# Wireless Sensor Tree Network monitoring system through Web Server

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**Abstract**— Wireless Sensor Network (WSN) has touched our daily life and is getting developed day by day. Recently new WSN are designed to monitor environment or bio-organic purposes. Application of WSN technology cannot be limited within home appliances; it can also be used in Industrial application. Now a day's Industries use expensive wired LAN network in order to monitor. In this paper a cost effective wireless Industrial appliances monitoring system has been designed and implemented. The implemented system can be used to collection data or monitor industrial machineries and equipment through web server and take necessary actions based on the received data of temperature or humidity. The implemented system is cost effective and simpler than existing systems and utilizes Tree networking approach and uses NRF protocol in combination of router to upload data to the web server.

**Index Terms**— WSN, Tree network, Web-Server, NRF protocol, temperature, Industrial automation, Sensor monitor,.



## 1 INTRODUCTION:

IRELESS Sensor networks have gained tremendous attention in present research fields. It has unlimited application and significance in environment [1] [2], CO2 monitoring [3], agriculture [4], habitat monitoring [5]. But all these environmental and habitat monitoring networks are for limited number of motes and limited coverage area. A large area network needs complex routing and huge expenses which are describe in [6]. There are several projects using IOT but the overall cost for each automation is not effective and only limited devices can be controlled. A wireless sensor tree network monitor system is shown in figure 1. The system can monitor and at the same time control the connected industrial **appliances**. Unlimited number of nodes can be connected through tree networking and a single wireless router can receive the data from all the nodes. Any computer or mobile phone device connected to the network can monitor and control from web page.

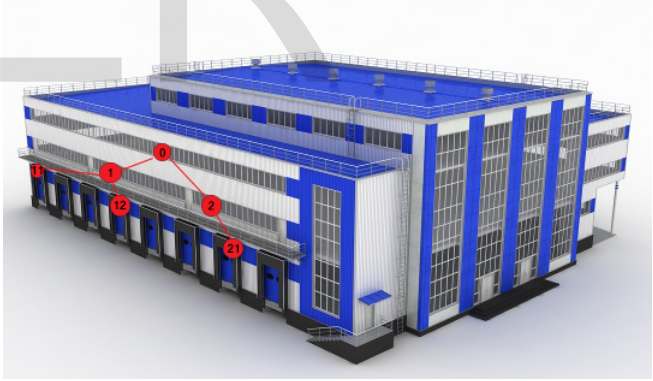


*Figure 1.* Wireless Sensor Tree Network Monitor

There are several projects using IOT but the overall cost for each automation is not effective and only limited devices can be controlled.A wireless sensor tree network monitor system is shown in figure 1. The system can monitor and at the same time control the connected industrial **appliances**. Unlimited number of nodes can be connected through tree networking and a single wireless router can receive the data from all the nodes. Any computer or mobile phone device connected to the network can monitor and control from web page.

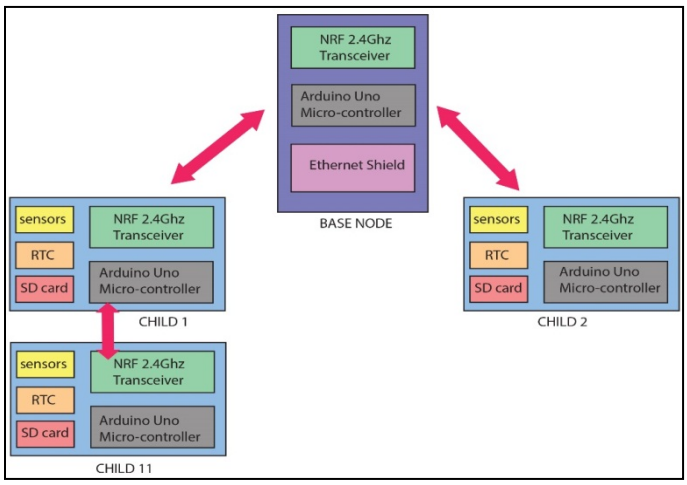


*Figure 2.* Basic Project Outline

## 2 WSN DESCRIPTIONS

This paper discusses a WSN tree network system which can monitor temperature of the connected appliance. NRF transceiver has been used to measure the temperature of the connected industrial load as it can cover 50 m distance indoor so the cost of the system will get reduced. Each mote can be equipped with different types of sensors like humidity and CO2 sensors. Figure 2 outlines a small wireless sensor network consist of 4 nodes. Base node is the parent node in this network. It has two direct child named as child1 and child2. There is a sub child named child11 which is a direct child of child one. Each node number is assigned according to their name and the name of each nodes parent for example there could be several child under base node. So any child of child1 is named as child11, child12, child13 etc. Similarly child of chil2 will be child21, child22, child23 etc. Base node receives data from its direct child but whenever a sub child transmits any data it route through its parents. Child11 sends temperature data to child1 and child1 sends its own data, also relays the data of child11. Base node understands data from its prefix. Base node decrypts these data and uploads them to webserver through a Wi-Fi router.

## SYSTEM ARCHITECTURE

In the system, there is a base station and several nodes connected to base station. These nodes are able to control, collect information and sense devices. The purpose of the base station is to transmit those data to web server. Unlimited number of nodes can be connected with one base station. Radio frequency is used to communicate between nodes and base station. On the other hand main child node needs to be within a circle of around 50 meter from the base station.

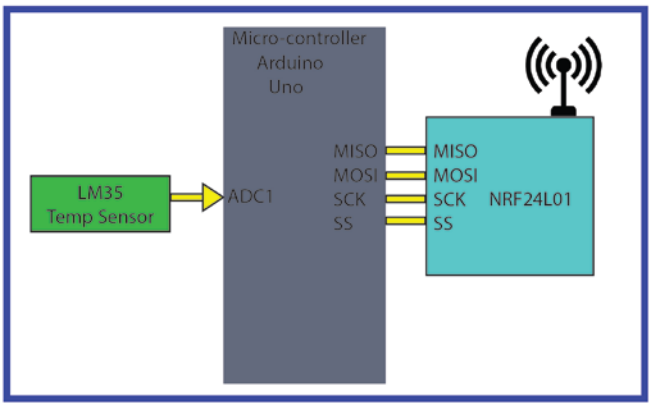


*Figure 3.* Block diagram of sensor node

Each node of the network can communicate with each other, if necessary. Base Node consists of a microcontroller called Arduino Uno, NRF transceiver, and an Ethernet module. The block diagram of transmission module is shown in Figure 3. Other nodes are similar to base module except that they do not have any Ethernet module connected to them. LM35 has been used as a temperature sensor. LM35 measures the temperature of surroundings and transmits it to micro-controller for further calculation. It gives analog voltage as output and micro-controller converts this analog value into digital value. To convert analog value into digital value micro-controller's ADC pins are used. To transmit the entire data Ethernet shield is used. Ethernet shield is connected with micro-controller through Serial Peripheral Interface (SPI). Data from Ethernet shield is transfer to web server through router.

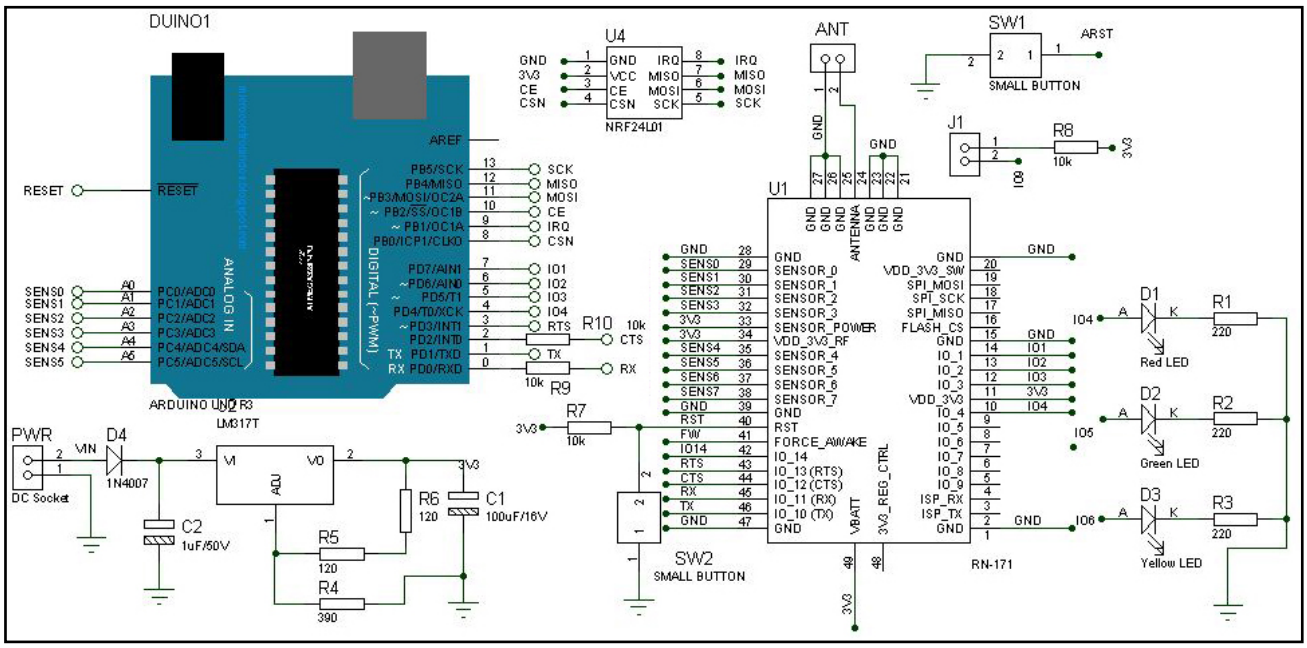


*Fig.4.* Main Circuit Diagram

The main part of the base station is Arduino Uno microcontroller. ATmega328 is the heart of the Arduino Uno. The internal configuration of Arduino uno is shown in figure 4. With Arduino Uno NRF24L01 RF transceiver is connected through serial peripheral Interface (SPI). The NRF24L01 is a highly integrated, ultra low power (ULP) 2Mbps RF transceiver IC which operates at 2.4GHz ISM band. It has a 6 data pipe MultiCeiver [6]. NRF transceiver operates through serial peripheral interface. MISO, MOSI, SCK & SS pins of Arduino is connected with the same pins of NRF transceiver which is shown in figure 3. Pin no 8, 9, 10, 11, 12, 13 of Arduino Uno is connected to 4, 8, 3, 6, 7, 5 no pins of NRF transceiver. Here Arduino is the master and NRF is the slave. NRF runs on 3.3v DC which collects from Uno. Each base node has its own Mac and IP address as shown below:-

Base Node Mac Address: - DE, AD, BE, EF, FE, ED

Base Node IP Address: - 192.168.5.180

Arduino Uno creates the webserver with each static IP. For example, for the base node at first Uno initialize the server through following code but to communicate and write data to an HTTP page the code must be in HTML language:-

// (port 80 is default for HTTP):

```
EthernetServer server(80);
Ethernet.begin(mac, ip);
```

For HTTP communication the default port address is 80. And for each mac and IP address Ethernet module create a communication. Following lines create test on HTML page.

```
client.println("HTTP/1.1 200 OK");
client.println("Content-Type: text/html");
client.println("Connection: close");  // the
connection will be closed after completion
client.println("Refresh: 5");  //refresh page every 5s
client.println();
client.println("<!DOCTYPE HTML>");
client.println("<html>");
client.print("child1");
client.print ("Temperature: "+ String(temp) +"*C");
client.println("<br />");
```

HTML pages needs to be refreshed to view new data. Most of the time which is done by refreshing

the web page. But while monitoring a continuous system it is not a practical solution. To overcome this problem here microcontroller will refresh the webpage every 1 seconds automatically. Human might not be able to check the temperature and alert manually all the time. Here Uno will monitor the system and generate alarm if the system finds any high temperature around any child. And the alert must be in red color to distinguish it from normal data. The following code generates alert in HTML page.

```
If (temp > 40)
client.print (F("<font color=red> ALERT: High temp</font>"));
client.println ("<br />");
```

This way the entire children are monitored and also updated in HTML page.

## V. Technology Used

To reduce the overall cost Here NRF24lo1 transceiver is used for communication part of the tree network and to connect the complete network with webserver. A NRF transceiver can communicate with 6 devices at a time as there are 6 different pipelines for communication. Each transceiver contains Rx address and Tx address. But the Rx and Tx address are same. In order to send data or receive data from the SPI port CSN pin of the 24L01 must be kept high to start out with. Then, bringing the CSN pin to low in order to give the alert to the NRF24L01 that it is about to receive SPI data. This CSN pin will stay low throughout the entire transaction. Thus transmission of the command byte of instruction can be sent. After transmitting or reading all the byte, CSN pin is brought back to high.. The TX_ADDR register is 5 bytes wide and 5-byte addresses is used. First, bringing CSN low and then sending the command byte '00010000' to the 24L01. This instructs the 24L01 that needs to read register 0x10, which is the TX_ADDR register. Then five dummy data bytes is sent and the 24L01 will send back to you the contents of the TX_ADDR register by finally bringing the CSN pin back to high. The tree network of 4 nodes with base station is shown in figure 5.

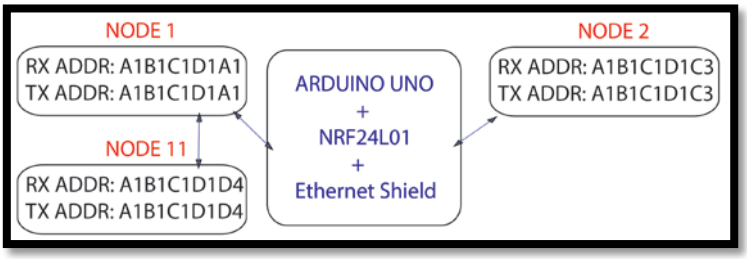


*Figure 5* Tree networking of 4 nodes with base Station

Transmission side of the node collects temperature, processes it and transmits it as fixed packet format. Here analog sensor LM35 is used. This sensor gives output voltage according to the room temperature. For each degree of centigrade change in weather a change in the voltage of 0.01v happens. So if the room temperature is 32 degree centigrade it gives 0.32v as output. As the input analog voltage is very low Arduino uses its internal voltage reference of 1.1v. The analog input range is 0v to 1.1v and equivalent digital value is 0 to 1024. For example if the room temperature is 32 degree centigrade corresponding digital can be achieved by following equation:-

$$\text{ADC\_value} = \frac{Analog\ Value * 1024}{Voltage\ Reference}$$

Here,

Analog_value = 0.32;

Voltage_ref = 1.1;

So, ADC_value= 297

From ADC_value we need to convert digital value into analog value as the analog value represents the temperature.

$$\text{analog\_voltage} = \frac{ADC\ Value * Voltage\_Reference}{1024}$$

So temp = 0.32 * 100

= 32 Centigrade.

## VI. SIMULATION AND DATA LOGGING

Each sensor sends data to receiver and receiver transmit it to base node. Here data logging of temperature is shown in Figure 6. Simulation is performed in proteus ISIS. With the base node only a virtual terminal is attached to monitor all the data it' s receiving from its child. Each micro-controller runs on 16MHz oscillator. Here LM35 temperature sensor is attached to ADC pin of each child. Child1 and Child2 transmit their temperature value to base station. Child1' s child transmits its temperature value to its parent. When Child1 transmits its data it also sends the temperature of child11. In this way Base node gets all the information from its entire child.

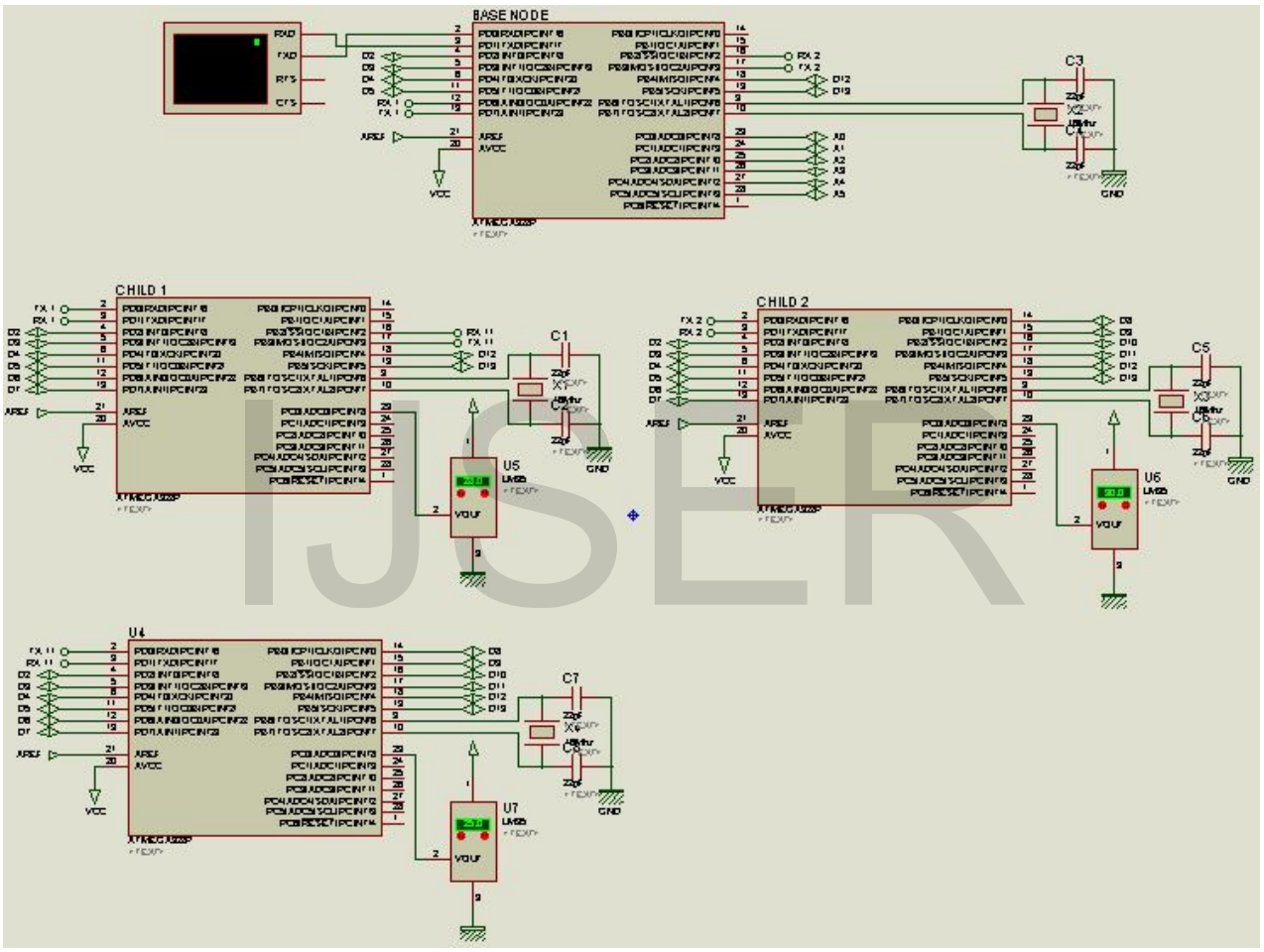


Figure 6. Simulation of WSN

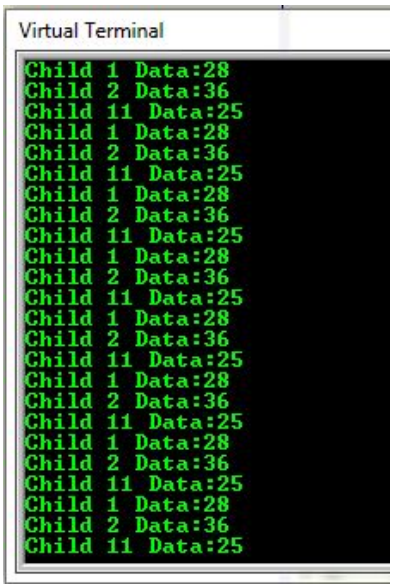


Figure 7 .Temperature of different Child.

## VII. HARDWARE IMPLEMENTATION AND OUTPUT MONITOR

To Develop WSN, each mote is connected with receiver through NRF transceiver. Figure 8 is the hardware representation of entire network.

*Figure 8.* Hardware Implementation

There are four Arduino Uno is in the hardware and TCP/IP Wi-Fi router. The base node sends the output data to webserver. The output data are shown in figure 9:-

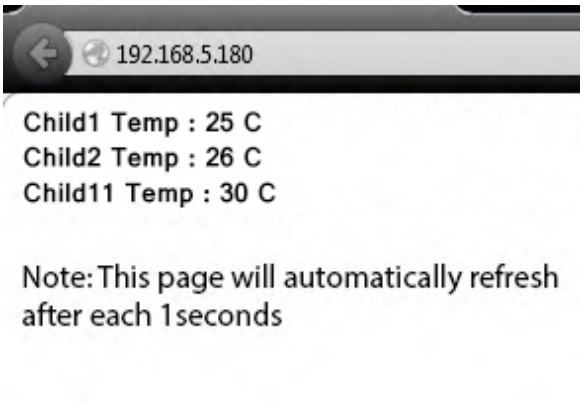


Figure 9.Web server Output.

If somehow temperature increases more than 40 centigrade webserver generates an alarm. Which is shown in Figure 10:-


Figure 10.Webserver output with Alarm.

## VIII. Further Application

In future by using Wireless Sensor Tree Network technology, complete industrial automation could be accomplished. Wireless Control of any machine via Internet can also be possible. Again real-time collection and transmission of the temperature, humidity and other environmental information in agricultural greenhouses can be completed. Official access & attendance systems, patient monitoring systems for doctors could provide a new approach to the realization of modern intelligent life. Monitoring the temperature of Industrial boiler and oven could also make industrial controlling easier.

## IX. Conclusion

For very small distance like 50meter NRF transceiver is reliable but if any movable object goes beyond this distance then it will be untraceable. ZigBee can be used for long networking. Here limited number of nodes has been used but more than 6 nodes are little complex through NRF24l01 transceiver. Overall we can say that a tree networking approach is cheap to connect the network with webserver and our dream of connecting each component of this world with internet can be achieved very rapidly. It could be considered as a perfect present time solution until Wi-Fi modules comes in cheap with IPv6



## X. Acknowledgement

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