DESIGN AND DEVELOPMENT OF A LOW COST AUTOMATIC WEATHER STATION

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ABSTRACT

Observation of weather data plays a major role in the field of meteorology. The Automatic Weather Systems (AWS) provide meteorological observations to users in real-time basis by gathering data from a network of automatic weather stations through various communication channels. Availability of real-time meteorological data is an essential tool for daily weather forecasting. The reliability of weather forecasting mainly depends on the amount of data received for analysis. Setting up of a manned meteorological station is relatively costly exercise. With the advancement of information technology and electronics and also the growing demand for meteorological information, it becomes more popular to disseminate the meteorological information through network means to meteorological community.

Main objective of the design of AWS is to have more user friendly and flexible network of instrument which is made by incorporating locally developed low cost and reliable sensors such as wind direction sensor for weather observation.

Rabbit 2000 8-bit core module micro-controller is used as the main processor. It handles data acquisition, field processing, data storage and data transmission and it can also handle both analog and digital signals. Assembly and C programming languages are used for Rabbit micro-controller. Both application and communication software are user friendly and flexible. IC based sensors are used for temperature, humidity and atmospheric pressure and are compatible with WMO standards.

1. Introduction

The Automatic Weather Systems (AWS) provide meteorological observations to users in real-time by gathering data from a network of automatic weather stations through various communication channels. Design and development of an low cost automatic weather station (AWS) is a challenging task because the data obtained from the device should be compatible with WMO standards and also be accurate. This paper describes the design and development of a low cost AWS which can use in meteorological and environmental applications. The state of the art technology was used for the design. The results were compared with the thermograph , barograph and other recording devices to verify the accuracy of the AWS.

2. Methodology

The following meteorological sensors were used for the design .

i. Sensirion SHT75 sensor provides - unlike other sensor elements - a combined relative humidity and temperature measurement. This would help for both temperature and relative humidity measurements.
ii. Pulse type wind anemometer for wind speed measurements.
iii. Motorola MPX 5100 pressure sensor.
iv. Tipping bucket type rain gauge for rainfall measurement.
v. New sensor with digital output was designed for wind direction measurement.

Output data of meteorological sensors were stored in the internal memory of the processor and could be accessed from data modem of the central location through one of the ports of the micro-processor Rabbit RCM 2020.Output data were being saved in a Microsoft Access data base.

Rabbit RCM 2020 micro-controller was used as the main processor. The Rabbit is an 8-bit processor with an 8-bit external data bus and an 8-bit internal data bus. Because the Rabbit makes the most of its external 8-bit bus and because it has a compact instruction set, its performance is as good as many 16-bit processors. Thus the Rabbit can handle many 16-bit operations. There are four serial ports designated ports A, B, C, and D. All four serial ports can operate in an asynchronous mode up to the baud rate of the system clock divided by 32. The asynchronous ports can handle 7 or 8 data bits. A 9th bit address scheme, where an additional bit is sent to mark the first byte of a message, is also supported.

In case of an analog output, a signal conditioned circuit and analog to digital converter were used. In this particular case of atmospheric pressure measurements, a signal conditioner circuit was used as the output of the pressure sensor was too small. After that all digital outputs were coupled to port D and port B of the Rabbit RCM 2020 processor. Output signal from the Port was connected to the external modem as shown in the Fig. 1.

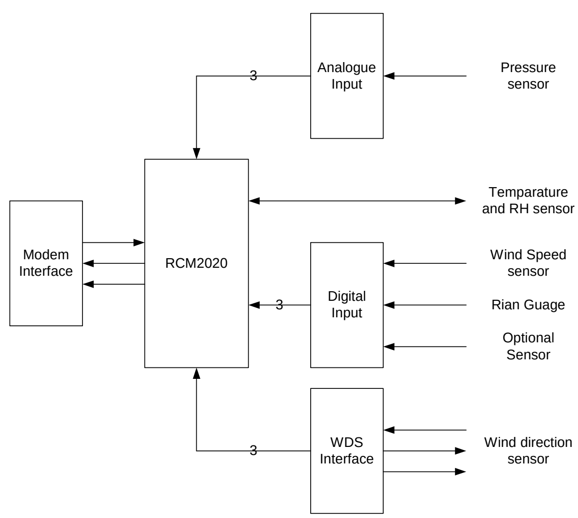

Fig. 1

Sampling periods of temperature, relative humidity and pressure sensors were taken as 10 seconds whereas sampling period of wind direction sensor was taken as 1 second. As the type of wind speed and rainfall sensors were pulse type, their respective sampling periods were calculated when a pulse occurred. Recording interval was taken as 10 minute for all data. In this recording period you can get average meteorological data for 10-minutes. Data, message or command formats are given in Fig. 2.

All firmware was written in Dynamic C and the application software was written in Visual Basic. Graphical representation of meteorological data was done in Microsoft Excel. The layout of the main PCB is shown in Fig. 3.

Message / Command packet

1byte	2byte	1byte		6byte		2byte	
Header (0x55)	AWS ID	Message / Command				CRC1	CRC2

Data packet

Header (0xAA)	AWS ID 2byte	Valid packet Len	Packet No 2Byte	Data(16*15)	CRC1	CRC2

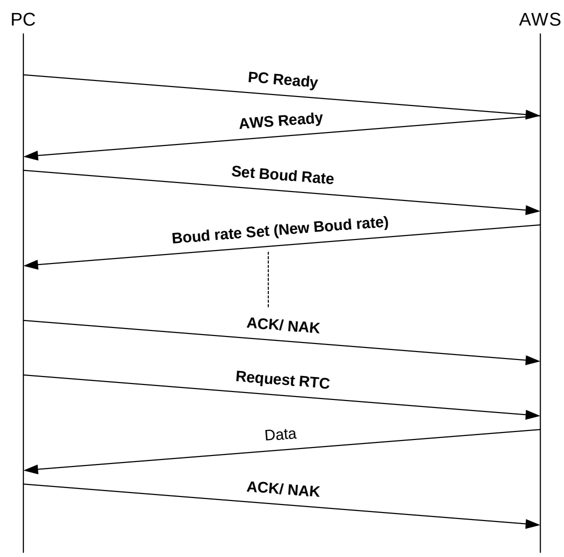

Fig. 2

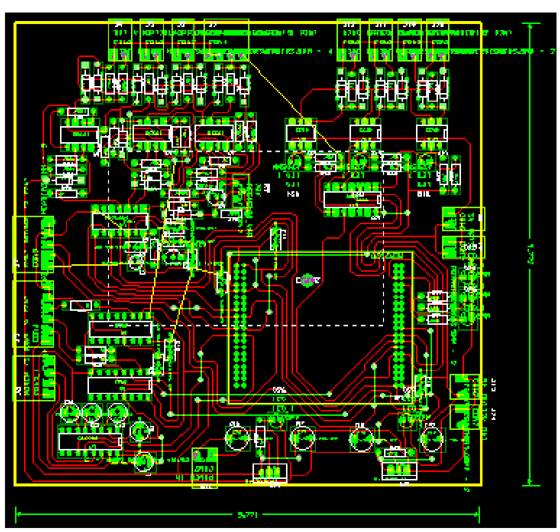

Fig. 3 Main PCB of the AWS

3. Results and Discussion

The AWS was tested in various weather conditions. The data obtained from the AWS was acceptable and its accuracy match with the WMO standards. Data were being recorded with the corresponded time. Comparison of the temperature data obtained from the AWS and thermograph is shown in Fig. 4, and it clearly shows the behavior of the AWS is acceptable.

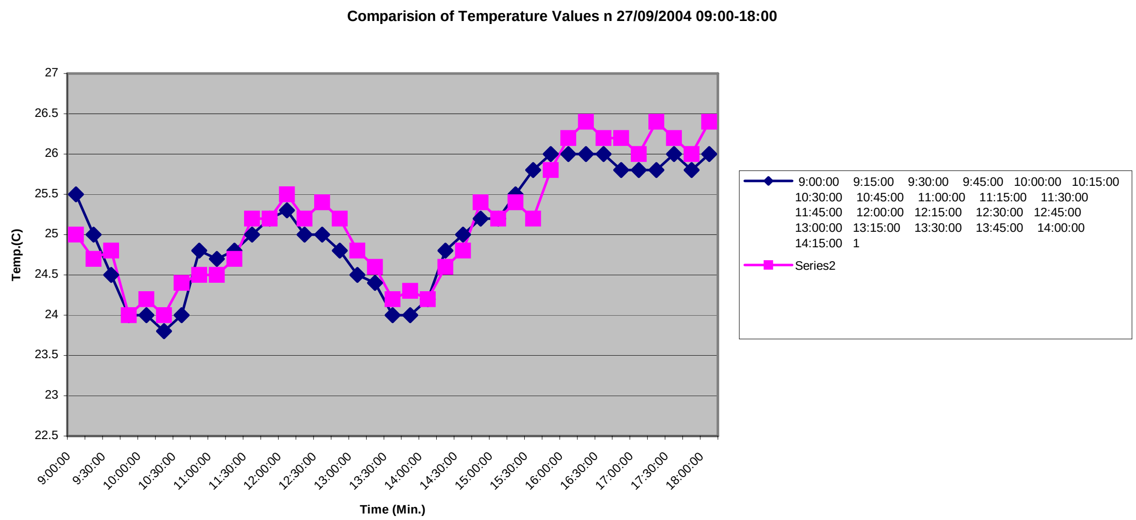

Fig. 4

4. Conclusions

This type of a low cost AWS can be developed with the state of art technology sensors which are easy to calibrate. As these sensors are at comparably low price and their output values are within the WMO standards. One can get remote meteorological parameters through a data modem. Its maintenance is fairly user friendly therefore a normal person also can attend its day today maintenance.

5. References

1. RabbitCore RCM 2000 C-Programmable Module Getting Started Manual.
2. Technical Notes – TN 231 Rabbit 2000 Features and Their Use in Board-Level Products.
3. Technical Notes – TN 232 Rabbit 2000 C Release.

   Sensirion Data Sheet SHT75/71.