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WIRELESS DISPLAY USING ZIGBEE

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ABSTRACT

Wireless notice board using ZigBee is designed for applications such as displaying information at public places. Today in the fast life ZigBee is helping people to control various activities happening around them by saving energy and increasing the safety of where they live, work and play. The various reasons for using ZigBee are that apart from it being low-cost and low-power sensor, its standards-based wireless technology are designed in such a way to address the unique technology. The basic working of the project is to develop wireless free notice board which displays messages when sent from the PC within a certain range. For this purpose we use an XBee explorer which receives and retrieve data from the PC and sends it to ATMEGA16 who displays it on the Graphic LCD. The range of around 300-400m can be obtained.

KEYWORDS: ATMEGA16, Graphic LCD, XBEE, ZigBee

INTRODUCTION

The project explained here is developed around ATMEGA16 microcontroller working at 16 MHz from Atmel family which performs the functions like display, wireless control and creating different display effects for given image. The ZigBee module is interfaced with the PC is of Digi Company and operates at 2.4GHz. It uses regulated 5V, 1A power supply. 7805, a three terminal voltage regulator is also used for voltage regulation. The wireless notice board developed is an advanced hi-tech wireless notice board. The ZigBee used is based on Pan technology which can form a mesh network between nodes thus helping in increasing the range thus covering larger areas.

BLOCK DIAGRAM

The block diagram is studied in two parts: from the transmitter side and other form the receiver side. The block diagrams are further explained below.

Transmitter

ZigBee

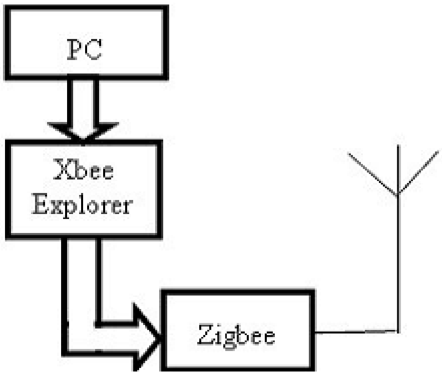
ZigBee is used for wireless communication. The data is then transmitted as it is from the ZigBee to another ZigBee in the receiver section. The baud rate is 115200.

PC

The data is in the form of an image. This image has to undergo few image processing techniques in order to get a final black and white image of 128 x 64 resolution. This is achieved with the help of MATLAB which is in the PC.

XBEE Explorer

An XBee Explorer provides the base for the ZigBee. The data from the PC is transmitted using COM PORT to the explorer and then to the ZigBee.



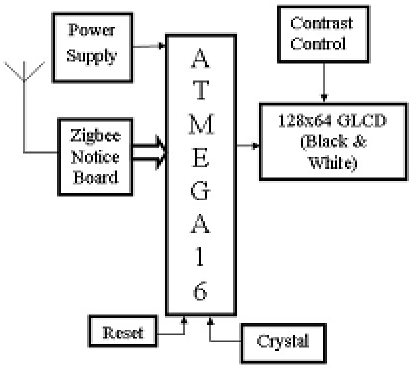


Figure 1: Transmitter Block Diagram **Figure 2: Receiver Block Diagram**

Receiver

Power Supply

Micro-controller needs power supply to operate. Thus the power supply provides 5 volts dc supply.

ZigBee

The receiver ZigBee accepts the data from the transmitting ZigBee and is given to the microcontroller ATMEGA16. For proper communication it is essential that both the ZigBee must be adjusted to the same baud rate i.e. 115200.

Microcontroller ATMEGA16

ATMEGA16 is a 16KB micro-controller. The data from the receiving ZigBee is given to the micro controller. The micro-controller decides whether to print white or black pixel on the GLCD depending on the data received.

128 X 64 GLCD (Black and White)

GLCD screen of 128x64 resolution is used to display the image that is being transmitted through the ZigBee. An exact replica of the original image should be obtained on GLCD if there is no disturbance in the communication path.

Rest and Crystal

The RESET pin is used to reset the controller. A 16MHz crystal oscillator is required by the controller to execute its operation.

Contrast Control

In order to adjust the brightness of the GLCD, contrast control is used. This contrast is achieved using a variable potentiometer.

WORKING OF ZIGBEE NOTICE BOARD

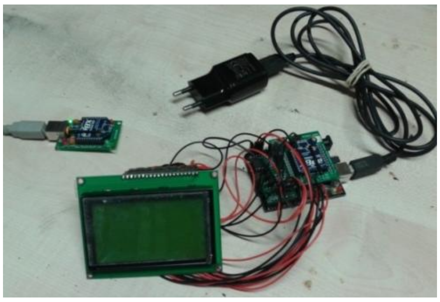


Figure 3: Project Hardware

The circuit at the receiver side consists of 16MHz crystal oscillator, ATMEGA16, GLCD, XBee Shield (on which the XBee is mounted). ATMEGA16 has a flash memory of 16KB and is operated with the help of the oscillator connected at pin 9 and 10 of the micro controller. A pull up resistor of 10KΩ is connected between the supply and pin no 1 of ATMEGA16 to prevent any damage to the micro-controller due to excessive current. A supply of +5 volts is given for the operation of the micro-controller. In order to receive the data and display it correctly on 128 x 64 pixel GLCD, an XBee shield is used, it's TX pin is connected to pin no 2 of the micro-controller while it's RX pin is connected to pin no 3.

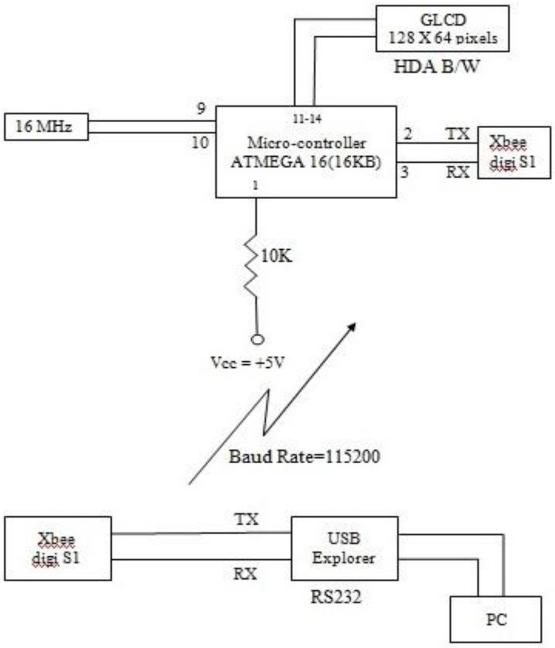


Figure 4: Circuit Diagram

The transmitter section includes a computer, USB explorer and an XBee. The MATLAB code reads the data which is in the form of an image and transmits the data via USB explorer. The explorer converts USB port to RS-232 for serial communication. The RX and the TX pins of the explorer are connected to the TX and the RX pins respectively of XBee for proper communication. The XBee in the transmitter as well as in the receiver section is operated at a baud rate of 115200 and PAN ID 31.

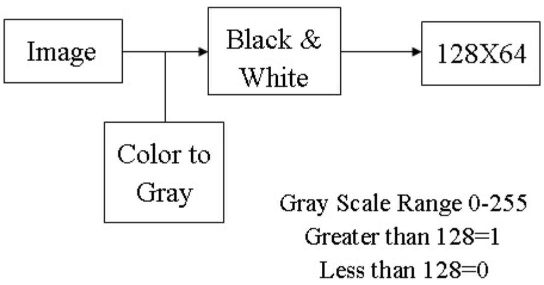


Figure 5: Image Color Conversion

The GLCD used is black and white GLCD; hence care should be taken in converting the colored image into black and white image. The colored image is first converted into gray scale image. Gray scale has 256 levels ranging from 0-255. This gray scale is then converted into Black and White image. Since black and white image has only two levels namely '0' (black) and '1' (white), values greater than or equal to 128 of gray scale is considered to be '1' (white) and values below 128 is considered to be '0' (black). Thus a colored image is converted into Black and White image. This image should be compatible with the GLCD therefore it has to be resized to 128x64 pixels. Finally a 128x64 resolution Black and White image is obtained.

The data used for transmission is in the form of an image. After performing few image processing techniques a 128x64 Black and White image is obtained, compatible with the GLCD. A MATLAB code is constructed for the image processing and for the serial transmission of the data. It is compiled first and then executed. During the execution of the code the pixels of the image is compared with logic 1 or logic 0 to determine a white or a black pixel respectively. If the first pixel corresponds to logic 0, then this value is given to the USB COM port which further sends it to the transmitting XBee. The XBee will transmit the data as it is to the receiving XBee. The data at the receiving XBee is given to the micro-controller. Now the micro-controller is coded in such a manner that when logic 0 is received it will print a black pixel and when logic 1 is received it will print a white pixel at the corresponding pixel value. This process occurs till the entire image has been read i.e. all the pixels have been transmitted. The transmitting XBee and receiving XBee operates at a baud rate of 115200. For a 128x64 image, total number of pixels to be transmitted and received is 128x64=8192 pixels. At a time only one pixel can be transmitted and these pixels are transmitted serially hence it is also known as serial communication.

FLOWCHART

The project includes two types of coding as explained below

FLOWCHART FOR ARDUINO PROGRAM

The flow chart to code the micro-controller is as follows: the process begins when the data is first received from an XBee. This received data is checked for logic 1 or logic 0. If the data received is logic 1 then it will print a white pixel at the corresponding pixel position on the GLCD, however if the data received is logic 0 then it will print a black pixel at the same pixel position. After printing a white or a black pixel, it will check for further data. This process goes on until the entire image has been transmitted. For a 128x64 image, total number of pixels to be received is 128x64=8192 pixels. After this since no new data is available, the execution stops and an exact replica of the image is printed on the GLCD.

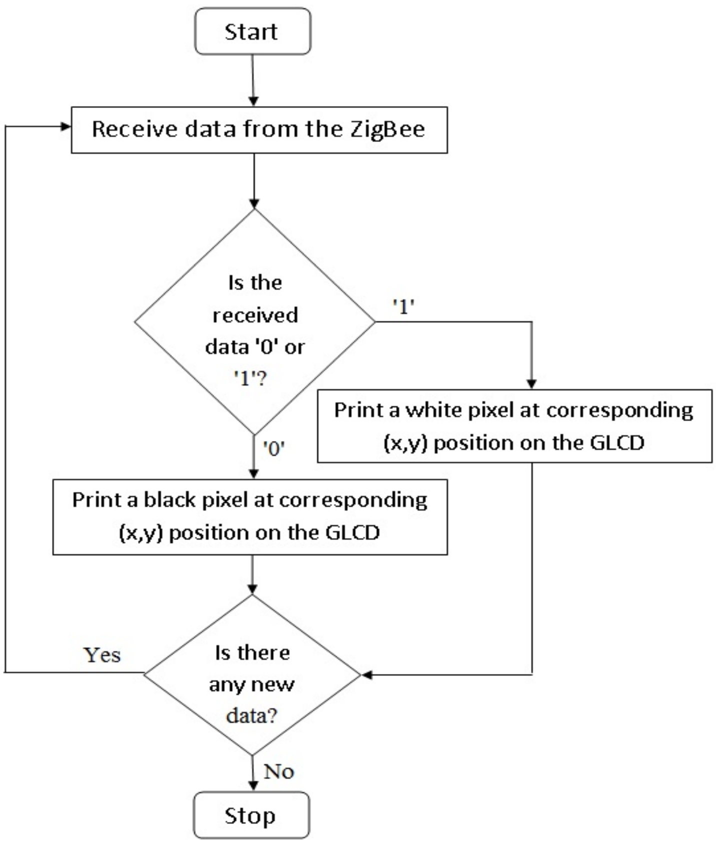


Figure 6: Flowchart for Arduino Program

FLOWCHART FOR MATLAB PROGRAM

The flowchart of MATLAB can be explained as follows: the process begins by reading an image. Since the GLCD used is Black and White, the color of the image should be checked. If the image is colored then it needs to be converted into grayscale and then into Black and White image by few image processing techniques. However if the image is originally in Black and White format then no conversion is needed. The size of the image must be compatible with the size of GLCD i.e. 128x64 pixels. After conversion if the size of the image is more than 128x64 then image should be shrunk and if the size is less than 128x64 then the image should be enlarged and be made equal to 128x64. However an image with 128x64 resolutions needs no processing and can be used directly for transmission. Thus a 128x64 Black and White image is transmitted serially. Further the program checks if the current image is the last image, if yes then the execution stops else the above process repeats.

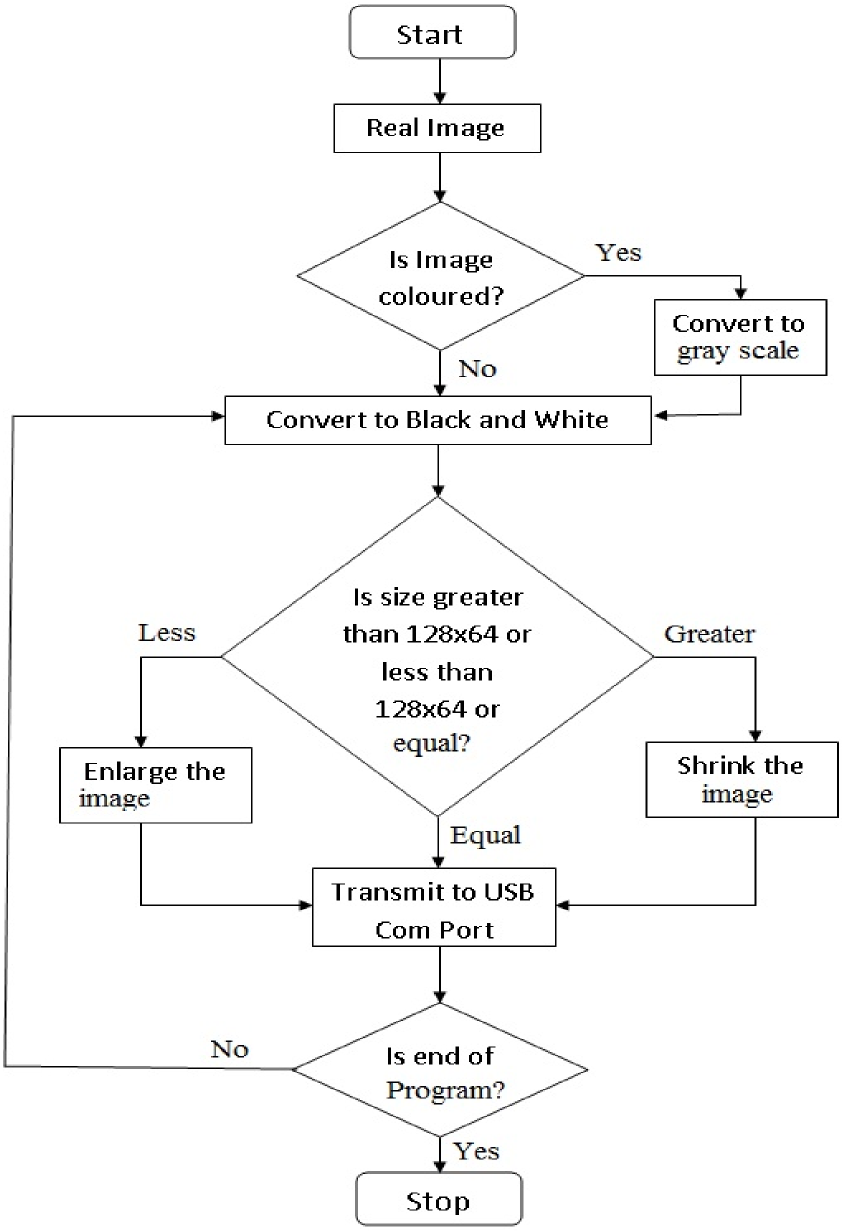


Figure 7: Flowchart for MATLAB Program

RESULTS

The result obtained when a colored or a black and white image is send are as shown below:

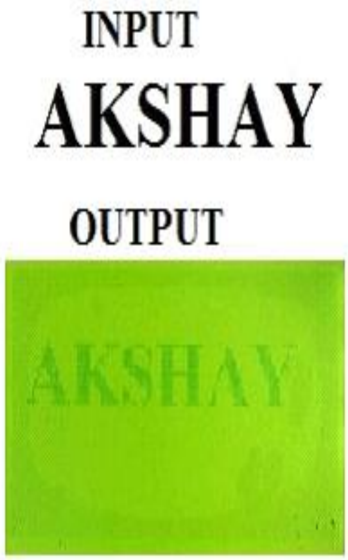


Figure 8: Output 1

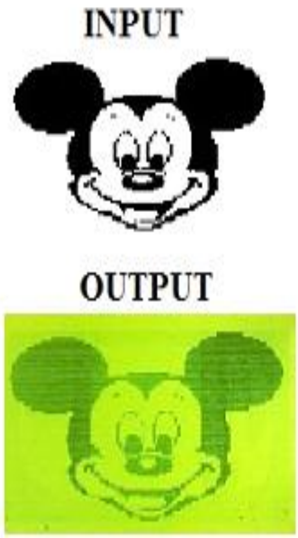


Figure 9: Output 2

Figure 10: Output 3

Figure 11: Output 4

COMPARISION BETWEEN VARIOUS WIRELESS TECHNOLOGIES

Bluetooth (over IEEE 802.15.1), ultra-wideband (UWB, over IEEE 802.15.3), ZigBee (over IEEE 802.15.4), and Wi-Fi (over IEEE 802.11) are four protocol standards for short range wireless communications with low power consumption.

From an application point of view, Bluetooth is intended for a cordless mouse, keyboard, and hands-free headset, UWB is oriented to high-bandwidth multimedia links, ZigBee is designed for reliable wirelessly networked monitoring and control networks, while Wi-Fi is directed at computer-to-computer connections as an extension or substitution of cabled networks.

Table 1: Comparision of the Bluetooth, UWB, ZigBee and Wi-Fi Protocol

Standard	Bluetooth	UWB	ZigBee	Wi-Fi
IEEE spec.	802.15.1	802.15.3a*	802.15.4	802.11a/b/g
Frequency band	2.4GHz	3.1-10.6GHz	868/915MHz; 2.4GHz	2.4GHz; 5GHz
Max signal rate	1 Mb/s	110 Mb/s	250 Kb/s	54 Mb/s
Nominal range	10 m	10 m	10 - 100 m	100 m
Nominal TX power	0-10 dBm	-41.3 dBm/MHz	(-25) - 0 dBm	15-20 dBm
Number of RF channels	79	(1-15)	1/10; 16	14(2.4 GHz)
Channel bandwidth	1 MHz	500 MHz-7.5 GHz	0.3/0.6 MHz; 2MHz	22 MHz
Modulation type	GFSK	BPSK, QPSK	BPSK(+ASK), O-QPSK	BPSK, QPSK COFDM, CCK, M-QAM
Spreading	FHSS	DS-UWB,MB-OFDM	DSSS	DSSS, CCK, OFDM
Coexistence mechanism	Adaptive freq. hopping	Adaptive freq. hopping	Dynamic Freq. hopping	Dynamic freq. selection, Transmit power control(802.11h)
Basic cell	Piconet	Piconet	Star	BSS
Extension of the basic cell	Scattemet	Peer-to-peer	Star	BSS
Max. number of cell nodes	8	8	>65000	2007
Encryption	E0 stream cipher	AES block cipher (CTR, counter mode)	AES block cipher (CTR, counter mode)	RC4 stream cipher (WEP), AES block cipher
Authentication	Shared secret	CBC-MAC(CCM)	CBC-MAC(ext. of CCM)	WPA2(802.11i)
Data protection	16-bit CRC	32-bit CRC	16-bit CRC	32-bit CRC

* Unapproved draft

• Acronyms: ASK(amplitude shift keying), GFSK(Gaussian frequency SK), BPSK/QPSK(binary/quadrature phase SK), O-QPSK(offset- QPSK), OFDM (orthogonal frequency division multiplexing), MB-OFDM(multiband OFDM), M-QAM(M-ary quadrature amplitude modulation), CCK(Complementary code keying), FHSS/DSSS(frequency hopping/direct sequence spread spectrum), BSS/ESS(basic/extended service set), AES(advanced encryption standard), WEP(wired equivalent privacy), WPA(Wi-Fi protocol access), CBC-MAC(cipher block chaining message authentication code), CCM(CTR with CBC-MAC), CRC(cyclic redundancy check).

APPLICATION

- At schools, colleges for displaying assignments.
- Public places, hospitals, government offices etc.

ADVANTAGES

- Paper free notice board.
- **Self-Forming and Self-Healing Network:** The ZigBee standard allows nodes in a network to adjust their communication paths on the fly to increase robustness. As new nodes are installed they automatically connect to existing networks. This reduces the effort required to set up a new network or add extra nodes to a new network. This also means that if a node becomes damaged or otherwise unable to communicate, links to that node can be rerouted so that other nodes on the network do not lose connectivity. This happens automatically without the network needing to be reconfigured.

- **Non-Interfering:** ZigBee adheres to the IEE 802.15.4 standard and uses the recognized 2.4GHz industrial, scientific and medical (ISM) band. ISM bands are reserved and used for license-free communications. Because the bands are expected to have other signals in nearby channels any communications protocols using them, including ZigBee, are designed to be tolerant of interference. Some other bands are only reserved for general use in certain countries and can be used elsewhere for more regulated use.
- **Standard Signal Equipment:** Because ZigBee operates within the standard 2.4GHz band it uses easily available boosters and antennas. This reduces the final cost of the product and also increases the overall performance of the entire network.
- **Security:** While neither IEEE 802.15.4 nor the ZigBee standard specifies a particular encryption method they both support implementation specific encryption.

DISADVANTAGES

- The data may be received by another ZigBee having same PAN-ID.
- The range is small.
- Low transmission rate: As seen in the table above, the transmission rate of ZigBee is very small as compared to the other wireless technologies.
- ZigBee compliant manufacturers slow to make an appearance in the market.
- ZigBee compliance certification for appliance manufacturers mandates lithium battery use.
- Replacement of existing appliances with ZigBee compliant appliances can be costly.

CONCLUSIONS

Thus we have successfully transmitted the data in the form of an image from the PC to the GLCD via the ZigBee. ZigBee have a long life time along with low power consumption as compared to Bluetooth and WIFI.

Also, by connecting ZigBee in mesh network we can increase the range of communication. The hardware can be implemented on a large scale at various public places like highways, railway and bus station, airports etc.

FUTURE SCOPE

Further development to this project can be done by providing message storage facility by non-volatile memory i.e. EEPROM attached to the microcontroller for retrieval of old messages if required. It can also be expanded to a bigger LCD screen.

ACKNOWLEDGEMENTS

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