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CAN based System for Monitoring and Controlling Humidity and Temperature in Textile Industry

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Abstract: *Many properties of textile material vary drastically as relative humidity and temperature changes. Humidity and temperature are crucial parameters in industries like paper, leather, pharmaceutical, sugar, food etc. apart from textile industry. Also the human efficiency, comfort and operations of electronic components and equipments are affected by humidity and temperature. This system proposes measurement and control of humidity and temperature using CAN based embedded system for textile industry. CAN is suitable protocol for monitoring data and for control commands as it is long distance, secure, reliable and flexible. PIC microcontroller is used for different nodes as it offers various on chip resources apart from on chip CAN.*
Keywords: *CAN BUS, Master- Slave communication, PIC Microcontroller, Sensors (humidity sensor and temperature sensor).*

I. Introduction

Water vapour or moisture content present in the air is called as Humidity. Whereas simply the addition of water to air is nothing but humidification. Humidity greatly affects or exerts influence on environmental and physiological factors. Improper humidity levels such as too high or too small can cause discomfort for both people and can damage many kinds of equipments and materials.

Proper humidification is essential for us as we are comfortable in it. In business and industrial environment, the performance of equipment and materials is enhanced by applying proper humidity levels. Humidity is 'water vapour or moisture content always present in the air'. Humidity is defined as 'The amount of water vapour in a unit of air'. But in this definition it is not considered that how dry or damp the air is. It can be only done by computing the ratio of the actual partial vapour pressure to the saturated partial vapour pressure at the same temperature. Thus relative humidity is expressed by the formula:

$$\%\,\mathrm{RH} = \frac{\text{Partial vapour pressure}}{\text{Saturated vapour pressure}} * 100\%$$

For practical purposes, at temperatures and pressures normally encountered in building systems, relative humidity is considered as the amount of water vapor in the air compared to the amount the air can hold at a given temperature. Thus temperature affects humidity. Relative humidity is maintained between 35% and 55% is comfortable for the people according to studies [1]. Improper humidity and temperature can cause problems in various industries like textile, paper, printing, leather processing, wood products and working at places like offices, libraries and museums. Hence it is necessary to take proper control action such as turning ON and OFF of air supply and turn ON and OFF valves to allow steam passage to maintain proper value of humidity and temperature. Many properties of textile materials vary considerably with moisture regain, which in turn is affected by the ambient Relative Humidity (RH) and Temperature. Dry textile material is placed in a room with a particular set of ambient conditions; it absorbs moisture and in course of time, set equilibrium. Physical properties of textile materials which are affected by RH are as follows:

- Strength of COTTON goes up when R.H. % goes up.
- Strength of VISCOSE goes down when R.H. % goes up.
- Elongation % goes up with increased R.H. % for most textile fibres.
- The tendency for generation of static electricity due to friction decreases as RH goes up.
- At higher levels of RH, there is also a tendency of the fibres to stick together [2].

Temperature alone does not have a great effect on the fibres. However the temperature dictates the amount of moisture the air will hold in suspension and, therefore, temperature and humidity must be considered together. Thus to overcome the problem of textile industry (quality of fabric) prime parameters humidity and temperature should be monitored and controlled [3].

II. System Architecture And Description

2.1. System Architecture

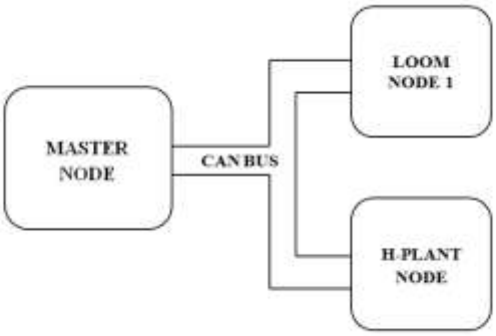

Fig1. System architecture for monitoring and controlling of humidity and temperature in textile industry.

For every loom a node is dedicated. Node monitors humidity and temperature over the loom. Master node can request this data from any node and will display it on the display. There is dedicated node for H-plant. This node will get command from master node and turn ON or OFF particular fan. The system contains master slave interface using CAN bus. Control system which will be working as master, will provide the commands to slave, receive data from slave unit via CAN protocol, stores data and takes action accordingly [4].

2.2 Requirement of Textile Industry

	Spinning	Twisting	Winding	Weaving
Wool	50-85	60-65	55-60	50-60
Cotton	35-65%	50-65%	55-65%	70-85%
Man-made fibres	45-65%RH	45-65%RH	60-65%RH	60-70%RH
Silk	60-65%RH	60-65%RH	60-65%RH	60-65%RH
Jute	75%RH	75%RH	75%RH	75%RH
Linen	80%RH	80%RH	80%RH	80%RH

Table 1: Optimal Humidity Levels [5]

The table shows the suitable humidity levels for different fibres at weaving department.

2.3 Textile Industry Scenario

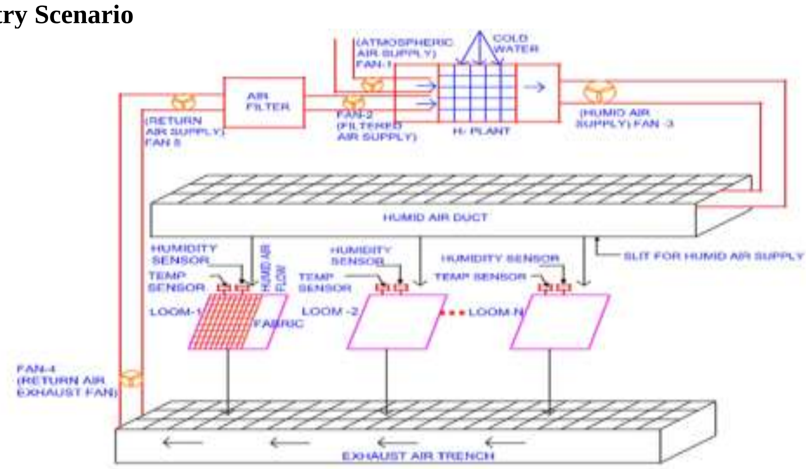

Fig2. Weaving department of textile

As shown in figure 2 in H-plant water is spread and passage of air is passed through it which produces humid air. This humid air is circulated with the help of fan (supply air fan 3 through ducts throughout the plant. As per the need slit above the loom may be opened or closed above the loom. Humid air passes over the fabric.

This air is exhausted in the trench as shown in figure. Same air can be circulated once again for humidification in H-plant. However there may be small fabrics, threads etc. Therefore this air is filtered before feeding to H-plant. Fan 4 and fan 5 are used for this purpose. Fan 2 provides filtered air to H-plant. If required atmospheric air can be supplied with the help of fan 1. As shown in figure humidity sensor and temperature sensor will monitor respective parameters on loom [6].

III. Implementation

3.1 System Block-diagram

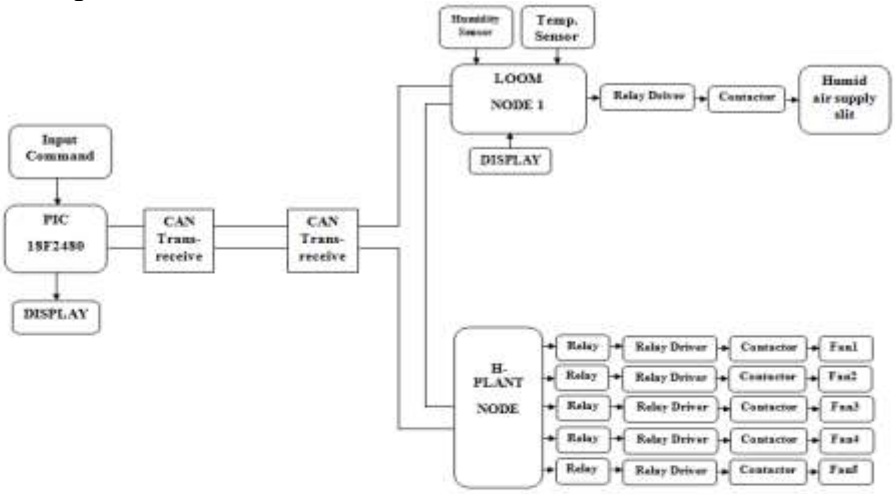

Fig3. Block diagram for monitor and control of humidity and temperature in textile industry.

Different nodes are connected to master node with the help of CAN BUS. CAN is suitable candidate as a protocol because it is flexible (nodes can be added and removed easily), serial (long distance), fast (even can offer data rate of 2 mega bits per second), secure and reliable. Above all it is cheap solution. As shown in figure 4 for every node PIC Microcontroller is used as a core. The reason is that PIC is having on chip CAN Controller apart from various other resources. Therefore there is no need to interface CAN Controller with microcontroller only CAN driver IC (MCP 2551) will be required to drive the signals to the particular value on both ends. The MCP2551 is a high speed CAN, fault tolerant device that serves as the interface between a CAN protocol controller and the physical bus. For humidity measurement, SY-HS 220 humidity sensor is used here because it's having a range of 30-90% RH and accuracy is of ±5%RH[7]. For temperature measurement LM35 temperature sensor is used here because it gives linear output and cost effective. Master node will give command using input device which will be conveyed to typical node depending upon address using CAN bus. The node will monitor Humidity and temperature values and these values will be conveyed by node to master using CAN bus. Master will display these values on LCD. If required to change the value of humidity, typical fan should be turned ON and OFF.

3.2 System Implementation

OrCAD software is used to draw a circuit schematic. As multisim 8 and proteus software does not provide directly PCB layout from the schematic but OrCAD directly provides PCB layout from the schematic, hence we used OrCAD to draw the schematic.

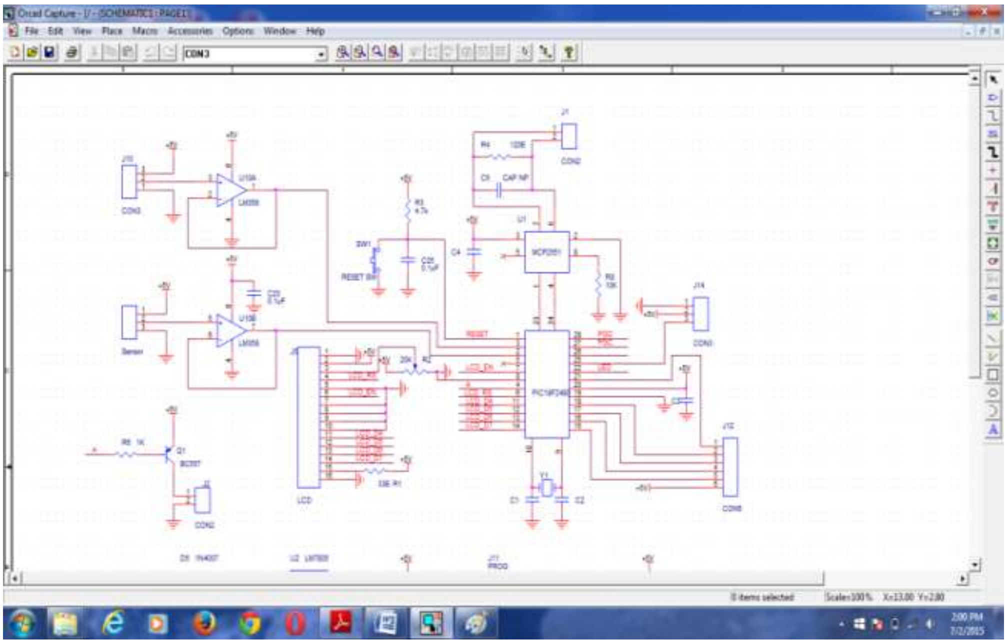

Fig4. Schematic of the system

In schematic, the microcontroller is of 28 pins. Pin1 is reset pin, Sensors are connected to pin 2 and 3. Pin 7 to 14 are used for LCD interfacing. Pin 23 and 24 is connected to CAN H and L. Pin 15 to 20 connected to relay circuit.

The system programming is done in embedded C using microC PRO for PIC.

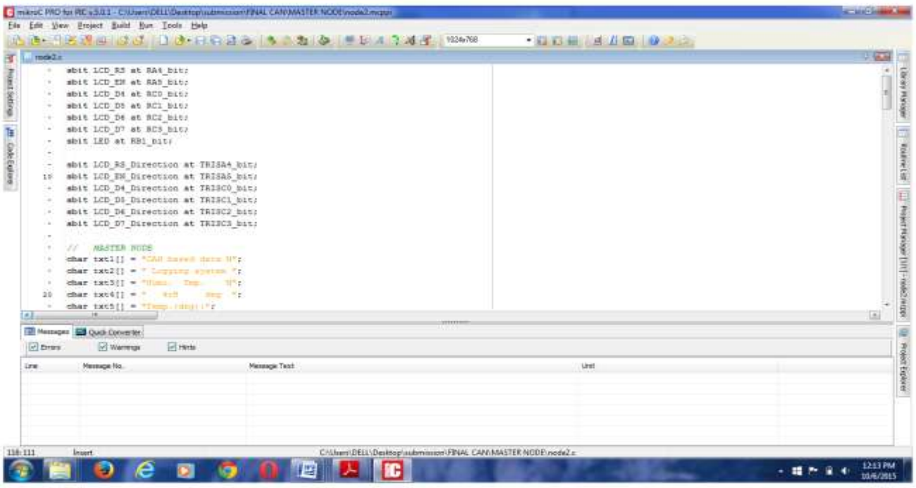

Fig5. Snapshot of programming in microC PRO for PIC.

3.3 System Algorithm

3.3.1 Algorithm for master node

1. Initialize Port, memory and serial communication.
2. Initialize LCD and send Welcome message on LCD.
3. Send commands to the slave nodes.
4. By receiving the values from slaves compare with threshold value.
5. Give suitable commands to the relay circuits for ON and OFF the particular fan.

3.3.2 Algorithm for Slave node

1. Initialize Port, memory and serial communication.
2. Display the value of temperature and humidity.
3. Receive the commands from master node.
4. Send CAN frame to the master node.

IV. Results

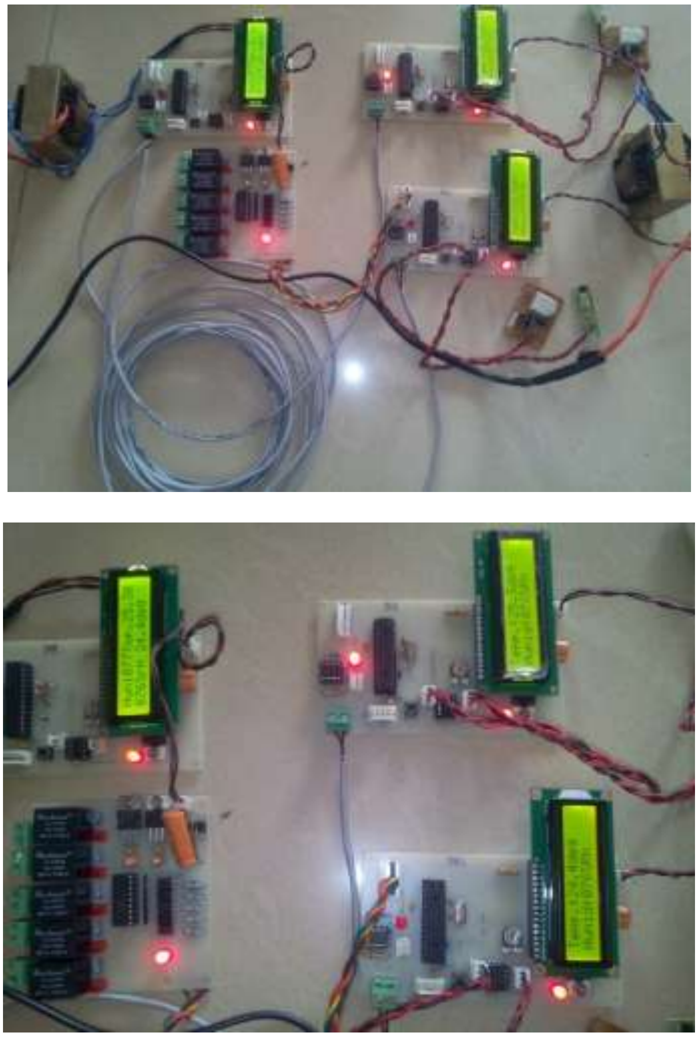

Fig5. System result

By receiving the request from Master node M, the slave nodes N1 and N2 sending the temperature and humidity values to the master node by CAN bus.

V. Coclusion

This system is useful in small scale units as it is cheap and can be modified as per the loom numbers of the unit. CAN Bus may be even twisted pair cable and therefore it is not necessary to have large metallic trays for carrying various signals of PLC based system. Thus this proposed system will be cheap, flexible and more secure. This system is not only applicable for textile industry but the industries like sugar, leather, food, pharmaceutical, paper and other various process industries.

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