Development of GUI for Wireless Sensor Network for Industrial Parameters

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Abstract: The establishment of Wireless Sensor Network (WSN) comprises two major parts, the systematically distributed and wirelessly connected nodes and the base station to demonstrate the information collected by the network. To enhance the features of the wireless sensor network, a smart GUI is designed and implemented at the base station, to monitor the environmental parameters, for which the Wireless Sensor Network is dedicated. This paper deals with the issues of design and implementation of GUI for base station, which performs the task of data demonstration and logging of the same for further process. Emphasizing these tasks the GUI is designed in Visual Basic environment. The present GUI is designed for 10 nodes. It reads data from coordinator node. Each node is labeled with the ID. The GUI disassembles the packet received serially from coordinator and respective parameters values are separated with respective node ID. The calibration of the system is done at node level. Therefore, the parameter values, in real units are displayed in the respective window. Moreover, the present GUI is designed to depict the path of the data flow from respective node. This realizes the emulation of the collaborative data collections. This designed GUI also helps to ensure fault detection. Thus, the GUI works satisfactorily to fulfill the need of base station of dedicated wireless sensor network.

Keywords: GUI, Visual Basic, WSN, Sensor Node, environmental parameters.

I. INTRODUCTION

In the monitoring and control system using Wireless Sensor Network, the data acquisition and presentation plays important role [1]. As the electronic fields are growing, the monitoring and controlling process becomes very sophisticated and user friendly. During early days, monitoring of site specific data and controlling of the same depicts human interface. Therefore, the measurements as well as controlling process are less reliable. Nowadays, limitations are minimized by the process of atomization. A field of atomization reveals the deployment of embedded technology [2-3].

To ensure measurement of environmental parameters, the data logger plays important role to store [4] as well as analysis of large number of data. For collection of site specific data and management of the same, a use of computer is inherent. Wireless Sensor Network [5] is the collaborative, establishment large number of nodes and the base station. Therefore, to ensure the field of Wireless Sensor Network, the base station should be smart, which may demonstrate the data and store the same in real time. Such Graphical User Interface (GUI) [6] are designed and reported by authors [7-8]. However, it demonstrates the data in dedicated windows only. However, it could not depicts the path of the data flow. Demonstration of value of the parameters along with its location from base station helps to realize the site specific variability (SSV).

On survey, it is found that, such types of GUI are rarely implemented to demonstrate the path of the signal within transmitter and receiver in wireless sensor network. Considering recent needs, the wireless sensor network is designed [5]. Present paper deals with the designing of graphical user interface (GUI) for monitoring the parameters and visualization of the path of data from every node present in the particular network. To design the GUI, Microsoft Visual Studio 2010 is deployed [9].

![Diagram of Base Station in Wireless Sensor Network](image-url)
In Wireless Sensor Network, nodes are distributed systematically within the area under investigation. Each of the nodes is autonomous and has limited computational capabilities. However, in present wireless sensor network, the nodes are calibrated for the parameter under investigation to scientific units. Therefore, each node senses the status of the environment and disseminates the parameter values in real unit. It is also known that, the wireless sensor node operates within IEEE 802.15.4 standards [10], wherein both PHY as well as MAC layers are predicated. Therefore, the parameter values are encapsulated in the specific frame and then transmitted to the coordinator or sink node. According to IEEE 802.15.4 standard the unpacking is done at coordinator and along with the node ID the data is given to the base station. The data values are separated with their headers and then allowed to display on dedicated window. Architecture of the base station is depicted in figure 1. As shown in figure 1, the computer is serially interfaced to the node. It receives the data from coordinator and display on the computer monitor through designed graphical user interface (GUI).

II. DESIGNING OF SMART GUI

Wireless sensor network, is the distributed network and may be spread over wide area of investigation. The data collected by the End Devices (ED) [2] of the wireless sensor network are disseminated to the central station called base Station (BS). Now the base station has to perform the task of demonstration of the data and logging of the same as well. Basically, the wireless sensor network is implemented to collect data of site specific variability (SSV) and users do not know how it happens. The wireless sensor network users want the data in understandable unit. For example temperature in degree centigrade, gas concentration in percentage, etc. Therefore, to ensure the design of smart and user friendly base station, Graphical User Interface (GUI) is designed in typical environment. To develop GUI for present dedicated applications various environments are suggested. However, for present wireless sensor network the smart Graphical User Interface (GUI) is developed in Visual Basic environment and it is installed in to computer of the Base Station. The issues regarding development of Graphical User Interface (GUI) are discussed. Moreover, such type of GUI can also be developed in LabView, matlab etc environment [11-12]. Software is designed using C sharp language in Microsoft Visual Studio 2010, which is windows based IDE, suitable to design GUI. An algorithm of the present GUI consists of following steps.

1. Settings and initialization of serial port.
2. Read data in to receiver buffer.
3. Disassembling the data packet.
4. Display data in proper format.
5. Demonstration of the distribution of the nodes and path of data flow.

III. COMMON TOOLBOX USED:

As discussed earlier, the graphical user interface is designed to facilitate the Wireless Sensor Network (WSN) in Visual Basic environment. The visual basic is reach in the library of tools. However, following tools are employed in present design. Each tool [13] is associated with the API, which is used in the software design.

**Button:** It is used to raise an event when a client clicks on it. In present work, it is used mainly to start and stop of serial port operation. In addition some more buttons are also used to provide regular expressions for handshaking such as Ok, Cancel etc.

**TextBox:** Text box tool enables user to enter text and provides multiline facility. For present GUI, text boxes are used to demonstrate input serial buffer data and mote parameters values as well, after sorting with respective headers.

**Label:** It provides descriptive text for viver, which is used for writing or labeling items.

![Figure 2: Designed Port Setting tab for COM port setting](image-url)
**Combo Box**: Combo box is a box which holds number of optional events or data and provides particular output which is selected from the list. In present work, Combo boxes are used for port setting parameters like port name, baud rate, Parity, etc.

**Serial Port**: Serial port tool provides easy interfacing with the external peripherals. Here, it is used to read signal given by the coordinator to base station from active sensor nodes present in particular wireless network, with header assigned by particular node for every parameters.

**IV. GUI DESIGN STEPS**

Steps involved in the design of present graphical user interface (GUI) are also described.

**First**: In the beginning Com control tab “Setting”, is created in new class and then assigned for control of various com port parameters like, com port name, baud rate, data bits, parity etc. Figure 2 shows the structure of setting window.

**Second**: Created class “port setting” is linked through code written in the event of Port Setting button. The code written for this class acts as API for this class. In addition to this, the class is also programmed to return values of selected com port name, baud rate, parity, etc, from class to main form.

**Third**: Form is designed, which realizes the actual design of GUI. Figure 3 shows the form designed for present GUI. As shown in figure 3, the form is fragmented in to two parts. One part is used to display the parameter values of the respective nodes. Remaining portion of the form is utilized to demonstrate the distribution of the nodes within the area under investigation. As shown in figure 3, the Base Station (BS) is located at the center and the nodes are distributed about Base Station. The nodes are connected to the Base Station through a path depicted by an arrow. The direction of arrow is the direction of data path.

**Fourth**: In fact, the data when received from buffer, comprises parameter values and node ID as well. These two fields are disassembled and availed to facilitate the purpose. Moreover, separated header is used for demonstration of the path of data flow. After completion of data demonstration, preservation of data is an important task. Hence, using excel tool from data base file is created. After, creating excel file, respective data of different parameters according to node ID are appended using excel tool.

**V. IMPLEMENTATION OF THE GUI FOR WSN**

Graphical User Interface (GUI) is designed in Visual Basic (VB), environment to facilitate the Wireless Sensor Network (WSN). The wireless sensor network incorporates the Base Station (BS) to monitor the distributed data regarding typical parameters. Deploying embedded technology the wireless sensor nodes have been designed about PIC microcontroller, wherein the zigbee [8] devices are deployed as RF module for realization of wireless communication. Following zigbee technology and the standards laid down by IEEE 802.15.4 group, the Wireless Sensor Network (WSN) is designed for industrial application. It is found that, within the industrial development region, various gases are liberated due to chemical, physical or physico-chemical process. Some of the gases are toxic and hence may adversely affect the living organisms. These gases spread over entire environment about the industry. The leakage of the gases may be the significant reason for pollution of the air. Concentration of such gas varies from site to site. Therefore, the concentration of gas depicts Site Specific Variability (SSV). The concentration of the gases dissolved in the atmosphere...
is more nearby industry. However, it decreases with the distance from source of the leakage. Therefore, it can be said that, the concentration of the industrial gas dissolved in to the air exhibits site specific variability. To collect information regarding the concentration of industrial gases spread into atmosphere, the wireless sensor network is designed. As per the architecture of the wireless sensor network (WSN), the nodes have been designed and routed by ensuring Zigbee technology. The nodes collect and disseminate the site specific data towards the base station. Now, the base station should be smart to demonstrate the site specific data. To facilitate the fundamental needs of the base station, Smart Graphical User Interface (GUI) is designed and implemented. Results of the implementation are discussed. Actually, the coordinator node is interfaced to the serial port of the computer. Immediately, the GUI act upon the serial port and read data from serial port. As discussed earlier, the data is in packetized form. The GUI under development disassembles the packets and isolates the parameters values and respective headers. The parameters values, concentration of various gases, are extracted and displayed into respective windows. The windows are continuously updated with the recent data. Moreover, instantaneous values of the parameters are also stored, in real time, into the data base created for this dedicated purpose.

The path from which the data is coming is also demonstrated. The node headers are considered to define the path of the data. The direction of the data is also helps to locate the respective node position within the area under consideration. To demonstrate the paths, an arrows of two distinct colors, blue and white, are designed. If any node is not functioning, may be due to any reason, then respective path is indicated by white color. However, the functioning nodes are of blue colored. This also helps to ensure fault detection and maintenance of Wireless Sensor Network (WSN) as well.

After enabling of the serial port start capturing the data from coordinator. However, if the nodes are in disabled modes, then no any data would be available. Therefore, the as shown in figure 4, the windows dedicated for parameters values are empty. Moreover, the figure 4 also shows the white colored paths. The simulation of white colored path is attributed to the fact that the nodes are not functioning.

With response to the power supply, the sensor nodes start functioning there task for which they are deployed in the typical area. Base station receives signal from the co-ordinator node. As discussed earlier, the packets are disassembled to the respective header and node ID. The parameter values are displayed in respective windows (Figure 5). For present investigations, the GUI is designed for 10 nodes and for four parameters such as, temperature (°C), concentration of Alcohol gas (%), concentration of ammonia (%), concentration of CO₂ gas (%) etc. Moreover, the present GUI is also successful demonstrates the source of the data. Both halves of the GUI depict good synchronization. As shown in the figure 5, the nodes nearby base stations are directly connected to the base station through wireless link and GUI demonstrate signal flow. Moreover, the nodes are situated far away from the base station are linked through routers to the base station. Typically, the sensor nodes SN6 and SN9 are located far away from base station, so they exchange information through SN8 and SN7 respectively which are the routers. Routers carry out their own job as sensor node. Figure 5, demonstrates that all nodes are functioning. Moreover, GUI reveals the demonstration of non functioning nodes by changing path color to white. Moreover, respective windows are also empty. In addition to this, the smart GUI is designed for data logging also. The received data is stored in excel file with date as well as time of data collection. Thus, created data base can be made available for presentation and deterministic planning as well. On investigation of the data base, the authorities of the industry can take decision to minimize the air pollution.
VI. CONCLUSION

The Graphical User Interface GUI using Microsoft Visual Studio 2010 has been successfully designed to realize the philosophy of Wireless Sensor Network. Moreover, this smart GUI helps user to easily detect the faults in sensor nodes, and hence in any node of Wireless Sensor Network, which are systematically mapped. The results of the real time implementation of the GUI support the validation of the design.

REFERENCES


