Design and implementation of a real-time remote measurement and monitoring of weather parameters system

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Abstract: Development of an automated real-time remote measurement and monitoring of weather parameters system is presented .This work brings forward new programmable device for remote real-time measurement and monitoring of weather parameters. Three levels are included in the system: the microcontroller for information processing using atmega32 with a control program for real time measurement, processing and monitoring, GSM unit to provide wireless communication via cell phones for monitoring of weather parameters, with the aid of sensors (temperature, humidity, wind speed, pressure sensors). RF transmitter is used to collect and transmit data from field to the controller which includes RF receiver. The System operates in two modes: the first one is for real time transmitting of data through fixed time intervals, these intervals are set via key pad according to the user requirement and GSM sharing between the different sensors. A real time clock (RTC) is used for time adjustment. The second mode is used in case of regular collection of data as well as rain fall expectation, where the data is to be collected in regular intervals,. In this mode the user can exclaim the system about the weather parameters (temperature, humidity, dew point and rainfall) ,then the user will receive a real time feedback SMS explaining the weather conditions.

Keywords: - Microcontroller, weather station, RF, GSM, real time system, sensors , RTC .

I.   INTRODUCTION

An automated weather station is an instrument that measures and records weather parameters using sensors, without the intervention of humans. The measured parameters can be stored in a built-in data logger or can be transmitted to a remote location via a communication link. If the data is stored in a data logger, the recorded data must be physically downloaded to a computer at a later time for further processing. However this is not a viable option especially when the weather station is located at a remote unattended location. Therefore a communication system is an essential element in an automated whether station.   Today, automated weather stations are available as commercial products, with variety of facilities and options [1-3].

Meteorology and geotechnical research institutes build weather stations to obtain quantitative measurements of atmospheric conditions. Long-term records and statistics of these quantitative measurements can be used to analyze the conditions and phenomena of the observed location. The measurements are often recorded periodically on an hourly basis or even more frequently.

Although modern automatic weather stations (AWS) are well developed, the scale of the observation and data resolution are limited by their cost, which is mainly the cost of high precision instruments and long-distance wireless telecommunication equipments, such as a satellite transceiver.

We proposed a simple GSM Based low-cost, real-time and less complexity remote weather station , using local telephone network. We can therefore extend the scale of weather monitoring without increasing the number of telecommunication equipments. This GSM-based AWS is able to cover a plane and gather multiple sets of weather measurements in real-time at a better data resolution. [5-6]

II.   APPROCH

The Block diagram of the system is shown in Figure (1) .It includes the use full component and the links which exist between them. Here the Mobile phone is connected to a GSM via wireless network then to the microcontroller. Hence the system provides the real time transmitting and receiving of data..

The microcontroller (atmega32), responses according to the input data via serial port and the incoming message in case of exclamation mode through SMS. The program is written in BASCOM languages. It is also connected with the wireless transceiver to communicate with the sensor nodes at the field.
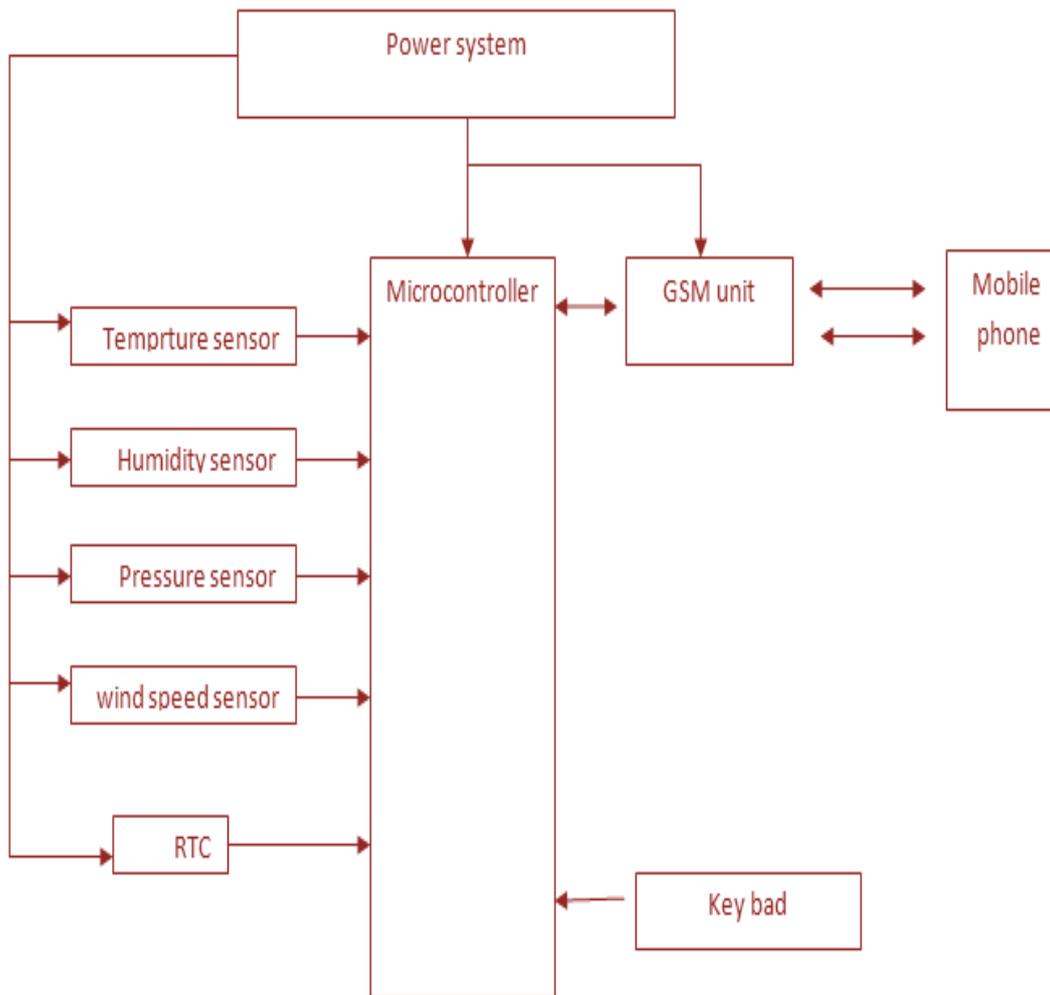
Figure (1) Block diagram of the system

III.   TEMPERATURE SENSOR

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in ^{o}C). The Temperature Sensor is shown in Figure (2).

The scale factor is .01V/^{o}C. The LM35 does not require any external calibration or trimming and maintains an accuracy of +/- 0.4^{o}C at room temperature and +/- 0.8^{o}C over a range of 0°C to +100°C. [6]

Figure (2) LM35 temperature sensor

IV.   WIND SPEED

For measurement of wind speed, the speed vortex wind sensor is utilized. This rugged anemometer has a high quality 3-cup rotor pressed on a stainless steel shaft which can handle speed from 3 to over 125 miles per hour (or 1.34 to over 55.88 meters per second, m/s). It uses a reed/magnet switch which provides one pulse per rotation and the latest edition also comes with a sapphire bearing to minimize wear. Conversion of pulses to wind speed is easily carried out as 1 pulse per second corresponds to 2.5 miles per hour (or 1.1176 m/s).

internal timer in atmega32 is used to time the pulse through which the wind speed is calculated by equation (1) below :

$W = 1/T_W \ X \ 1.1176$ ………………. (1)

Where ; (W) is the wind speed in m/s and (Tw) is the period of a pulse in seconds.

V.   PRESSURE SENSOR

The barometric pressure sensor was used to measure the atmospheric pressure [1]. It gives a linear output which varies from 0 V to 5 V with the variation of the pressure. Even though the factory calibration curve was available, a separate laboratory calibration was done to calibrate the sensor and to prepare the calibration chart to program the microcontroller.

Figure (3) pressure sensor

VI.   HUMIDITY SENSOR

Humidity measurement instruments usually rely on measurements of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. By calibration and calculation, these measured quantities can lead to a Measurement of humidity. DHT11 is the humidity sensor used in this work.[1]

VII.   SOFTWARE IMPLEMENTATION

There are two parts in the software design, one for the main controller circuit (atmega32) which is connected to the temperature sensor, humidity sensor, pressure sensor and wind speed sensor , while the other is for the GSM modem that is connected the microcontroller for remote transmission of data   .The software package used here is BASCOM. BASCOM is an Integrated Development Environment (IDE) that supports the 8051 family of microcontrollers and some derivatives as well as Atmel's AVR microcontrollers. Two products are available for the various microcontrollers - BASCOM-8051 and BASCOM-AVR. In a microcontroller project one needs to know the hardware base, i.e. the microcontroller with internal and connected peripherals, and the software used. It contains the 8051 assembler and AX51 cross compiler. It operates under basic and assembly languages and it has a very powerful set of instructions and containing a useful simulation capability.

VIII.   ALGORITHM

The proposed algorithm includes a sequence of steps for the operation of the system .The algorithm is:
Start
--- Put the system in the initial state.
-select mode
-If (mode = 1), then enter the sensors transmitting delay via keypad.(every sensor must send data in separate time to share GSM modem and serial port)
-If mode = 2) , then read sensors .
--- Check the incoming mobile message dial no. for authorization.
        - If authorized , continue processing.
        - If not authorized , deny access and wait for a mobile message.
Analyze:
--- Analyze the incoming SMS.
--- If the code is equal to (acquire temp), then read the temperature sensor and send the real time value of temperature.
--- If the code is equal to (acquire humidity), then read the humidity sensor and send the real time value of humidity.

--- If the code is equal to (acquire pressure), then read the pressure sensor and send the real time value of pressure.

--- If the code is equal to (acquire wind speed) , then read the wind speed sensor and send the real time value of wind speed .

--- If the code is equal to (acquire dew point), then calculate the value of dew point and send it via SMS.

--- If the code is equal to (X), then end the program.

--- Go to analyze

End.

IX. RESULTS

Following are the results from implementing the proposed system design on two different days in December 2014.

Table (1) System commands and their correspondent action on the devices (15-9-2014)

Result	SMS	SMS number
35.7^{o}c	Acquire temperature	1
27٪	Acquire humidity	2
23.0 m/s	Acquire wind speed	3
14.0^{o}c	Acquire Dew point	4
1010 hpc	Acquire pressure4	5
End the system operation	X	6

Table (2) System commands and their correspondent action on the devices (19-9-2014)

Result	SMS	SMS number
35.5^{o}c	Acquire temperature	1
29٪	Acquire humidity	2
20.0 m/s	Acquire wind speed	3
15.0^{o}c	Acquire Dew point	4
1012 hpc	Acquire pressure4	5
End the system operation	X	6

X. CONCLUSION

Automatic remote measurement and monitoring of weather parameters system provides a number of benefits to the users with a very low cost and high flexibility. According to the existing technology, today, these stations can be built locally and maintained at remote locations to transmit digitized data at regular intervals .Any cell phone can send order to the controllers or browse the information from the controllers through the exclamation mode using SMS. The work showed that multiple weather parameters can be captured precisely at pre programmed intervals in real-time, or captured remotely via SMS on demand.

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