Advanced Communication For Industrial Monitoring And Control System

Uppala N S Ram Sudheer, Y.Madhavi Latha

Abstract—The industrial monitoring system using wireless technology is a primeconcern in some industries. There are several approaches to Wireless Network for Industrial Applications nowadays. In this paper, we have tried to increase the security standards by combining new design techniques to wireless industrial monitoring and controlling system. The personal computer based wireless network for industrial application using Zigbee can be adopted at micro and macro Industries. Here Microcontrollers, Temperature Sensor, Gas Sensor, Power and Voltage Sensor, Intruder Sensor, Zero crossing detector, Voltage regulators are used. The whole system is controlled by the Personal Computer through Visual Basics GUI (Graphical User Interface).The GUI is developed based on application by the user. All the processor and controllers are interconnected to personal computer through Zigbee. The Personal Computer will continuously monitor all the Data from remote processing unit and compare with value preloaded process structure. If any error is found the personal computer takes necessary action. The Zigbee connected to the personal computer acts as full function device and is used to send and receive data from other nodes and used to control the speed of DC motor. GSM will be used to send a warning to the author/user.

Index Terms—Wireless Communication,Face detection, Zigbee Network, Graphical User Interface, Secured data transmission, Dual bridge D.C Motor Control.

In recent years, the wireless sensor networks become widely spread in industrial data transfer and process control applications.Sharing data is far easier with a wireless network. These are Very flexible within the reception area.The wireless networks are more robust against disasters like earthquakes, fire etc..These uses very low power for battery use. These networks not need special permissions or licenses needed to use. This system uses ZigBee to build transmission network, which is mostly used for the transmission of sensor data, and uses customized wireless transmission protocol, which is designed based on simplicity and reliability.

Here we use data broadcast algorithms for the 802.15.4 based Zigbee network standard and their applicability. Zigbee network is used to creating control networks for power electronics and driver applications. In this paper, it is proposing to employ Zigbee transmit and receive data between computer and microcontrollers. Zigbee is used to control the direction and speed of DC motors through Dual H-Bridge converter[1],[3]. One Zigbee is connected to personal computer which is used to receive and transmit data.The Zigbees are communicating to external devices through serial port by using RS232 protocol [4].

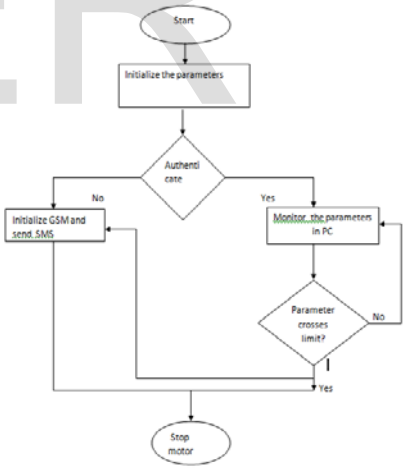

Figure1: Structure of entire system

First step is to detect the face of the author/userwho is operating the monitoring station. For this we follow several algorithms.

2 Face Detection

User can control and monitor the entire wireless network by using computer and Visual Basic based GUI. This GUI is for detecting the operating persons face. This is for security

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purpose in monitoring unit. Skin Color is a powerful fundamental cue of human faces. The distribution of skin colors clusters in a small region of the chromatic color space. Processing color is faster than processing other facial features information should be considered.In order to get better efficiency, face data should be sufficiently used and both 2D and 3D face[9],[11]

Therefore, skin color detection[15] is first performed on the input color image to reduce the computational complexity. Because of the accuracy of skin color detection affects the result of face detection system, choosing a suitable color space for skin color detection is very important.The totally corrective algorithm was applied to the face detection problem using the framework introduced by Viola and Jones[12].

Here we are using Adaboost classifier algorithm[8].

1. For the given images $(x_1,y_1),\ldots,(x_L,y_L)$ where yi€{0,1} indicates positive or negative examples ; $g_j(x_i)$ is the ^{j}thHaar-like feature of the ^{i}th example x_i.
2. Initialize weights as
   $W_{1,I} = 0.5/m$, i<=m
   $= 0.5/n$, otherwise. (1)
   m,n are the no.of positive or negative examples respectively, L= m+n.
3. For t= 1……T
   (a) Normalize weights
   $Wt,i=Wt,j/\sum_{j=1}^{L} Wt,j$ (2)

   (b) For each feature j, train a weak classifier hj, and evaluate its error €j with respect to Wt,
   $€ = \sum_{i=1}^{L} Wt,i\left|H_j(X_i) - y_i\right|$, (3)

   $h_j(X) = 1$, if $P_j g_j(x) < P_j\theta_j$
   $= 0$, otherwise (4)

   Pj € {1,-1} is a parity bit and θj is a threshold.

   (c) Choose the classifier ht with the lowest error €t
   Update the weights $Wt+1,i = W\ t,I\ \beta_t^{1-e_i}$
   Where $e_i = 0$ if example xi is classified correctly, $e_i = 1$ otherwise, and
   $\beta t = €t/(1- €t)$.
4. Final classifier:
   $H(x) = 1,\ \sum_{t=1}^{T} \alpha_t h_t(x) \geq 0.5 \sum_{t=1}^{T} \alpha_t$
   $= 0,$ otherwise (5)
   Where $\alpha_t = \log\left(1/\beta_t\right)$

The main steps are described in below figure2.

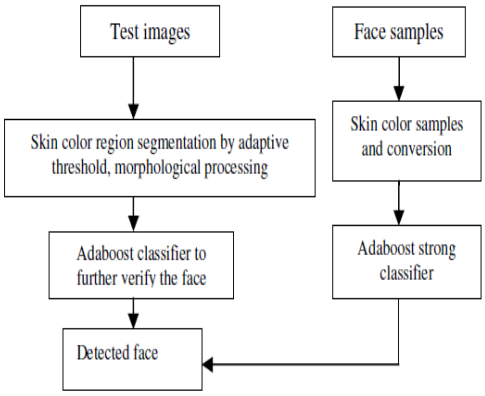

Figure2: Face detection Process

Forface detection, a very large training set has to be explored. So In order to improve computational efficiency greatlyand also to reduce the false positive rate, a sequence ofgradually more complex classifiers called a cascade isbuilt.Since easilyRecognizable non-face images are classified in the earlystages, classifiers of the later stages of the cascade can be used to detect the faces.The detailed procedure of my algorithm is described below [10],[13].

1. First a training database of human face is built .
2. Second, average face vector is calculated. Then average face vector is subtracted from vector of each face image.
3. Third, calculate eigenface vector and space, and project the training faces into eigenface space. Here the Coordinate coefficients can be obtained.
4. Finally, project the testing face image into eigenface space and obtain the coordinate coefficients.
5. Calculate the Euclidean distance between coordinate coefficients of test image and images in database, the test image will be classified by using the nearest distance.

After this steps the output images will be as in figure2. The final detected image is shown in figure3.

Figure3: The original image and its processed output images

Figure4: The detected image

This image will be used for authentication purpose and the system is now ready to monitor the various parameters. This can be done by using the wireless network like Zigbee .

3 Wireless Communication

Wireless communication is the transfer of information over a distance without the use of any electrical conductors or wires. The distances involved may be a few meters as in television remote control or thousands or millions of kilometers for radio communications. This consists of various types of fixed, mobile, and portable two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking. Here we use the Zigbee wireless network for industrial data communication.

3.1Zigbee Protocol

Zigbee is a wireless network protocol specifically designed for low data rate sensors and control networks[2]. Zigbee uses the IEEE 802.15.4 physical and MAC layers to provide standard-based, reliable wireless data transfer[6]. The applications that uses the Zigbee protocol are building automation networks, home security systems, industrial control networks, patient monitoring, remote metering etc. IEEE 802.15.4 provides three frequency bands for communications. Zigbee uses a DSSS radio signal in the 868 MHz band (Europe), 915 MHz band (North America), and the 2.4 GHz ISM band (available worldwide). In the 2.4-GHz ISM band sixteen channels are defined; each channel occupies 3 MHz and channels are centered 5 MHz from each other, giving a 2-MHz gap between pairs of channels.

Zigbee uses an 11-chip PN code, with 4 information bits encoded into each symbol. It will give a maximum data rate of 128 Kbps. The physical and MAC layers are defined by the IEEE 802.15.4 Working Group and share many of the same design characteristics as the IEEE 802.11b standard.

3.2Zigbee Protocol Features

Zigbee has Low duty cycle which provides long battery life . It has Low latency. The 128-bit AES encryption - provides secure connections between devices. Zigbee supports Collision avoidance. Zigbee supports up to 65,000 nodes on a network. Static, star, dynamic and mesh network topologies are supported by Zigbee.

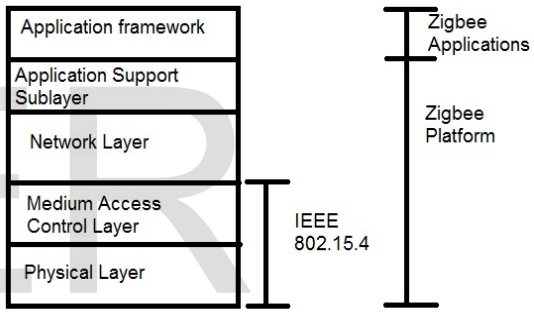

Figure 5. Zigbee protocols stack

3.3Collision Avoidance

Zigbee does not change channels during heavy interference, instead it relies upon its low duty cycle and collision-avoidance algorithms to minimize data loss caused by collisions. Zigbee specifies a collision-avoidance algorithm similar to 802.11b, each device listens to the channel before transmitting in order to minimize the frequency of collisions between Zigbee devices.

3.4 GSM Network:

GSM stands for Global System for Mobile communication. GSM is a globally accepted standard for digital cellular communication. The digital nature of GSM allows the transmission of data (both synchronous and asynchronous) to or from ISDN terminals, although the most basic service support by GSM is telephony. A unique feature of GSM is the Short Message Service (SMS). SMS is a bi-directional service for sending short alphanumeric message in a store-and-forward process. SMS can be used both "point-to-

point‟ as well as in cell-broadcast mode. A GSM modem is a wireless modem that works with a GSM wireless network. This GSM modem is used for sending a SMS as error occurred with users mobile numbers. The data base is already stored in the PC.

A GSM modem can be an external device or a PC Card / PCMCIA Card. Typically, an external GSM modem is connected to a computer through a serial cable or a USB cable.Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands.

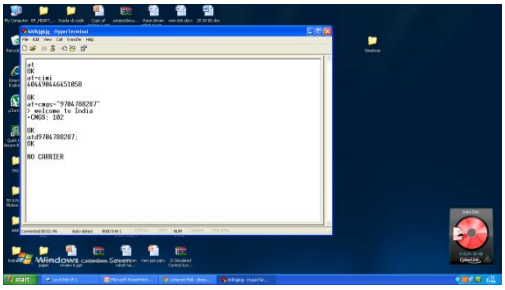

Figure 6: The usage of AT commands in Hyper Terminal to communicate with Personal Computer

Here we use GSM Modem to send an alert SMS when any authentication failure or any error occurs due to parameters exceeds the limits at the industrial site.

4 Hardware Platforms Overview

The hardware includes An evaluating hardware was developed with Maxstreem, xbee pro Zigbee module, it consumes only 2mW and 1.25 mW power at active and sleep mode. It is compatible to transfer data upto 400 Meter range at 250Kbps. Zigbee pro communicate based on DSSS (Direct Sequence Spread Spectrum) and it's very suitable to Mesh, point-to-point and point-to-multipoint networks. it also gives 3V CMOS UART option to interface External devices like microcontroller, sensors and etc.Xbee pro manufacturer provide XTU software package to programme the xbee module.

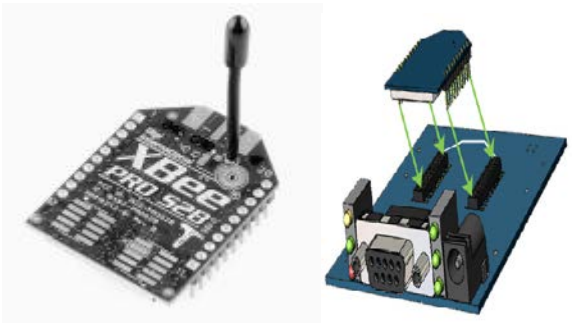

Figure 7. Zigbee Module and mounting on board

The Zigbee module and its mounting is shown in figure 6.

Here LPC 2148 microcontroller is used to process individual systems and personal computer is used in monitoring and control station[5].The microcontroller and personal computer are interfaced with Zigbee module through UART port. L298 dual full-bridge driver is used to control the speed, direction of DC motors and also it saves motor from high current and short circuits.

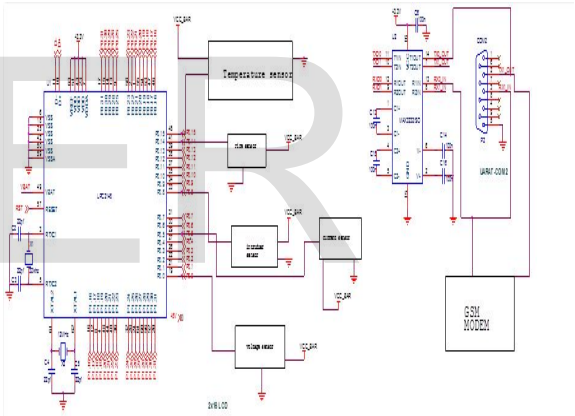

Figure8:Circuit for industrial Monitoring and Controlling System

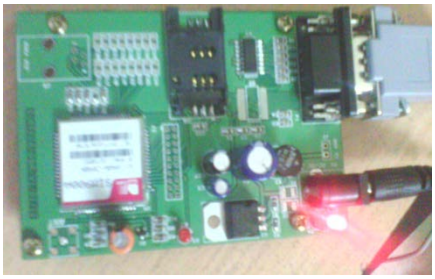

Figure9: Working of GSM modem

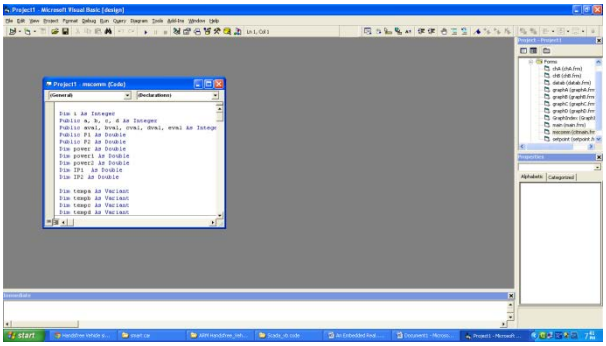

Figure 10: Creating the user interface in personal computer

The monitoring station continuously monitors the all parameters. First we set up the parameters limits. When any parameter value is exceeds the limit or any authentication failure occurs the GSM Modem sends an SMS or a Voice call to the number in its database. Also the control commands will be issued. When the control commands are received from the monitoring station, immediately microcontroller at control station process the command and give respective control signal to associately connected power module.

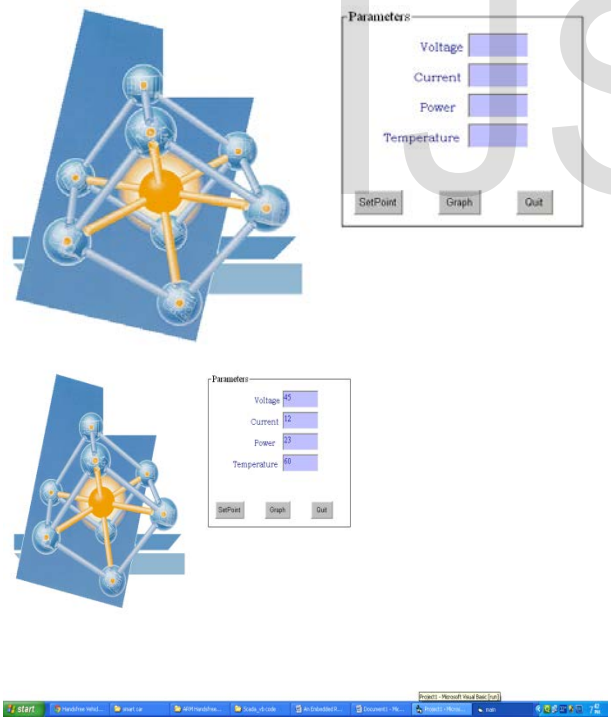

Figure11: The initialization of all parameters, setting their limits and monitoring

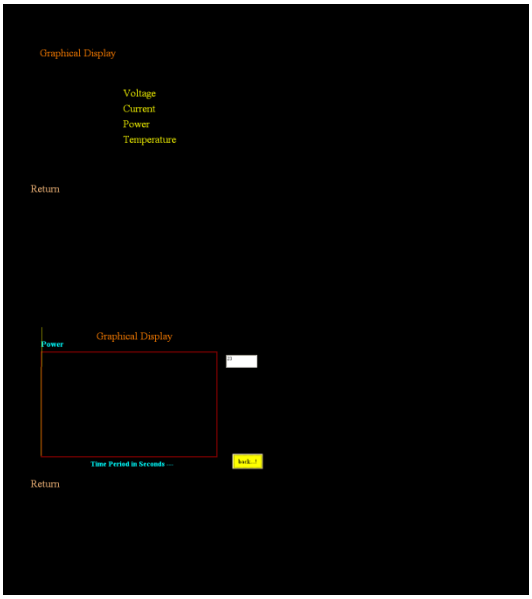

Figure12: Output for the parameters and the waveform for power vs time period.

5 Conclusion

The wireless technologies like Zigbee, Wi-Fi etc. have challenges like Electro-Magnetic Interference / Radio Frequency Interference and fading due to industrial environments are not yet fully removed or ignored. The face detection process at some times may lead to wrong authentications but it is in very rare situations. The detection process can be further improved by using new algorithms that can come in future but they are cost effective. It was seen that there was an error free communication has been established between monitoring PC and control station.

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