminal

It is important to note the procedure to connect the cable; firstly, the router zigbee board is first powered up and thereafter the coordinator zigbee board is powered up too and finally, the USB-to-serial Converter is connected to the coordinator sensor board not the router sensor board. Now the button from the HyperTerminal can be clicked to display the output and our programs. The diplay of the result is normally as shown in fig 8

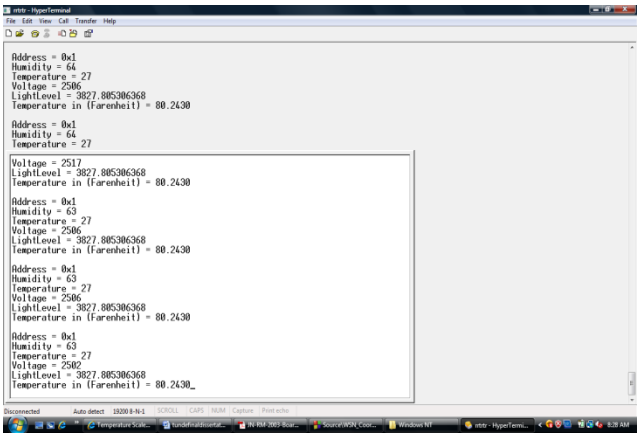

Fig 8 Diplay of communication Result

VI. Communiction Setup between the ZigBee boards

The communiction procedure between the two ZigBee board ie coordinator and The router; are just a modification of what has been done previously. The modification is aimed at using a button switch ON temperature, humidity and light via the serial port under I2C and display the result on a PC.
This is achieved by modifying the coordinator program and the router program so that I2C protocol would able to communicate with other devices.
The I2C bus has two similar ends but different applications. The first end is called SDA (Serial Data Line) and the second end is called SCL (Serial Clock Line), both work in two ways communication or direction and they have their own special address.
A code must be used in order to enable the I2C protocol to read the slave devices.
In the End device, one push button is used to switch between temperature, humidity and light. When the push button is pressed, the chosen parameter needs to be not only sent to the Co-ordinator via the I2C bus connection, but also sent to the OC via the serial port under name I2C data.
The Co-ordinator then sends the data received from I2C to the PC
Both values shown on the PC (one from the End Device and the other from the Co-ordinator) would be noticed as same.

VII. Communiction Setup for a LCD Controller Boards

This section includes a controller board that has LCD with the coordinator and router zigbee sensor boards. The zigbee sensor boards measure temperature, humidity and light levels, and this automatically send all the reading to the controller board to be displayed through LCD. The controller has in built LCD display and act as a coordinator, the other two sensor board act as Router and End Device. Three separate programming codes required to achieve this task. First is to write a End Device C Code to receive data from the 12C bus and send them wirelessly to the co-ordinator unit, secondly is to write another C code for router to receive data from the End Device and route

them to the Co-ordinator unit wirelessly and lastly writing a C code to receive data from the router/End Device units and send them to the 16Mbit serial flash memory rather than a local PC.

Finally, providing a menu interface using the push buttons and the 128*64 LCD screen provided with the Co-ordinator to view/delete data from the memory.
The output is thus seen on an on board LCD instead of HyperTerminal used previously.
The advantage of this controller is that it has a push button which can be used to select different parameters (temperature, Humidity and Light readings).

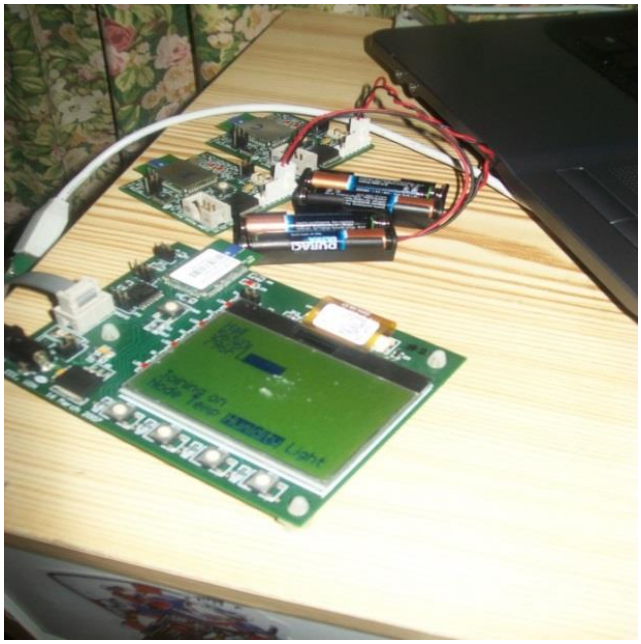

Fig 9 Controller Board showing the Humidity reading

VIII. ACKNOWLEDGEMENT

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IX. CONCLUSION

ZigBee-based generic wireless data acquistion system is a wireless technology that can be achieved in 3 basic ways depending on the purpose of need. With in built sensors the first posible way is to read all output via HyperTerminal on a Personal Computer; in so doing all parameters will be displayed.
The second possible way is to use a button to choose a desire parameter which can be temperature, humidity or light level via the serial port under I2C and display the result on a Personal Computer.
And lastly view desired parameter on the LCD Controller Boards

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