Chapter-5

Conclusion & Future Scope
5.1 Introduction
The main thrust of the research was to design and develop a remote monitoring system that can work independently and with minimal human interaction. The objective was achieved using the microcontroller TINI which has capability to interface with the Ethernet card. The system was tested for acquisition of parameters associated with weather, like temperature, humidity etc.

5.2 The Hardware
The system was designed through the tight coupling of various sensors, LCD to the base board with TINI board. For monitoring the weather parameters remotely we have used the TINI board instead of a personal computer at remote location, as this board has a capability to get connected to internet directly. This board is also used as HTTP server. For this purpose we have assigned a separate IP address to the TINI board. A server computer at weather station is used for acquiring the data and to transfer it in the database. We have used a PC for development and for transferring the application software onto the system. Hence we can say the actual weather station is just one base board and TINI. This reduces the cost of the system and on the other hand it makes our system portable, easy to install and maintain.

5.3 The Software
Our aim was to enable the hardware to work as a self supporting system. We have developed the application software for the base board and for the TINI board. The base board software is firmware and developed in C language. The compiled code is firmware. Since we have used TINI board having embedded java, its runtime environment provides the entire software infrastructure needed to write network aware applications. We have developed our application software in Java using NetBeans. The application software plays an important role both on client side as well as on server side.

5.3.1 Software for the Client server
The client side has to view the weather data from a remote place. For this we need to provide user interface from where user can easily interact with TINI. The TINI itself does not support any graphics classes and so output can only be viewed from the command line. One could just log onto the TINI from a remote location via a TELNET session and view the output; provided the user must know the user-id and password to access the TINI board. Providing the same to each and every user is not a good practice for our hardware as well as software. This however leaves the TINI open to malicious attacks and also does not provide a user-friendly interface to
the user as well as the fact that the information is not being transferred from TINI to Ethernet. Hence we have decided to provide a common platform for everyone, so that accessing weather information became easy. We have enhanced the communication capabilities of TINI board and developed a graphical user interface (GUI). As stated earlier TINI board does not support any graphics classes hence we needed to develop the GUI using simple HTML programs and not used scripts. This development lead to remote accessibility, avoids the unnecessary installations of the supporting software’s on client machine. This reduces the space complexity. As windows operating system provides the internet browser support; accessing the remote weather station became an easy task. The user needs to know only IP of the weather station. The user over a network can access the server application by typing the IP number of the TINI in a web browser. On receiving the user request the Index.html page is served to the user.

5.3.2 Software for the Server Side

The server software does all the handshaking between client and base board. As already said, the base board is connected to TINI via serial port. The request received from the client through various web pages is checked by service provider of server. Depending on the request, the command is passed on to base board, be it for LCD display or reading of parameter. On receiving the command from the TINI, the base board, if it is for parameters, reads all the parameters and pass on to TINI as per the protocol. The Server receives this information and after segregation the data is displayed on the relevant page for the client. The server also checks the data received and compares it with the last one, if the data defers, it is also sent to the central database. This is done to avoid redundancy to manage the size of the central data base.

5.4 Testing and Results

Initially the system was tested for temperature monitoring by interfacing many 1-wire temperature sensors. The test was carried out to monitor the temperature of any particular area over local area network. The 1-wire temperature sensor has been used in the system for the simplicity, as no glue logic is required for converting this analog parameter to digital form. After setting up the 1-wire communication protocol we are able to monitor the temperature. The results are very encouraging. The data has been transferred to global network as well as the same is stored in a file on board, which can then be downloaded for further use. The 1-wire sensors are used for temperature monitoring made the system very simple and on the other hand expandable. With few modifications in the firmware for addition of more number of devices.
The system was extended for sensing parameter associated with humidity. The humidity sensor gives the output in the form of frequency. The number of frequency pulses per second is counted. With the help of this value we have calibrated the humidity.

The weather cock is also developed for detecting wind direction. For this development we have used eight reed switches and a fly wheel. The magnet is placed on a cock, which is fixed on a small ball bearing for free movement. This is done in such a way that at any given time it is over one of the reed switches. The closure of the reed switch gives information about wind direction.

The system was capable of providing instant visual feedback at remote location after the successful implementation of weather monitoring. This was done by developing the serial communication protocol using the Keil C software. The LCD was used to communicate this types of interruption.

The LCD is used for instant visual feedback of weather parameters at local sub station, as well as the same can be used as messenger. If any of hardware components fail & system produces wrong results, this facilitates the developer to correct the same by passing the message through LCD. Then the concerned person at remote location can take care of the same. This reduces the need to visit & replace the failed components by the developer. This can be done remotely.

The same system with only 1-wire temperature sensors was implemented in IVF laboratory in one of the hospitals in Aurangabad. The temperatures of IVF laboratory & operation theatre are made available at doctor’s desk on a single click in GUI as well as the same will be displayed on LCD located at reception hall. This implementation is done over local area network of the hospital. Considering emergencies in hospitals we made LCD based communication to work as a messenger for receptionist. Any staff member of hospitals can pass the message in case of emergency on this display.

The salient features of the system were data storage capability, end-to-end data reliability, a flexible and easily extensible framework, and a robust architecture. The data is sent to client and to the central database at user defined time interval. This process is repeated continuously. The data will be continuously displayed on Web page. With the help of this data the statistical manipulation could be done.

The present implementation meets all of these functional and design objectives. The system has been successfully tested using the wired Ethernet interface on the TINI.
5.5 **Salient Features**

The system developed has following advantages:

5.5.1 Users can interact with appliances using a device having a web browser such as PC, Cell phones etc.

5.5.2 The cost of hardware is very competitive and it is very friendly and can be adaptive in different environments.

5.5.3 The devices can be controlled, monitored, updated remotely.

5.5.4 Software has user friendly interactive features.

5.5.5 The add on of additional sensor can be interfaced and integrated easily. The future demands on weather parameters or any other requirement can be done easily.

5.7 **Future Scope**

The present system monitors three weather parameters only. Being embedded system, the expansion of the system is very easy. We can update the system and make it feasible to monitor other weather parameters.

The single serial port available on TINI makes it single user system. The sharing of this serial port among many threads could also be done to make this system true multi user.

Wireless networking could also be used. In this case, this station could be placed at any location regardless of other resources. Use of solar energy will solve the problem of the power required by the system at such remote place. Graphical user interface can be updated & made available in user selectable languages.

The system needs to be installed at different places and also needs to be integrated with global monitoring system for its effective application in global forecasting of the weather.