Computer Controlled System Using Bluetooth Technology

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Abstract

The implementation of monitoring, controlling, and archiving system with data communication based on Bluetooth technology is described. Design and implementation of a temperature sensing and power line frequency measurement system is presented. The application has been accomplished using Bluetooth USB dongle. One of the Bluetooth enabled PC acts as a server. The implementation process consisting of application architecture design, system requirement, software design, hardware design, establish Bluetooth connection, and visualization of measurement data is described in detail. Experimental results show that the designed system is more reliable and easy to use.

Keywords: Computer Controlled, Bluetooth, Temperature sensing, power line frequency

منظومة السيطرة بالحاسبة باستخدام تقنية البلوتوث

الخلاصه

تم تنفيذ منظومة مراقبة وسيطرة وأرشفة مع تبادل المعلومات باستخدام تقنية البلوتوث، انجز بناء منظومة متحسس حراري ومنظومة قياس تردد خط القدرة. استخدمت شرائح البلوتوث لتفعيل احدى الحاسبات كمحطة مراقبة رئيسية تستلم المعلومات من المحطات الفرعية عن طريق تبادل المعلومات لاسلكيا. عملية البناء تضمنت تصميم هيكلية التطبيق واحتياجات المنظومة والبرامجيات والكيان المادي. انشاء الاتصال عن طريق البلوتوث والمشاهدة والقياس تم التطرق لها بصورة تفصيلية. نتائج الفحص العملي أشرت وثوقية وسهولة استخدام المنظومة.

1. Introduction

Replacing of wired connections between electronic devices with wireless connections will revolutionize the way for organizing industrial, office and home environments [1]. Bluetooth is currently arises as one of the most promising personal wireless network technologies. Bluetooth is a short range wireless technology standard intended to replace cables connecting mobile and fixed electronic devices , such as handhelds, mobile phones, and laptops to external peripherals and with each other forming a Personal Area Network (PAN) [2]. Bluetooth key features are robustness to interference, low complexity, low cost, inherent security and low power, where it operates in the 2.4 GHz frequency ISM band [3]. industry applications containing Bluetooth communication is a new area being investigated Bluetooth could be used for monitoring, transferring, and logging of data or operator communication. Currently many companies are working on

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deploying Bluetooth to their products in order to decrease wiring, weight and price of the product this way . Some examples of industrial applications of Bluetooth is monitoring and diagnostics currently many applications are already using Bluetooth enabled sensors to trace the chosen objects or its characteristics. Bluetooth satisfies the basic requirements for wireless monitoring: immunity against interference, security, power consumption modes and easy implementation (no cables). The monitoring process can be an online monitoring, where Bluetooth forwards the data from sensors to master/server immediately [4].

In this paper a wireless Bluetooth radio network is used to transfer the measurement data from the two slaves to the master station. Connection without cables enables us to have a much greater freedom to physically distribute the nodes. It is possible to place actuators and sensors without worrying about the location of the master station.

2. Application Architecture

The objective of the system is to reduce the complexity of wired network by using wireless network. It has the capability for sending/receiving real time data through a Bluetooth enabled nodes and check the history of the measurement data by using the developed archiving system. Application areas are:

- Industrial applications to record data.
- Sensors and actuators.

The architecture of the application consists of 3 PCs (see Figure 1) :

- Master Station to receives the measurement data.
- Slave A to process the data from temperature sensing unit, sends it to master station, and performs the control action sends by the master station.
- Slave B to process the data from frequency sensing unit and to sends the data to master station

After the creation of the physical connections between the master station and slaves using PAN profile, these connections are programmed using Microsoft visual basic 6.0 language to make the master station communicate with slaves using a technique called sockets.

3. System requirement

The following technology is used to realize the system architecture:

- Three PCs to receive and visualize data with Windows XP operating system
- Three Bluetooth USB dongle V2.0
- LM35 precision centigrade temperature sensors [5]
- ADC0804 8-Bit µP Compatible A/D Converters [6]
- 6402 CMOS Universal Asynchronous Receiver Transmitter(UART) [7]
- MAX232 dual driver/receiver [8]
- CD4046BC Micropower Phase-Locked Loop[9]
- FAN unit
- Visual basic studio 6 programming language

The three PCs used to process and visualize data where one of them acts as the server (Master station) to process and display the temperature

and frequency values from the two slaves (A and B).

The Bluetooth dongle establishes wireless links between the PCs. The delivered software WIDCOMM provides access to the Bluetooth operations and is used for configuration.

LM35 is used to sense the temperature value .The ACD is to convert the analog output of the sensor into digital form. UART convert the serial data into parallel data and vice versa. MAX232 converts voltage levels of the RS232 to Transistor Transistor Level (TTL) level and vice versa. PLL used as frequency multiplier.

visual basic studio 6 quick language to create windows applications, High speed processing, Support RS232 Interfacing, support creation of Internet Protocol (IP) based applications, and Visual Basic generally fit applications databases.

Software Design 4.

The following software components have been designed and used:

- Slave A software (designed) . network socket slave application to read data from the temperature sensing unit and to send data to the master station. Also performs the action send by master station to control the fan unit.
- Slave B software (designed). network socket slave application to read data from the frequency sensing unit and to send data to master station upon request send by master station.
- master station software (designed). Winsock server application to receive data from the two Nodes and to store data in archiving developed system. Also show alarm messages and voice alert at emergency state.
- WIDCOMM (commercial). Application software for Bluetooth USB dongle on a network PCs.

Programming of data communication of the Bluetooth connection was done for the PAN profile in order to connect the master station with the two slaves.

5. Hardware design

Appropriate sensing elements should be used to produces electrical output voltage proportional with the variations of the physical parameter to be monitored. In some cases depending on the sensed signal level and condition it may be necessary to carry out signal filtering and amplification before converting the signal into a digital form.

5.1 Temperature Sensing Unit

The LM35 temperature sensor is fabricated in a three terminals transistor package the output signal is 10mV for every 1 ºC corresponding change in temperature above zero. Its rated full range is -55 to +150 ºC [5]. Figure 2 show the block diagram for temperature sensing unit.

For a linear relation between the temperature sensor output and the ADC output, the reference voltage for the ADC should be appropriately set. The reference voltage (Vref) in this application should be set as 1.28V in order to correspond linearly with the 256 binary output steps provided by an 8 bit ADC. This is important especially when dealing with the temperature measurement. To transmit the sensed signal serially, it should first be converted to the parallel output format of the

ADC to serial. For processing at the receiving end it should first be converted back to the parallel format. A Universal Asynchronous Receiver Transmitter (UART) circuit can be used to convert between parallel to serial and vice versa before serial transmission. The serial signal requires some signal level conversion so as to be conveniently transmitted over the serial link and an RS232 signal level converter circuit is used for the voltage level conversion. In the states of alert when the readings from the temperature sensor higher than the threshold setting in the Master Station or slave A an action must be done to overcome this problem .So 5 VDC fan is putting for this purpose. The ON or OFF states of the fan is controlled by the Master Station or the remote Node A. Figure 3 show the final and functioning temperature sensing unit.

5.2 Power Line Frequency Sensing Unit

Figure 4 show the block diagram of power line frequency sensing unit Node B. The main part is the frequency control circuit which contains many electronic devices to count the frequency with two digits after point resolution Figure 5 show the block diagram for this circuit.

The circuit consists of voltage transformer which is used in this application as a step down for the input power while preserving the frequency. The Square Wave Generator converts the sinusoidal signal output of the transformer into square wave suitable for electronic circuits. Phase-locked loops (PLLs) are used to multiply the frequency by 100 to increase the resolution. The counters are used to count the frequency pulses. Figure 6 shows the final and complete functioning circuit.

6. Establish Bluetooth Connection

A connection is initiated from the slaves.

- On the server side, the service must be started.
- On the slaves side, initiation of the connection.

The master station must provide Bluetooth Personal Area Networking Service. The slaves performs devices search and then when the master station is found they search for Bluetooth Personal Area Networking Service when the service is found they request for connection to the master station .The master station authenticate the slaves to enable them to access to it. During this process, a Bluetooth passkey is asked for the both connection sides. If the passkeys are the same, the authentication process is success and the connection can be established. If the passkeys are different, then authentication fails and the connection cannot be established. The master station also performs authorization process to enable the slaves to use the Bluetooth Personal Area Networking Service providing by it. After the authorization process the connection is established and the master station and slaves connected physically with Bluetooth.

7. Data visualization

Slave A socket program, the software of this unit performs the following tasks:

- reading the data from temperature sensing unit
- process the received data
- Display results on screen
- Show alarms message
- check the connectivity with the Master Station

- Response to Master Station request
- set the temperature threshold
- control the FAN unit

Figure 7 show the application window for this slave A.

To making connection with the Master Station the user must inputs the IP of the master station from Edit list and then selects server IP command which causes to appearing the window as shown in Figure 8. The user can set the temperature threshold from Edit icon and then selects set temperature command. In the case of emergency, when the temperature becomes greater than threshold value, the alarm message "Temp. is higher than threshold" is appear instead of "Normal Temp." message. In this case, the operator must switch the FAN Unit on from either the check box or the master station monitoring and control software.

Slave B socket program. The software of this unit performs the following tasks

- Reading the data from Frequency Sensing Unit.
- Process the received data.
- Display results on screen.
- Check the connectivity of the Master Station.
- Response to Master Station request.

Figure 9 show the application window of this node. To connect this Node with the master station the IP of master station must be input by the user as in node A. The frequency displays as a digital clock with two digits resolution.

8. Master Station Socket Server Program

The master station monitoring and control software performs many tasks of monitoring readings and control action also responsible for archiving system. The functions of the Master Station summarized as:

- Sending requests to the both Nodes (Node A and B).
- Display the results of temperature and frequency.
- Check the connectivity of the Nodes.
- Show alarm messages.
- Voice called warring at emergency state.
- Control the FAN unit.
- Set the temperature threshold.
- Temperature history database.
- Frequency history database.

The application window of master station consists of commands, status messages, date, and the display parts. When Node A is connected with the master station, the software shows that the Node A is connected as shown in Figure 10 and the master station starts to get the temperature value from Node A. The initial temperature threshold value is 30C. The user can set the temperature threshold by entering the value into textbox and click the set temp command. At the emergency state when the temperature reading becomes higher than threshold a message of higher temperature is shown and at the same time voice alarm is operated to get the attention of the operator. The FAN unit is controlled by Fan on and Fan off commands.

Figure 11 shows the master station application window when both Nodes are connected to the master station. At this point the master station is connected to the both nodes and sends requests to

receives the temperature and frequency values. The master station sends request to the Node A every 5 seconds while Node B every 2 seconds.

The temperature and frequency values are directly put in archiving system. The archiving system is 24 hour archiving system and there is separate database for every day. From which the operator can reads the value of the temperature or frequency at any given time or date. From which the user can reads the value of the temperature or frequency at any given time or date. The operator can show the frequency chart using show the frequency chart command which causes to display the Reporting Program window as shown in Figure12. The user must input the date to check the readings of the power line frequency at that day.

By clicking GO command, the software performs the required action. After short time small window as in Figure 13 will appear tell the user to see desktop. On desktop a file is created which show the frequency chart for the date entered. Figure 14 show the frequency chart of 14/2/2008.

The chart gives the frequency in range 48.50 to 50.50 during 24 hour. Temp history command performs the same action of frequency history the user must input the date as shown in Figure 15.

After short time the temperature chart shown on the desktop as in Figure 16.The chart shows the temperature with the range 0 to 128 during 24 hour.

9. Conclusions

A distributed wireless control system has been designed, where Bluetooth is used to communicate between the temperature sensing node, power line frequency measurement node , and the master station node.To prevent the complete failure of the system when the Bluetooth connection is lost the control algorithm is divided into two parts, one for the supervisory control, executing on a host system and one for the mission-critical control, executing locally in the substation.

10. References

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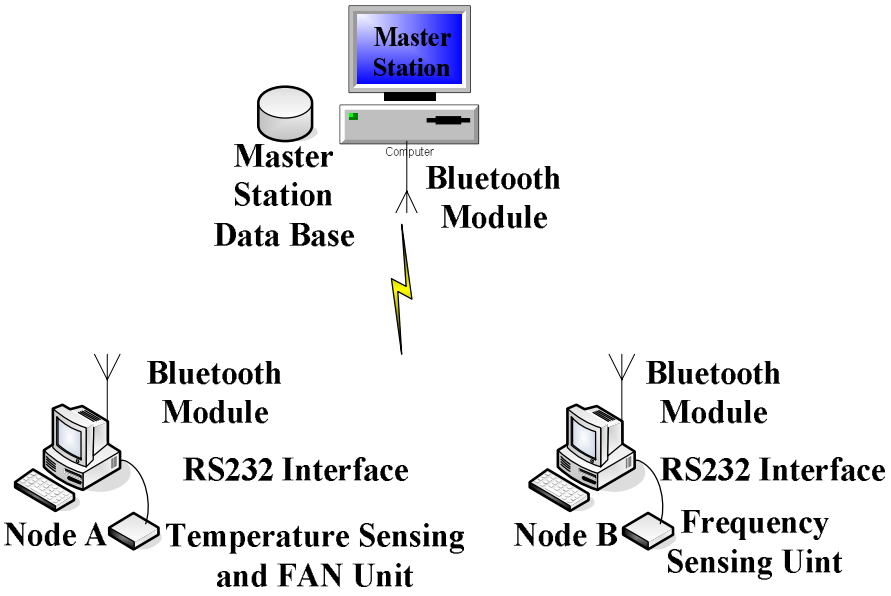

Figure (1) System Architecture

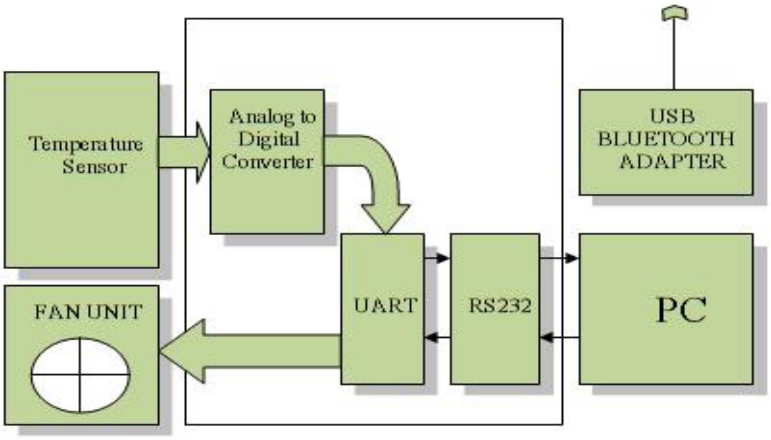

Figure (2) Temperature sensing unit (Node A)

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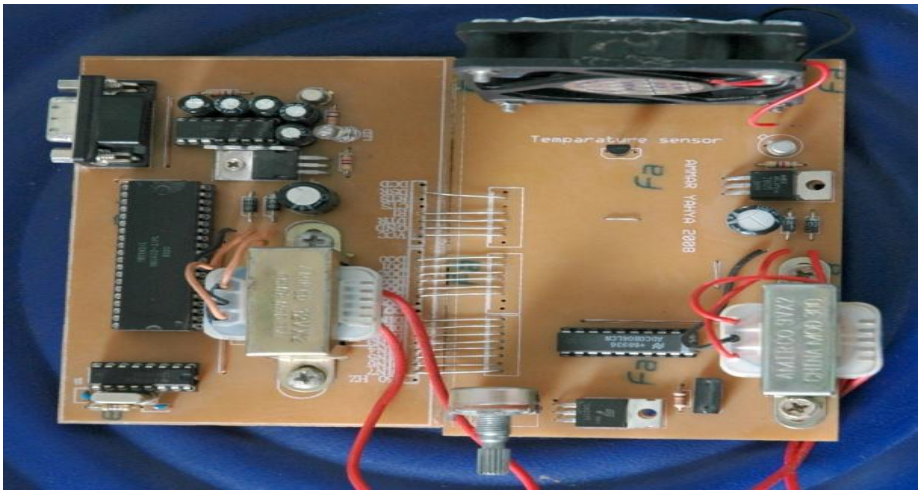
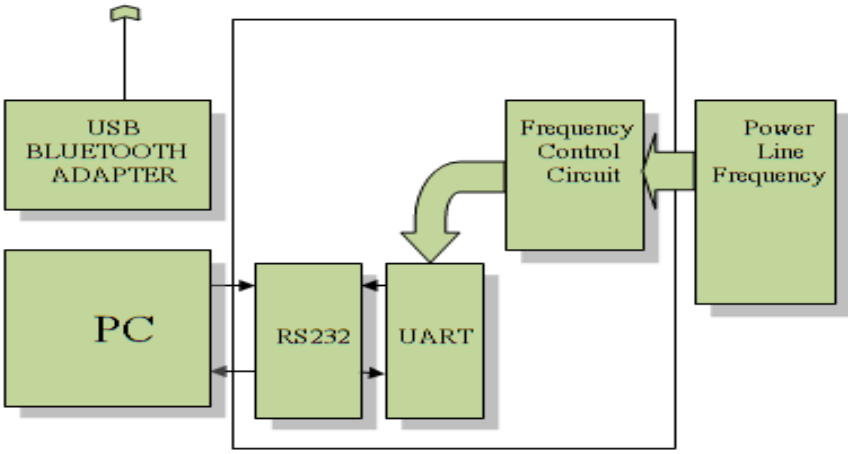


Figure (3) Temperature sensing unit board



. **Figure (4) Frequency sensing unit (Node B)**

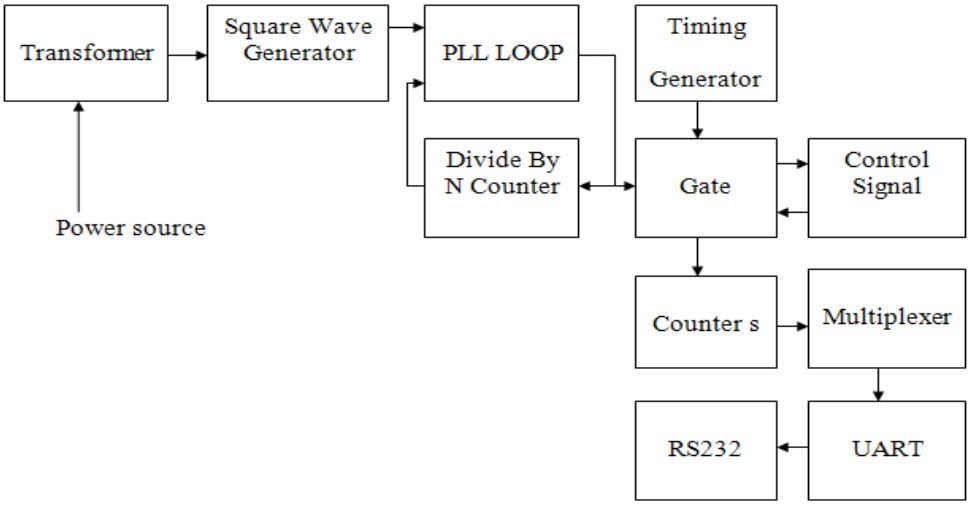


Figure (5) The frequency control circuit

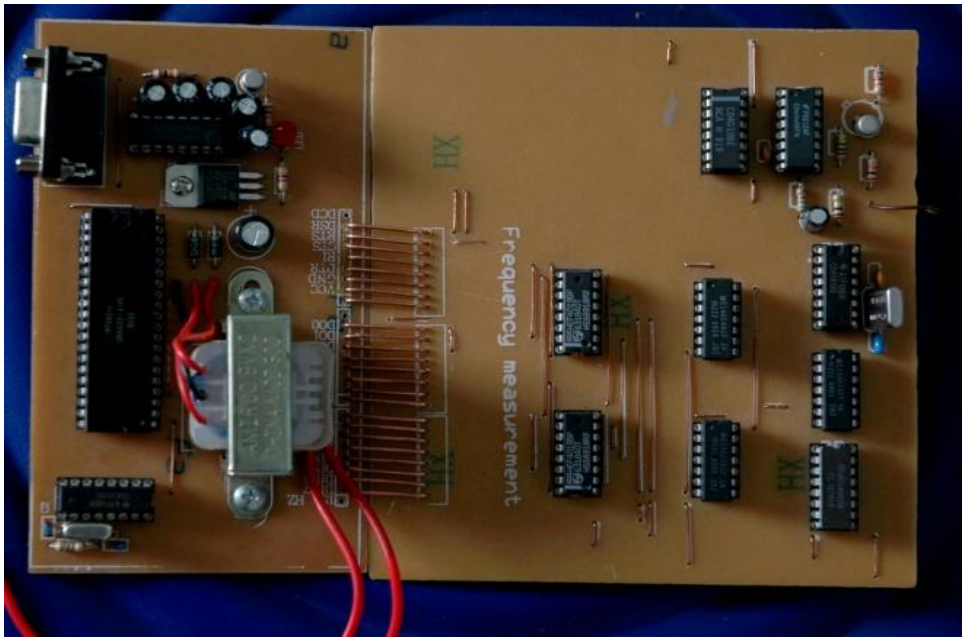


Figure (6) Frequency sensing unit

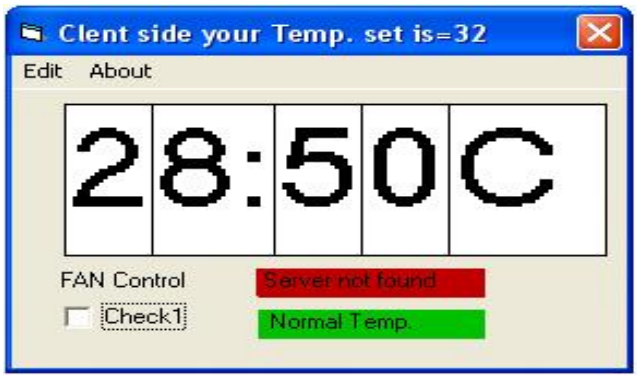


Figure (7) Node A socket program window

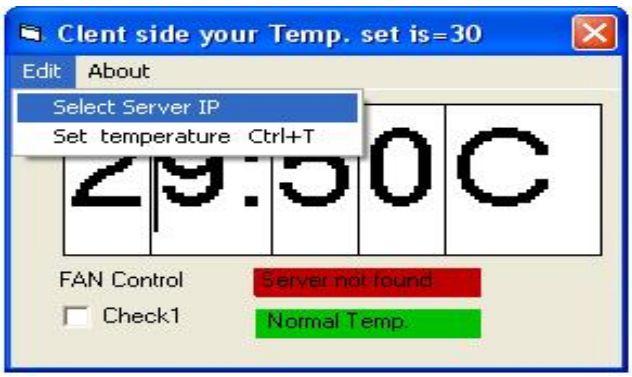


Figure (8) Setting of Server IP

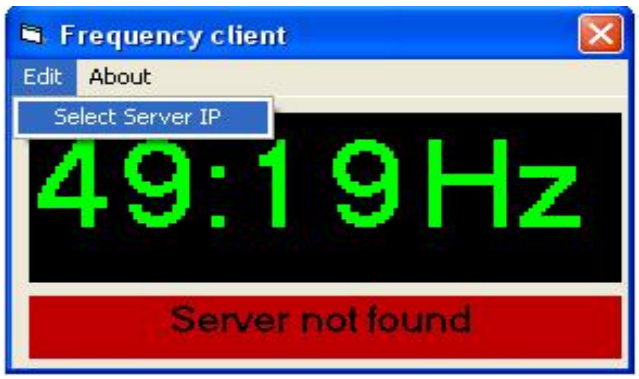


Figure (9) Node B socket program window

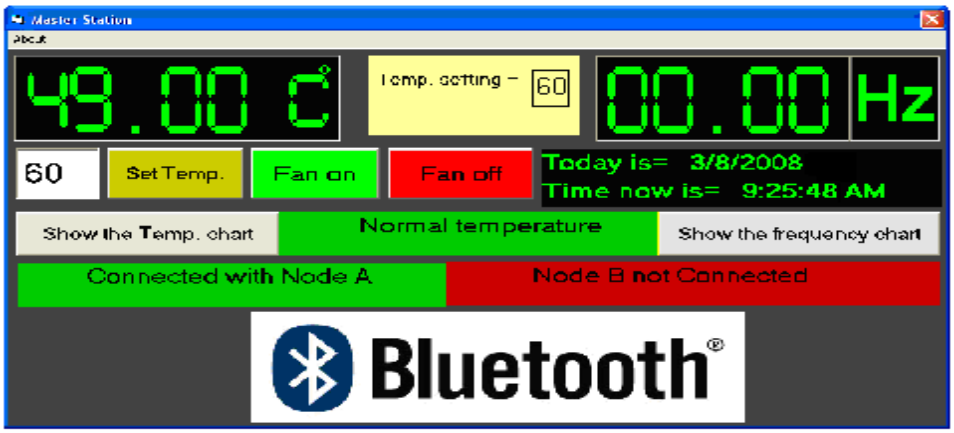


Figure (10) The connection state with Node A

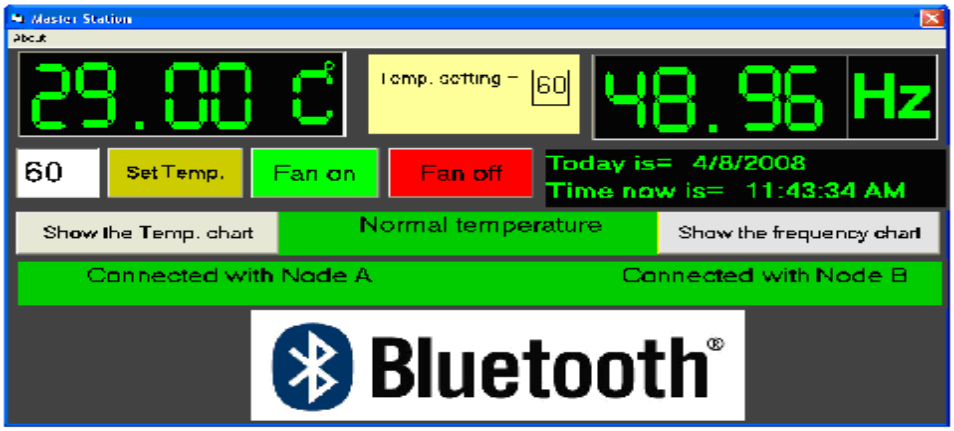


Figure (11) Master station connected with both Nodes

Figure (12) Frequency Reporting program

Figure (13) Report Message

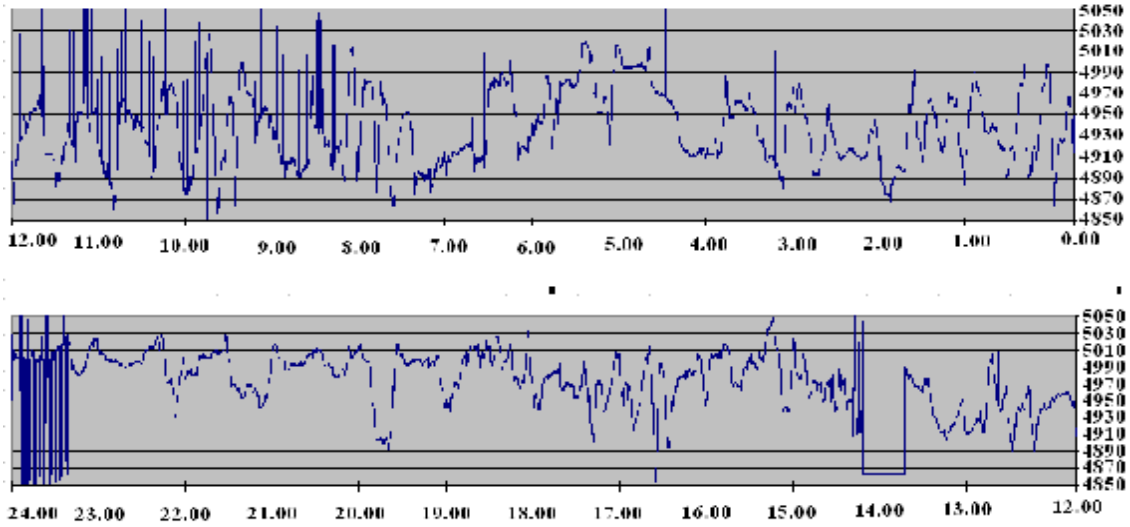


Figure (14) Frequency Chart of 4/2/2008

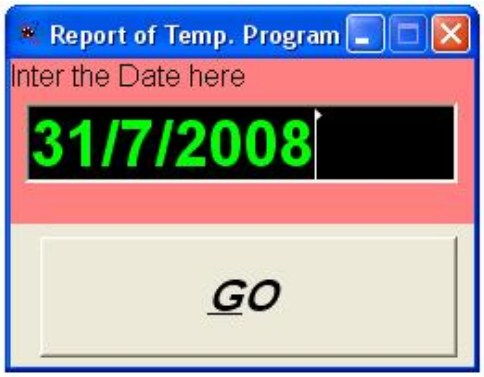


Figure (15) Temperature Report Program

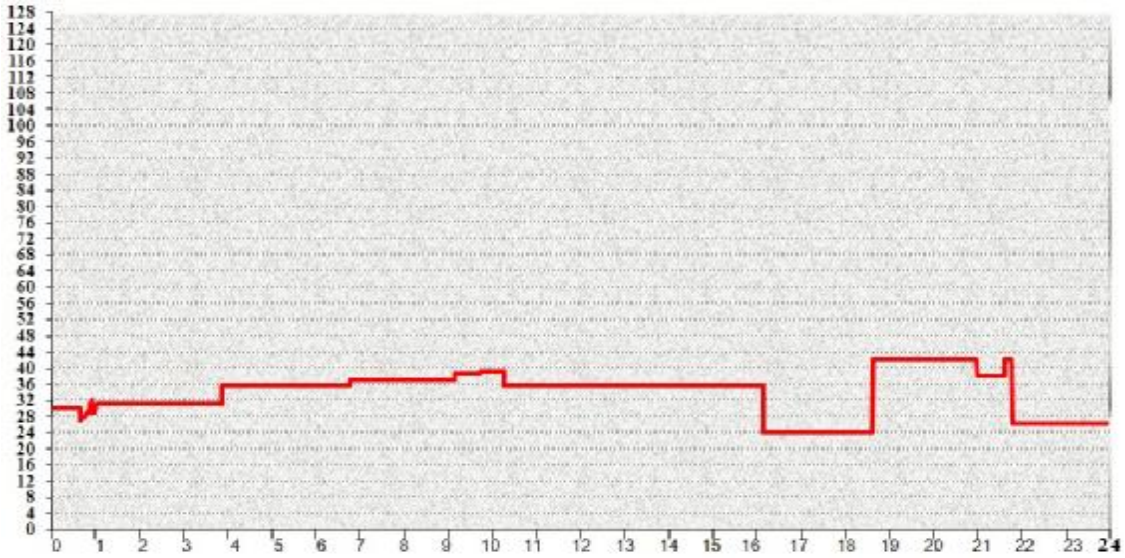


Figure (16) Temperature Chart of 31/7/2008