Implementation of Efficient Parameter Monitoring Using Cooperative Communication Technique

Abstract
In order to improve the Quality of Service in wireless networks it is crucial to design and optimize the communication systems. This system shows that instead of relying on traditional wireless networking we rely on the much broader definition of a link, used in the context of cooperative communication by which we can improve the performance of relay transmission systems operating over the wireless medium. Enabling cooperation among nodes in an optimal manner can lead to significant increase in the throughput for multi-hop wireless networks. We implement cooperative communication that leads to increase in throughput. Wireless sensor network using co-operative communication based on ZigBee data acquisition system is implemented in view to overcome the problem of potential loss of data. This system which includes ZigBee network and database management system has many important advantages such as low cost and low power Consumption. Furthermore, the system is simple, anti-interference and highly practicable. The system dedicates to automatic data collection without potential loss of data.

1. Introduction
Telecommunication is a science of sending and receiving information such as sound, visual images, or computer data, over long distances through the use of electrical, radio, or light signals, using electronic devices to encode the information as signals and to decode the signals as information. Wireless communication is the transfer of information between two or more points...
that are not connected by an electrical conductor or physical media. Wireless operations permit services, such as long-range communications, that are impossible or impractical to implement with the use of wires. The term wireless is commonly used in the telecommunication industry to refer telecommunication systems (e.g. radio transmitters and receivers, remote controls etc.) which use some form of energy (e.g. radio waves, acoustic energy, etc.) to transfer information without the use of wires. In recent years, the field of wireless communication has shown a tremendous amount of development with respect to research and practice.

Applications range from the daily needs like mobiles, Wi-Fi, to commercial uses like satellite communications. With the aid of current technology, it is possible to communicate with any corner of the world. These technologies require a reliable and integrated system for better performance. Wireless communications are often hindered by noisy environments and that make the system unreliable. The interference from neighbouring nodes is also a problem. Hence there is a necessity to improve the performance of the system where the Neighbor nodes can work in coordination with the sender. Cooperative Communication is one of the methods by which one can obtain a reliable communication. In this method, intermediate nodes cooperatively communicate with each other to transmit the information i.e. cooperative communication by multiple users in a diverse environment can be called as cooperative diversity. This type of transmission is reliable and also increases the throughput, hence it gradually improves bit error rate (BER).

Temperature Sensor LM 35 is used to sense the temperature at each node. The sensor used for temperature is calibrated in degree Celsius with Sensitivity +10mv/C. Output range for this sensor is 4 to 30 volts and operating current is 60μA. MQ6 is used as gas sensor which has high sensitivity to gases like methane. Output range for this sensor is 1 to 3 V DC. Light Dependent Resistor is used sense light. The output from sensors is in the form of analog signal. This signal is fed to ADC which will convert it into digital form. The digital signal is then applied to ARM controller. The ARM Controller used in the system is LPC2148. The ZigBee module is interfaced to ARM controller. Here the ZigBee module works on TTL Txd and Rxd pins. LCD will display the data at each wireless sensor node. Relays are used for controlling action. Zigbee modules operate within the ISM 2.4 GHz frequency band. There are three analog sensors interfaced with the ARM microcontroller. ARM7 microcontroller has in built in 10 bit ADC. Microcontroller 89C51 is used for Sub master units.

Figure 1.1: Block diagram of Wireless Sensor Network
2. System Implementation

At regular interval Master will send the request for data to wireless sensor node through sub masters. Personal Computer generally acts as a Master terminal. The request will be sent in the form of frames. The frame transmitted by PC master will contain information regarding the sub master id and the wireless sensor node id from where the data is to be retrieved. The sub master on receiving the frame will then check for the wireless sensor node id and will retransmit the frame as it is.

If one of the sub masters fails then the other sub master can also send the data of the other wireless sensor node. The ZigBee module is interfaced to ARM controller. The wireless sensor nodes who are in range receive the incoming frames and stores in the internal RAM memory. If the incoming slave ID matches with their own slave ID then they accept the frame and send the parameter back to the master. If the ID does not match then the slave discards the frame. Wireless sensor nodes will measure the different parameters like temperature, light intensity and Gas and will send back the data to PC master through sub master units. The data will also be displayed on LCD. Relays are provided for controlling action. If the parameters at one of the wireless sensor node are not as per the expected, then the controlling action will be taken by the PC master terminal. ZigBee, namely IEEE802.15.4 technology standard, is one of WPAN standards. ZigBee aims at short distance two sided communication.

3. Algorithm & Flowchart

A. Basic Algorithm
1. Start
2. PC Master will send the request.
3. Sub master will receive the request and will send the same to wireless sensor node.
4. Wireless sensor Node will collect the data.
5. ZigBee module will transmit the data to sub masters.
6. ZigBee module connected to PC will collect the data from sub masters.
7. The data will be displayed graphically.
8. Stop

![Flowchart](image-url)
B. Slave Unit Algorithm
1. Switch on the power, initialize LCD and display project name.
2. Check if time is reached an interval of 2 seconds to fetch the data.
3. If yes, then select channel 3, read data, store and display temperature readings.
4. Then select channel 4, read data, store and display light readings.
5. Check temperature and light with set point values and switch relay on/off.
6. Select channel 7, read data, store and display gas readings.
7. Check gas with set point value and switch relay on/off.

C. Sub Master Unit Algorithm
1. Receive data frame from PC Unit.
2. Check Slave Unit ID for which that data frame was sent from PC.
3. Send request to respective Slave Unit.
4. Get response back from Slave Unit with respect to original request.
5. Send that response back to Sub Master Unit which sends it back to PC Unit.
6. PC Unit sends that response back to PC.

4. Results
A. Slave 1 is ON
1. Turn on PC Master and Wireless Sensor Node1 and sub master unit.
2. The parameters temperature, GAS and Light intensity will be measured and will on GUI for Slave 1.
3. When wireless sensor Node is in range of PC master terminal it will directly communicate else the communication will take place through sub master units.
4. When we click on the Temperature Slave 1, the graph of temperature vs. time will be plotted.
5. When we click on Light Slave 1, the graph of light intensity vs. samples will be plotted.
6. When we click on Gas Slave 1 the graph of Gas vs. samples will be plotted.
7. Following fig shows the results for Slave 1 and the graph shows the variations of Light Intensity.
B. Slave 2 is ON

1. Turn on PC Master, Wireless Sensor Node 2 and Sub Master Unit.
2. The parameters temperature, GAS and Light intensity will be measured and will on GUI for Slave 2.
3. When wireless sensor Node is in range of PC master terminal it will directly communicate else the communication will take place through sub master units.
4. When we click on the Temperature Slave 2, the graph of temperature vs. time will be plotted.
5. When we click on Light Slave 2, the graph of light intensity vs. samples will be plotted.
6. When we click on Gas Slave 2 the graph of Gas vs. samples will be plotted.
7. Following fig shows the results for Slave 2 and the graph shows the variations of temperature.
C. Slave 1 and Slave 2 are ON

2. The parameters temperature, GAS and Light intensity will be measured and will be displayed on GUI for Slave 1 and Slave 2.
3. When Wireless Sensor Node is in range of PC master terminal then it will directly communicate else the communication will take place through Sub Master Units.
4. When we click on the Temperature captured by Slave 1, the graph of temperature vs. time will be plotted.
5. When we click on Light captured by Slave 1, the graph of light intensity vs. samples will be plotted.
6. When we click on Gas captured by Slave 1, the graph of Gas vs. samples will be plotted.
7. Following fig shows the results for Slave 1 and the graph for temperature vs. time.
8. The data will be stored in database and we can view this data in excel file. Please find below the saved data in excel for Slave 1 and Slave 2.

![Graph showing results for Slave 1](image)

Figure 4.3: Results when both the slaves are on

Table 4.1: Relay Operations for Measured values

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Light Intensity</th>
<th>Gas</th>
<th>Time</th>
<th>Temperature</th>
<th>Light Intensity</th>
<th>Gas</th>
<th>Action Taken</th>
<th>Relay 1</th>
<th>Relay 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>50</td>
<td>60</td>
<td>17:34:04</td>
<td>25.7</td>
<td>14</td>
<td>15.7</td>
<td>OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>60</td>
<td>17:34:08</td>
<td>42</td>
<td>35</td>
<td>20</td>
<td>OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>60</td>
<td>17:34:10</td>
<td>42</td>
<td>13</td>
<td>39</td>
<td>OFF</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>60</td>
<td>17:34:12</td>
<td>25</td>
<td>12</td>
<td>65</td>
<td>OFF</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>60</td>
<td>17:34:14</td>
<td>32</td>
<td>20</td>
<td>87</td>
<td>OFF</td>
<td>OFF</td>
<td></td>
</tr>
</tbody>
</table>
As shown in the table relays 1 and 2 will operate on the monitored values of parameters. Relay 1 will switch to On/OFF depending on the values of the temperature and light intensity. Relay 2 will switch the operation if there exists a gas leakage.

5. Advantages of the System

I. High accuracy in terms of data collection for each node.
II. Co-operative communication technique is used to avoid potential loss of data.
III. High efficiency and reliability in terms of data collection and control. For multiple wireless sensor nodes data will be collected efficiently.
IV. The systems where manual interaction is involved there exists a time delay in parameter measurement. Hence to achieve the high speed this system is developed.
V. Simpler and highly practicable circuit in terms of system operation.
VI. Reduction in complicated cables and to avoid failure of data collection over large networks.

6. Applications of the System

I. Data Logging in hazardous application like gas plants, nuclear plants and chemical plants.
II. Wireless communication in industries.
III. It also finds application where it is difficult to measure and control the different parameters.

References