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DESIGNING OF TEMPERATURE & HUMIDITY MONITORING EMBEDDED SYSTEMS

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Abstract— The places such as weather forecasting system, nuclear radiation measurement, greenhouses, agro-automation systems require real-time monitoring of environmental parameters like temperature and humidity. So a low-cost, low-power temperature and humidity sensor interfacing with embedded systems using PIC microcontroller and PLC is designed. The paper is analyzing the operating mechanism of DHT11 temperature and humidity combined sensor; where it features temperature and humidity sensor complex with calibrated digital signal output. The DHT11 sensor interfacing with controller is programmed, then the temperature and humidity acquisition program porting to embedded platform. Meanwhile, the data through human machine interface is intuitive feedback to the user. The system has good scalability and stability, and has good application prospects in climate change measurement.

Index Terms— Temperature and Humidity sensor, Embedded System, Human Machine Interface

I. INTRODUCTION

With the launch of microprocessor technology, operation systems and sensor technology, embedded systems are widely applied to environment parameters monitoring system of various places. At the same time, such monitoring systems in terms of efficiency, accuracy, durability and intelligence leads to improvement, the functions continue to strengthen, which results in improvement in sensor performance and to minimize deficiencies to some extent. For the crops growth, nuclear radiation measurement and other applications, temperature and humidity are the two most important factors. Therefore, in detection of these parameters, digital sensor acquisition plays vital role. This design is based on PIC microcontroller 16F877a as well as Allen Bradley Programmable Logic Controller Micrologix 1400 series and use of DHT11 temperature and humidity sensor as data acquisition module, to build hardware platform. With analyzing the process of temperature and humidity sensor, programming and Compiling with embedded controller system, the real-time temperature and humidity monitoring is completed [1].

II. BLOCK DIAGRAM OF PROPOSED SYSTEM

DHT11 temperature and humidity sensor features a temperature and humidity sensor complex with calibrated digital signal output. It is exclusive Digital-signal-acquisition technique with temperature-humidity sensor technology to acquire reliable data with great accuracy. It is resistive type humidity measurement and NTC type temperature measurement component offering excellent long-term stability, fast response, cost effective. The component is 4-pin in single row pin package. It adopts serial interface communication. The first pin is power pin, which requires 3 to 5.5V DC. For power fluctuations filtering 100nF capacitor can be used between V_{DD} and GND. 5kΩ pull-up resistor should be used while connecting second data pin to micro-controller when the connecting line length is less than 20 meters [3]. The forth pin should be grounded properly. Third pin should not be connected i.e. floating.

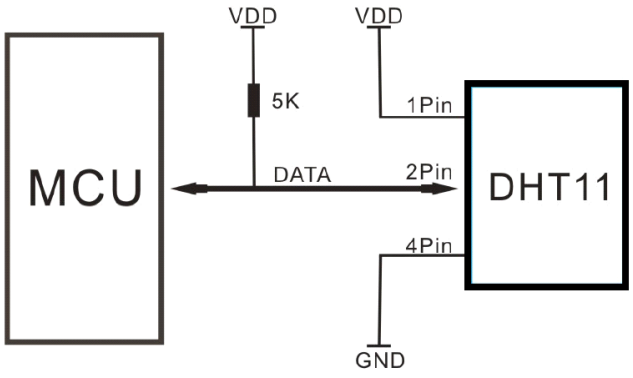

Figure-1. Dht11 connection with the PLC unit or single chip PIC microcontroller

The serial communication mode is single bus bi-directional. DHT11 sends 40bits in response which includes both integer and fractional values of both temperature and humidity [6]. The format of data acquisition is as shown in Table-1.

Table-1. Data Acquisition Format of DHT11

Humidity parts(16 bits)		*Temperature parts(16 bits)*		*Checks(8 bits)*
Byte4	Byte3	Byte2	Byte1	Byte0
Humidity Integer	Humidity Decimal	Temperature Integer	Temperature Integer	Checksum

III. HARDWARE DESIGN

A. Design using P16F877A microcontroller

DHT11 is interfaced with PIC microcontroller P16F877A. 16x2 alphanumeric LCD is interfaced with microcontroller to show the results. The code is written using MPLAB software. In program, first by configuring PIC pin connected to sensor as output, start signal should be sent to the sensor then sensor sends response signal to MCU. To detect this response signal from sensor MCU pin must be configured as input. The whole interfaced system is simulated using Proteus software as shown in Figure-2. The real-time monitoring of weather parameters like temperature and humidity is done with hardware set-up as shown in Figure-3.

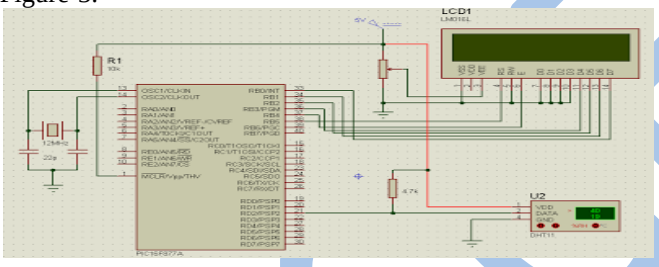

Figure-2 Schematic diagram of DHT11 interfacing with P16F877 PIC microcontroller

Figure-3 Display of result on LCD connected to microcontroller

B. Design using Programmable Logic Controller

Nowadays PLCs are widely used control hardware in control applications. PLC is a digital computer, designed for multiple inputs and outputs arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. PLC is an example of a real-time system. Advantages of PLCs are flexibility in programming and reprogramming, cost effectiveness for controlling complex systems, reliability, high speed operations, ease of troubleshooting, energy saving [2].

PLCs are mostly used in automation plants to increase productivity, quality and safety in working critical conditions, and to reduce cost. Automation solutions are required in various sectors from agriculture to space technology. For time-to-market manufacturing, plant automation is necessary.

DHT11 temperature and humidity sensor is interfaced with Allen Bradley Micro-Logix 1400 series PLC. WECON HMI is used to provide collected data of temperature and humidity to the user through graphical representation. By monitoring these temperature and humidity values, user is able to take appropriate decisions and actions for process control. The connection set-up of DHT11, PLC and HMI is as shown in Figure-4.

Figure-4 DHT11 interfacing with PLC Allen Bradley MicroLogix 1400 series

PLC programming can be done adopting Ladder logic diagram, instruction list, function block diagram (FBD), sequential function chart, structured text; either of these programming methods. Ladder diagram programming is used to program DHT11 sensor interfacing. Ladder diagram logic is easy to construct and configure [4].

Supervisory control and data acquisition (SCADA) software can be used to display dynamic process graph and to provide information to human operator. SCADA adopts features like device connectivity, easy script for logic development, database connectivity, real-time and historical trending. To design the template with SCADA WinLog Lite software one has to follow some steps shown in Figure-5. SCADA is purely a software package which is positioned on hardware to which it is interfaced via PLC to monitor supervisory levels.

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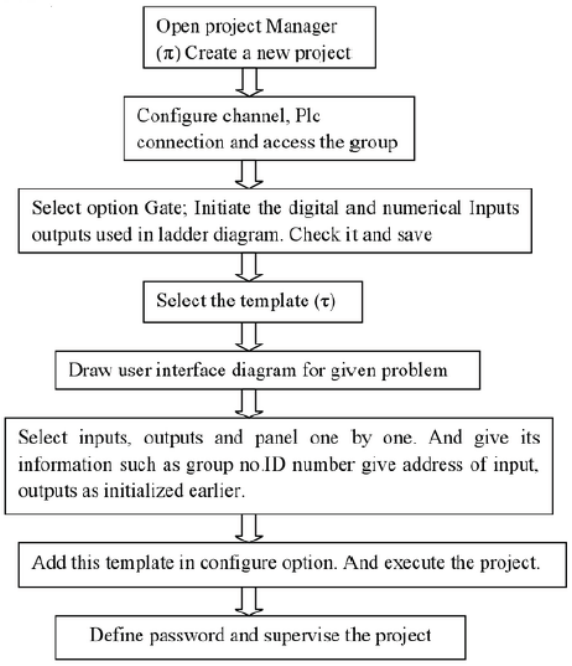

Figure-5 Flowchart of SCADA Template design using WinLog Lite software

To visualize and control whole process to human operator human machine interface device is used [5]. SCADA and HMI systems operations go hand in hand to manage information and to diagnosis data. 7inch TFT LCD display WECON HMI model Levi-777A is used, which supports RS-232, RS485 and serial port interface with computer. LeviStudio-U-2015 software is used to create the template on HMI. The temperature and humidity graphical template is as shown in Figure-6. The result of hardware connections in terms of real-time calibrated values of temperature and humidity are represented with two individual curves as shown in Figure-7. Green color curve represents temperature values and red color curve represents humidity curve on HMI.

Figure-6 Template on HMI

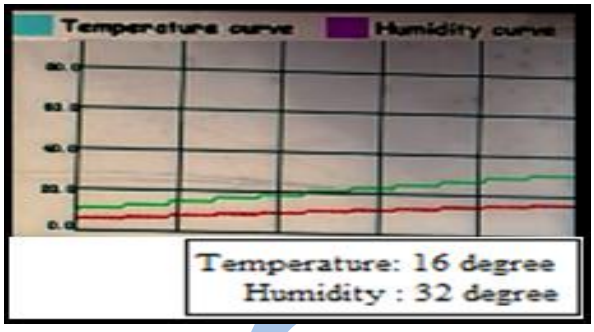

Figure-7 Temperature and humidity curves on HMI

IV. CONCLUSION

The DHT11 temperature and humidity sensor interfacing works in embedded platform of micro-controller and PLC, and carries on analysis and representation of surrounding temperature and humidity. The showing results of temperature and humidity is shown in Figure-3 and Figure-7. The system consists of micro-controller technology and embedded system to process the monitoring system by modularity, realizes the modularization of temperature and humidity data acquisition and user-machine interface module. Simple connections and low power consumption hardware system is easy to assemble and maintain. The data acquisition of temperature and humidity by this system gives much more accurate results than ordinary meter.

V. REFERENCES

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