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DEVELOPMENT OF A GSM SMS BASED HUMIDITY REMOTE MONITORING AND CONTROL SYSTEM FOR INDUSTRIAL APPLICATIONS.

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Abstract-*The project paper offers a wireless solution, based on GSM (Global System for Mobile Communication) networks for the monitoring and control of humidity in industries. This system affords ideal solution for monitoring critical plant on unmanned sites. The system is wireless therefore more cost-effective and flexible. Utilizing Humidity sensor HSM-20G, PIC-16F877 and GSM technology this system offers a cost effective solution to wide range of remote monitoring and control applications. The system can also be configured to transmit data on alarm or at present intervals to a mobile phone using SMS text messing. The suggested system monitors and controls the humidity from the remote location and whenever it crosses the set limit the PIC-16F877 controller will sends a SMS to a concerned plant authority(s) mobile phone via GSM network. The concerned authority can control the system through his mobile phone by sending AT Commands to GSM MODEM and in turn to processor. Also the system provides password security against operator misuse/abuse. The system uses GSM technology thus providing omnipresent access to the system for security and automated monitoring and control of Humidity.*

Keywords: GSM, SMS, Humidity Sensor (HSM-20G), Automation, Remote monitoring, Control System.

1. INTRODUCTION

Remote monitoring control and intelligent maintenance is one of the most important criteria for maximizing production and process plant accessibility. Wireless media [1] has been undergoing a rapid innovation process in search for a dependable, simple and business-viable technology for fast, easy and economical diagnosis of faults in industries.

Nowadays, growth is coming from global expansion and services. A new surge of growth will come through new technology (Wireless) [2], production at the lowest cost for global distribution and fast time-to-market. A Wireless Industrial Automation communication segment at the present time, presents a mixture of standardized and proprietary technologies.

Recently, there has been much interest in remote monitoring and control in the field of the Industrial automation. There has also been much interest in wireless communication in industrial sector for uses in automation as well as to increase the safety and security Standards. There is a great deal of benefits for industries to adopt the wireless communication to control systems. Currently the common conditions of use of SCADA systems [3] only allow for control and supervision to take place when the operator and the plant being observed are in the same general vicinity. It led to the emergence of the wireless remote monitoring and control systems. This contribution develops the systematic design methods for the development of a low cost GSM SMS-based Humidity Remote Monitoring and control for the industrial applications over the wireless communication. Measurement and control of relative humidity [4] has significant appliance in industry, science, healthcare, agriculture and controlling technological processes.

The use of mobile phones or handsets has grown exponentially over the years [5].

The dominant mobile phone network in the world today is GSM [6]. It is a digital mobile communication network, which developed, rapidly in recent years. This network has coverage in most urban areas and offer support for the SMS [7] that allows users to communicate with each other by sending short text messages to each other at minimal cost.

The primary aim of this paper is to propose the concept of Development of a Low-Cost GSM SMS-Based Humidity Remote Monitoring and Control system for Industrial Applications using the combination of a Embedded PIC Controller (PIC-16F877) and a GSM communications module linked by a serial communications port. Using this relative humidity could be efficiently recorded from the remote location and whenever it crosses the set limit, the PIC microcontroller

will send an SMS alert to a concerned authority(s) mobile phone. The concerned authority(s) can control the system through the mobile phone by sensing AT commands to the GSM MODEM. Also the system provides password security against operator misuse or abuse.

Benefits of this paper are:

- Flexibility / modularity in control by the use of a PIC controller.
- Global coverage through the use of the GSM network.
- .Extremely low cost device adapted for different applications.
- Scalable, Robust and Reliable.
- Provides password security.
- Efficient and cheap means of communication by use of SMS.
- True mobility using mobile phone sets.
- Ideal for monitoring and control critical plant on unmanned sites.

2. FUNCTIONAL BLOCK DIAGRAM AND DESCRIPTION

The Functional Block diagram of the entire system is as shown in the Fig. 1. All the major subsystem blocks are shown with their interconnections to each module .The block diagram consists of Humidity Sensor (HSM-20G), PIC 16F877 [8], GSM MODEM (SIM300), MAX232 Level converter and inverter, Controlling device, Mobile phone, Line driver ULN2003 and Relay set and Personal computer. In this application, the system was set up to monitor and control the relative humidity and ensures that it was within safe operating limits. The detailed descriptions of the blocks used in the system are explained below.

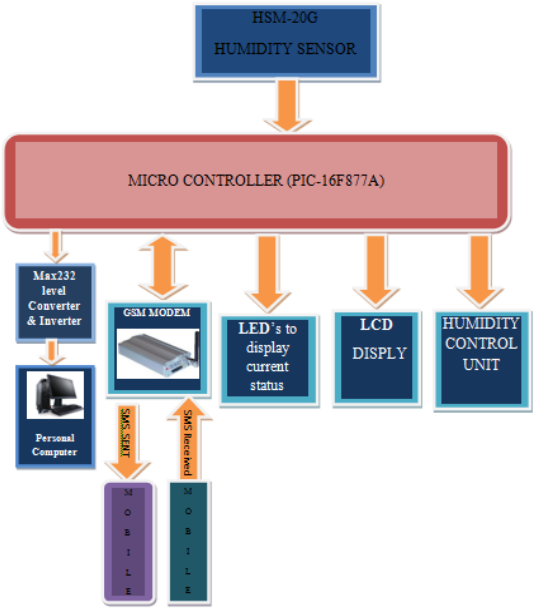

Fig. 1: Functional Block Diagram

2.1 Microcontroller (PIC-16F877A):

Basically, microcontroller is a small and compact chip which can reads input, process and produce output to control other electronic devices. There are so many brands of microcontroller available in the market today, such as PIC, Motorola, Philip, Hitachi and Atmel. There are a lot of similarities between the microcontrollers such as low cost, it is easy to get, where we can order the microcontroller from Cytron, Farnell, and electronics store. Various software are available such as MPLAB, AVR Studio, mikroC PRO, WinPIC, C compiler for microcontroller coding and the software is distributed as freeware. Another advantage of microcontroller is the program code can be loaded-reloaded frequently many times. PIC microcontroller was used in this project. The code was written in Programming language microC. The pin configuration of the microcontroller is shown in Fig. 2.

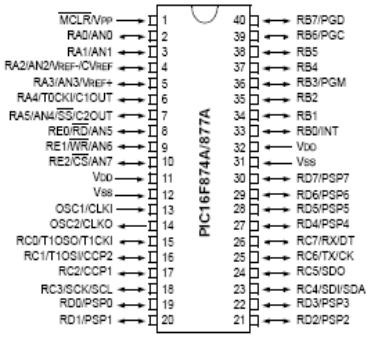

Fig. 2: Pin configuration of the microcontroller.

2.2 Humidity Sensor (HSM 20g):

The HSM 20G is an integrated circuit sensor that can be used to measure humidity with an electrical output. The module of HSM-20G is essential for those applications where the relative humidity can be converted to standard voltage output. Humidity Sensor (HSM 20G) [9] is shown in Fig. 3.

Fig. 3: Humidity Sensor (HSM 20G).

2.3 GSM Modem

GSM modem is a specialized type of modem, which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a phone. A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it may be a mobile phone that provides GSM modem capabilities. A GSM modem could also be a standard GSM mobile phone with the appropriate cable and software driver to connect to a serial port or USB port on computer. Any phone that supports the "extended AT command set" for sending/receiving SMS messages, as

defined in the ETSI GSM 07.05 Specification can be supported by the Now SMS/MMS Gateway. In the proposed system we have used SIMCOM SIM300 GSM module and it shown in Fig. 4.

Fig. 4: GSM Modem

2.4 Mobile Phone

A mobile phone also known as a wireless phone, cell phone, or cellular telephone is a little portable radio telephone. Mobile Phone can serve as powerful tool for world-wide communication. The Mobile Phone is a natural choice, since it is a communication resource generally available by people, which makes them practically always contactable and capable to send commands to operate the parameters in the industries.

The mobile phone can be used to communicate over long distances without wires. It works by Communicating with a nearby base station (sometimes called a "cell") which connects it to the main phone network. As the mobile phone moves around, if the mobile phone gets too far away from the cell it is connected to, that cell sends a message to another cell to tell the new cell to take over the call. This is called a "hand off," and the call continues with the new cell the phone is connected to. The hand-off is done so well and carefully that the user will usually never even know that the call was transferred to another cell. Since a cell phone allows you to be anywhere, and to move around while calling, they became very popular.

2.5 MAX 232 Level Converters

Since the RS232 is not compatible with today's Microprocessors and Microcontrollers, we need a line driver or voltage converter to convert RS232‟s signals to TTL voltage levels. One example of such a converter is MAX 232 from Maxim corp. The MAX232 converter [10] converts from RS232 voltage levels to TTL voltage levels and vice versa. One advantage of the MAX232 chip is that it uses a +5v power source, which is the same as the source voltage for the microcontroller. In other words, with a single +5v power supply we can power both the microcontroller and MAX232, with no need for the dual power supplies that are common in many older systems. The MAX 232 has two sets of line drivers for transferring and receiving data.

2.6 Line Driver (ULN 2003)

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers. The ULN2003 has a 2.7kilo ohms series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices. The features are 500mA rated collector current (Single output), High-voltage outputs: 50V, Inputs compatible with various types of logic, Relay driver application.

2.7 Controlling Device

The device used to control the humidity in the industry is "Alarm" which is mainly fabricated with the hardware and it will indicate whether the humidity value is within the limit or not.

2.8 Personal Computer

A Personal computer is a programmable machine that receives input, stores and manipulates data, and provides output in a useful format. A personal computer may be a desktop computer, a laptop, a tablet PC, or a handheld PC. The most common microprocessors in personal computers are x86-compatible CPUs. Software applications for personal computers include word processing, spread sheets, data bases, Web browsers and e-mail clients, games, and myriad personal productivity and special-purpose software applications. Modern personal computers often have high-speed or dial-up connections to the Internet allowing access to the World Wide Web and a wide range of other resources. Personal computers may be connected to a local area network (LAN), either by a cable or a wireless connection. The data logging is achieved continuously by the PIC 16F877 microcontroller to the personal Computer via the MAX232. This data is received by the software running on the PC and continuously updates a database by using Visual Basic and also we can generate reports and graphs automatically. Focusing on the client requirements, the following capabilities have been provided in the software.

- **Monitoring** – This is the main feature of the system where extracted information is presented for the operator in near real-time. Monitoring has been divided in two sections.
- **Full graphical data representation** – In this section, the user is able to monitor the plant in a very user friendly manner where details are represented in dynamic graphical interfaces in personal computer.
- **Text base data representation** – In this section the near real time details are represented in tables without graphical objects.

3. HARDWAFE IMPLEMENTATION AND DESCRIPTION

The circuit diagram of the entire system is as shown Fig. 5. Humidity is taken as a parameter and the humidity sensor HSM-20G will sense the humidity and will give a voltage output corresponding to the humidity value. This signal is taken into PIC-16F877 processor through the analog input channel for comparison. This signal is

digitized using the inbuilt 10-bit ADC of the PIC-16F877 processor and compare the data with its threshold value for any status changes or value crossing the limit. If the value crossing the threshold warning alert the concerned authority(s) by sending an SMS through GSM MODEM

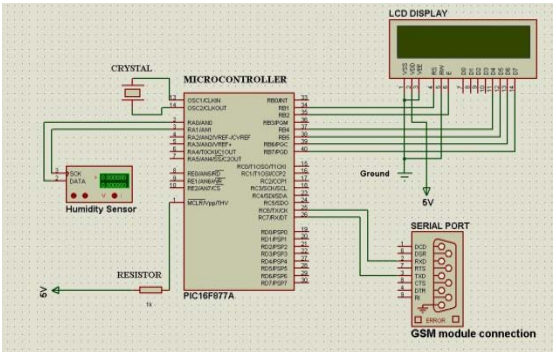

Fig. 5: Circuit Diagram of the Entire System.

value crossing the threshold warning alert the concerned authority(s) by sending an SMS through GSM MODEM to his/her Mobile phone and switch the Bulb ON. If the values are within limits switch Bulb OFF. The authority(s) concerned to the plant can control the threshold value by changing the humidity value or by switching ON the Bulb by sending AT commands to GSM MODEM, which will be directed to the processor. The authority(s) can also monitor the status of the humidity value remotely through his/her mobile phone by issuing a string of commands to GSM MODEM and in turn to the processor. The measured values are displayed in personal computer for further analysis to download reports and graphs.

4. SOFTWARE DEVELOPMENT

The software for the system is developed in microC program language. The flowcharts depicting the monitoring and the control of humidity are shown in Fig. 6 and Fig. 7.

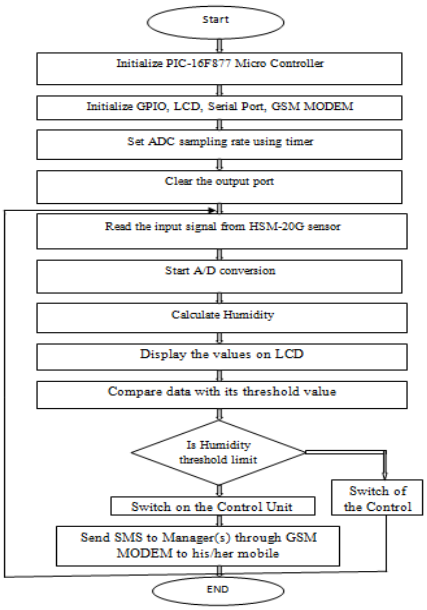

Fig.6: The Flowchart for Monitor Process.

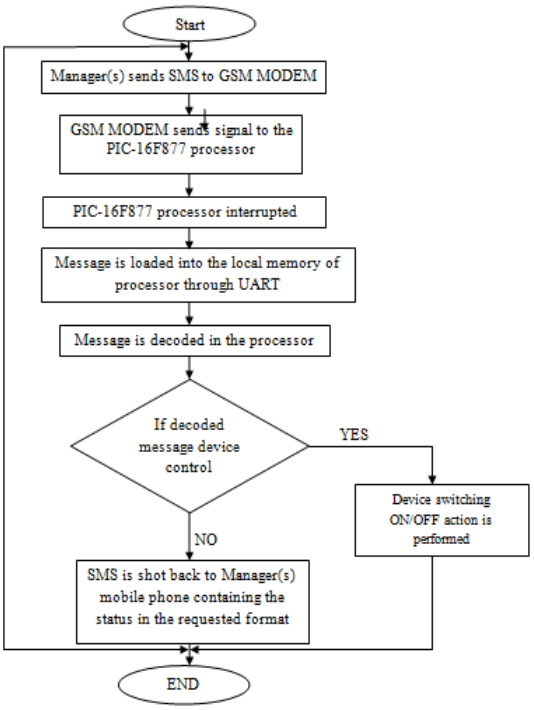

Fig. 7: The Flowchart for Control Process.

5. RESULTS AND DISCUSSION

The results obtained by using the proposed system are discussed in this section. Figure 8 shows the measurement and control of Humidity in the graphical representation, Figure 9 shows the status of the humidity in LCD display, Figure 10 shows the current status of humidity and controlling of humidity.

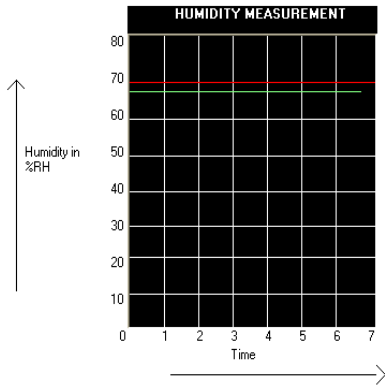

Fig. 8 : Graphical Representation of Humidity Measurement.

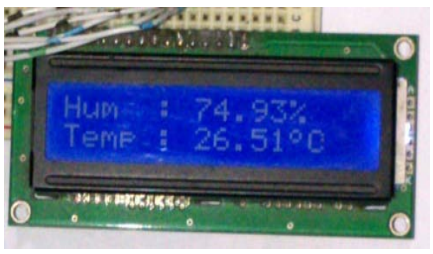

Fig. 9: Status of Humidity.

Fig. 10: Status of Humidity in the Remote Mobile Phone Screen.

Table 1: Results of the system

Humidity % RH	Control unit status	SMS Status	SMS Message
45	OFF	NO	-
55	OFF	NO	-
65	OFF	NO	-
75	OFF	NO	-
80	ON	YES	Humidity is 80% and your Control system is ON
85	ON	YES	Humidity is above 80% and your Control system is ON

The above results confine that the monitoring and control device is always with the concerned authority(s) and also it is possible to read the data from any remote place. If the input value is near or more than the threshold limit then the processor will sends an SMS as "Humidity is 80% and your Control system is ON" and "Humidity above 80% and control system is ON" to a authority(s) mobile phone through GSM MODEM. The authority(s) concerned to the plant can control the set point by changing the input value or can switch ON the Control system by sending AT commands to GSM MODEM, which will be directed to the processor. The authority(s) can also monitor the status of the Humidity remotely by issuing a string of commands to GSM modem. The system was tested by measuring humidity up to %90 RH and the results are in good agreement with experimental values.

6. CONCLUSION

The system has provided a low cost, secure, ubiquitously accessible, remotely monitored and controlled solution for automation of industries has been introduced. The use of a PIC microcontroller, GSM module, Sensors and actuators provide exciting possibilities. However as far as the industrial applications are concerned this can be viewed as a low cost, customized wireless RMACS system. Thus this solution can be customized to suit any other industrial requirement related to monitoring and controlling provided industrial sensors are in use.

The approach discussed in the paper is novel and has achieved the target to control humidity remotely using the GSM SMS-based system satisfying user needs and requirements. GSM technology capable solution has proved to be controlled remotely, provide security and is cost-effective as compared to the previously existing systems. Hence we can conclude that the required goals and objectives of the system have been achieved.

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