3. Hardware design aspects of the proposed system

Primary function of the proposed system is to monitor and control temperature and humidity from geographically dispersed locations. Basic hardware of embedded system is fabricated into two boards, Monitoring and Controlling board. Monitoring board which continuously sense temperature and humidity and after calibration value is made available in LCD connected with it as well as RS232 interfaced with it. Controlling board will continuously monitor the sense values against some set(limit) values. If the sense values exceed the set values it carry out necessary control to start some hardware devices for controlling parameters at desired limit. Devices are connected through relays connected in controlling board. RS232 of both boards are connected with the two COM ports of the Embedded/Database server computer. Server computer stores sense data of temperature and humidity in tables of database which itself is connected in LAN/WAN. User interactive front-end is designed in server as well as clients for monitoring and controlling the parameters. As a web enable system web server and mail server configuration has done with browser configuration at clients.

3.1 Stand-alone hardware view of the system

Stand-alone hardware view is explained through its block diagram and schematic diagram in next two sections.

3.1.1 Features and block diagram

It mainly consist of two boards monitoring board and controlling board. Monitoring board with attached transducer [1] sense the physical parameters. These analog values are fed into ADC for conversion. Microcontroller on receiving digital value perform necessary operation for displaying and storing of same in attached computer through COM1 port. MAX232 is inserted between microcontroller and DB9PIN to make these devices compatible. Controller board responsible for running hardware devices for controlling parameters through relays. ULN2003 is the driver IC used to supply necessary current to drive the relay. A brief explanation on design [2,3] and basic functional components of proposed embedded set up is given in the section 3.1.2
Figure 3.1: Block Diagram of the system with embedded server
3.1.2 Schematic description of the functioning components

Figure 3.2 Schematic Diagram

Schematic Diagram (Monitoring Circuit Board)

Schematic Diagram (Controlling Circuit Board)
a. **Power supply section:** The regulated power supply section made with full wave rectifier (with IN 4007 diodes) using voltage regulator IC 7805 and IC 7812 which provide a constant voltage of 5V to the circuit as well as constant 12V to relays.

b. **Analog to digital conversion section:** Analog parameters temperature and humidity are converted into digital by ADC 0809 which is a 8 channels microprocessor compatible ADC with easy availability [4]. It will convert the analog signal of the transducer to digital value with respect to the reference voltage which is 2.5V in proposed system. This reference voltage is obtained using TL431, which is a programmable shunt voltage reference with output voltage range of 2.5V to 36V and works like zener diode [5]. For the conversion ADC requires a reference frequency which is supplied from 555 IC in the form of astable oscillator. The conversion frequency is kept around 150 kHz.

Sensor used for temperature measurement is LM 35. LM 35 is calibrated in °C and is linear in +10 mV/ °C scale factor with 0.5°C accuracy [6]. It uses humidity sensor LM324DG [7].

Amplifier circuit is used to amplify the electrical characteristic obtained through the transducer to raise the strength sufficiently.

c. **Controller section:** The analog value is converted to digital value by ADC and is picked up by microcontroller AT89S52 which is a 40pin device. The AT89S52 is a low-power, high-performance CMOS 8-bit microcomputer with 8K bytes of Flash programmable and erasable read only memory (EPROM) [8].

d. **Display section:** In addition to continuous display of sense temperature in the front end screen of computer in hardware circuit(a) on board 44780 LCD is used which is a 2x16 line display [9, 10].

e. **Temperature control section:** This section consists of a 12V relay to control hardware to start cooling for maintaining temperature as set by the user. [11]

f. **Data transfer:** Displayed temperature is transferred to RS 232 which is interfaced with microcontroller through MAX232 [12, 13]. In this implementation monitoring board can be considered as transmitter as after converting the sense temperature into digital form it will transmit the same to RS232. A program executed simultaneously in computer will read and display the same in the front-end designed in the monitor. Additionally front-end will display temperature set value and status(on/off) of hardware device and enable user to enter new value of temperature in the database generate curve of temperature with respect to time. Controlling board will continuously compare sense data with set value and run hardware device for controlling temperature and humidity.
connected with relay through ULN2003[14] to amplify the required current necessary to drive the relay.

3.2 Hardware features used for Intranet and Internet

Hardware features with Intranet is the normal Ethernet based LAN system. Embedded server is the computer where embedded boards are connected through COM ports. Due to some hardware constraints of processor Atmel 89S52 monitoring and controlling boards are connected through COM ports. Embedded server used is a normal PIV system with processor E7400, 160 GB HDD, 2GB DDRII RAM, Intel DG31PRII motherboard. Clients are also having same configuration. Some clients are having Celeron processor. MySQL Database server configuration is done either in embedded server or in any one of the node to store the updated values of temperature and humidity. Network is in star topology and connected by two switches DGS3100-48 [15]. It is a 48 port 1000mbps switch with 4 SFR ports from Dlink. For internet access user should have a IP address for interactive use. For testing as web enable device one of the node of existing system IIS configuration is done for providing web services.

3.2.1 Hardware features with LAN implementation

As already stated monitoring and controlling boards are connected to embedded server which itself is connected to LAN through structured cabling. LAN itself is capable of connecting nearly 100 of nodes in a STAR topology. LAN is Ethernet based and connected by Cat 6 UTP cable capable of giving performance upto 1000gbps.

Block diagram of the system implementing LAN can be depicted as given in figure 3.3.
Figure 3.3 System with LAN setup
3.2.2 Hardware features with Internet implementation

It is proposed to connect the LAN to internet with its own IP address to make it accessible from any location [16]. Mail server is implemented to check the authenticity of Internet user when try to make change the limit values of parameters. It keeps track of authorized mail addresses in a database. Functioning of same explained in parts 4.7, 4.8 and 4.9. Figure 3.4 shows the system implemented in Internet.

Figure 3.4: System with Internet setup
References


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[12] RS232 Interface using MAX232, written by Peter Luethi Dietikon, Switzerland, Date-23-Apr-2001, Page-7 of 8, Revision-1.03


