The Development of the Monitoring Software for the Mobile Weather Station

Napat Watjanatepin and Pakorn Somboonkij

***Abstract*—The objective of this research is to develop the high performance monitoring software extended data base of the mobile weather station by using the embedded computer. The monitoring software that the author developed could measure and record temperature, relative humidity, wind speed and direction, rainfall, solar irradiance and UV index. These parameters can be sent from mobile unit to base unit via radio frequency signal. The embedded computer is used as a database and hosts the monitoring software. This software was developed by using LabVIEW. It comprised of the Monitoring Program, the Data Acquired and Record Program, and the Report Generating Program. It can monitor and display any parameter in real time of graph and numerical data. It could also make a report in the format of research information. The research information could be created well-suited for the Microsoft Office.**

***Index Terms*—Monitoring software, weather station, labview, report generating program.**

I. Introduction

This For the past 20 years, the number of renewable energy system that is installed around the world is increasing every day. The research and development of these systems is necessary to use the meteorology data in order to find the performance of the system and other issue in the research. Especially in the photovoltaic/Wind energy system, we need to know the data of solar irradiance, wind speed and direction, rainfall, temperature, air pressure and relative humidity. [1] To obtain this weather information, we need to have the appropriate weather station. Normally, the weather station is classified into 2 types acceding to their installed area. The two areas are wire and wireless weather station. The weather station will need to have in any types of sensor. These are used for measuring any parameters. After that the data will be send to the data logger, or send to the storage computer by using a mean of communication system

Usually, the data logger will have a small memory size so we need to use the interface cable to load the data into the computer. The drawback is that it cannot display the real time data. This system is inconvenient to be used in the remote area. Consequently, the communication system is an essential component to consider The weather station and sensors are not the problem, because we can buy conveniently from various companies.[2], [3]. However the development of the high performance of the control and monitoring software is even more important. So the software needs further development according to the requirements of the researcher.

The study of Marcelite Jenkins (2003), shows that the development of the monitoring software to support the Radio Telescope of the Pisgah Astronomical Research Institute(PARI) at South Carolina state University. This is the wireless system, it use the 418MHz Radio frequency to transfer data from the sensors to the receiver. The receiver model is CC-2000 Computer interface. The monitoring software was developed by LabVIEW, and can be monitored by the internet network [4].

Jenkins's study is consistent with the study of Kyle Sendevich (2009) who had developed "The Real Time Weather Information Using LabVIEW and Unset HUBO weather Station". The system sends the weather data to the data logger. It supports the web operating system by using wireless modem. The receiver of the system was developed by using LabVIEW along with JAVA, database and the PHP webpage. The information can display real-time via internet network [5]. Similarly, the study of M. Benghanem (2009) "Measurement of Meteorological Data Based on wireless Data Acquisition system Monitoring". This system was developed to measure the weather data and solar energy for remote area of Saudi Arabia. This system used the wireless communication control with micro-controller. The software was developed by using LabVIEW [6]. These information showed that, the LabVIEW is popular to used to develop the control and monitoring software for the automatic weather station.

However, on one has never try to use the embedded computer for data recording and generating weather information. For the small size weather station, this might be the most complementary.

This research used the Vantage Pro II weather station. It is the product of DAVIS INSTRUMENTS. We need to develop the existing system because of the small capacity of the data logger that is installed in the base unit. The limitation is that the data can be stored for only 8 days with 5 minute sampling time. If we reduce the sampling time to 1 minute, the data logger can store for only 42 hours [7]. In addition to that, we also wanted to create the "Report Generating Program" so that we could create research information for further uses. The objective of this research is to develop the high performance monitoring software extended data base with the embedded computer. This software could be create the

Manuscript received August 23, 2012; revised December 19, 2012. This work was supported the budget by the research funding from the Rajamangala University of Technology Suvarnabhumi Thailand.

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DOI: 10.7763/IJIEE.2013.V3.342

research information, and display any weather parameters as a real-time. We can also access this information via internet network. Moreover we can install them at remote areas because we designed the power supply from solar cell to support them.

II. Material and Method

A. Material

1) Wireless Vantage Pro II Weather Station
2) Console/Receiver Vantage Pro II
3) Embedded computer model WEBS_1010
4) Software LabVIEW 2009

B. Design and Development

The original system is Vantage Pro II weather station. It consist of rain collector sensor, UV index sensor, pyranometer, anemometer, solar power supply, Barometer, mounting pole, solar power transmitter, these sensors will be transfer data to the sensor interface module and transmit data by the radio frequency 868 MHz. The data will be transmitted to the receiver across the RF wireless. The receiver includes the small size data logger. We can use the RS-232 cable to download weather data to your computer as show in Fig. 1. Consequently, the author needs to design the new system to enhance the original system. By using the RS-232 interface between console/receiver and the embedded computer. The system will be able to transfer the weather data and store them in the database of the embedded computer. The LabVIEW was used to develop the monitoring software. The monitoring software can process, display and store the collected data in the embedded computer. The measured parameters are available on-line over the internet network to any user. The data flow diagram as show in Fig. 1.

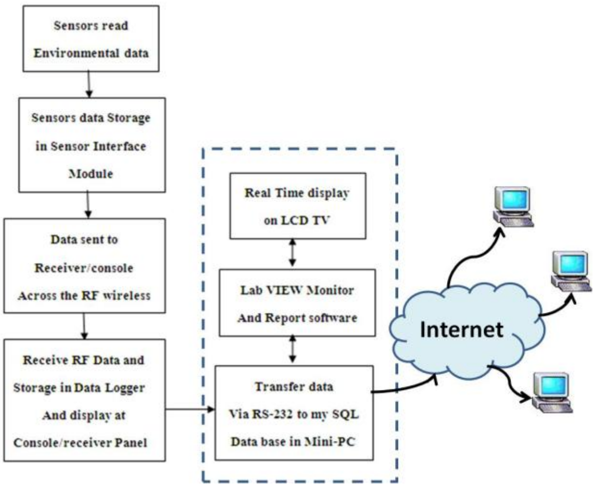

Fig. 1. Data flow diagram of original and the new system

C. The Mobile Weather Station

The mobile weather station in this project consists of two major parts. There are mobile unit and based unit as shown in fig. 2. Mobile unit comprise of any sensors, which will measure various weather parameter. They are also the solar power transmitter. It is a wireless communication component. The transmitted data send though the 868.0-868.6 MHz of the radio frequency signal. The base unit consists of the console/receiver with data logger and an embedded computer. This computer is very small and consumes power for only 6 to 8 watts when the CPU operates. The author develops the solar power with battery storage as the supply for the base unit. It is around 30 watts DC power supply as shown in Fig. 2.

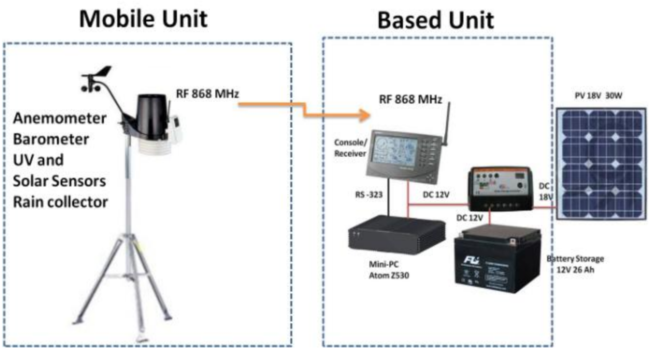

Fig. 2. The hardware diagram

D. Development of the Monitoring Software

The author has developed this program which has two main programs. There are:

1) Main program:

The function of the Main Program is to read the data from the Console/Receiver of the base unit, and write the data to the database. The database that the author chose for this project was the MySQL. It is the Open Database Connectivity program. The Main Program could select the interval time to read the data; it has the user connecting part and the data monitoring display. The Main Program was divided into four sub-programs, which are: Data acquire and store program, Set parameter program, Monitor and Display program, and Connect to user program. [8]

2) Report generating program:

The function of this program is to create a report appropriate to the user's need. This program could automatically call the Microsoft Office to make the report via graphs or tables. Also, it can export data files into any format.

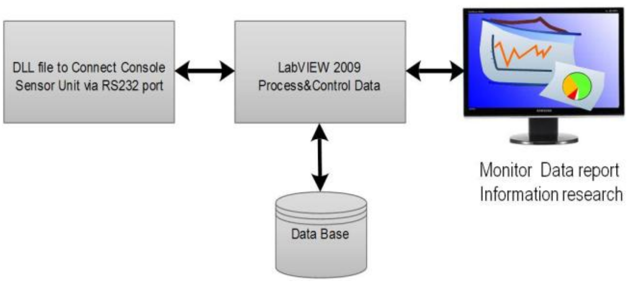

Fig. 3. The Development of the Monitoring Software's diagram

III. Implementation

The experimental implementation of this research could be set as follows:

- Install the Mobile Unit 50 meters away from the Base Unit.

- Install the Base Unit inside the building, and turn on the power supply of the Console/Receiver so that it would be ready to use (do not use the power supply from the PV energy system).
- Turn on the embedded computer, and run the monitoring software. After that, recheck the reading/writing process of the software to see if it is complete or not. Start the experiment and correct the weather data. (Experimental period is December 18, 2011 to February 18, 2012)
- The author choose by random the data for analysis from 20 to 29 of January, 2012 and make the research information report.

IV. Results And Discussion

A. Results

1) The results of the developed program

The display of the program is as shown in fig. 4 and 5. This shows a real-time data that was acquired from the system. The program's features include setting the time to sample the data and showing the data in the terms of graphs. The parameters that can be displayed are humidity, temperature, wind speed, wind direction, solar- radiation, ultraviolet, rain rate and barometric. Furthermore, the program can also select the data that will be analyzed and generate it as a report, as shown in fig. 6. Then you can export file to the format of MS office.

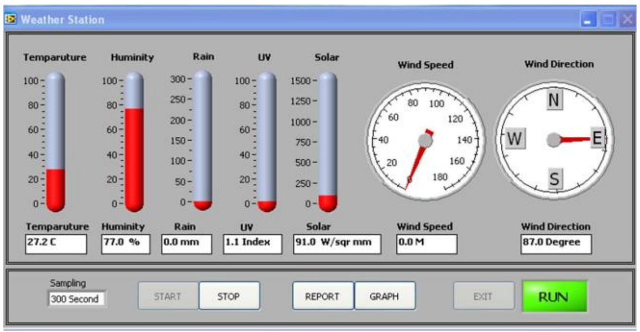

Fig. 4. The front panel of the Main program in Numerical mode

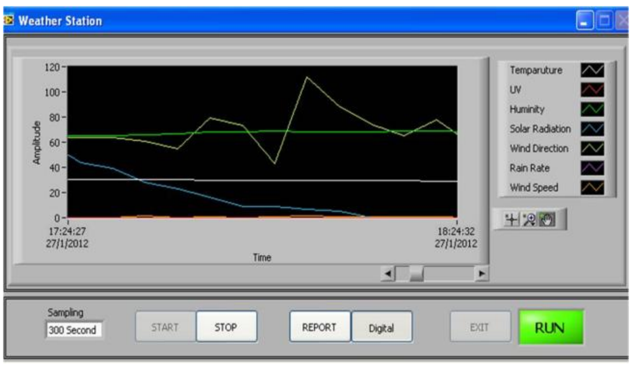

Fig. 5. The front panel of the Main program in Graphical mode

According Fig. 6, this show devices that can be selected in the "Select Data" panel, and analyzed time period will be selected from "Analysis By" control. The time range will be set in the right panel. Lastly, we can choose the port of data communication and unit of parameter by the front panel of the program.

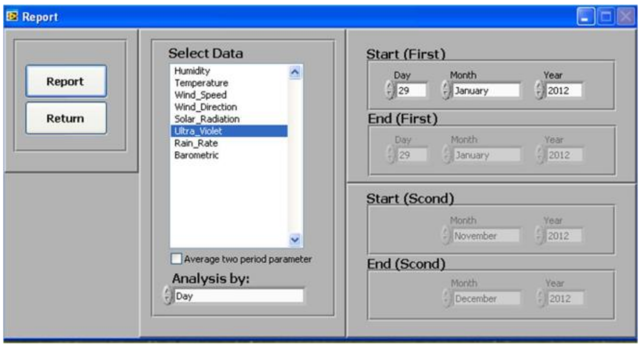

Fig. 6. The front panel of the Report Generating Program

2) The results of the monitored

The author installed the program that was developed by LabVIEW2009 in to the embedded computer. The program was run in order to connect it to the sensors. These sensors were installed outside of the building by the author. The installing distance is around 50 meters as shown in fig. 7. After the program completed its running, the weather station will monitoring and correcting the weather's data. There are 7 parameters as follow: Humidity, Temperature, Wind speed, Wind direction, Solar- Radiation, Ultraviolet, Rain rate, and Barometric. The starting date is January 10, 2012. The author chose the monitoring results during January 22 to 29, 2012 by using the random process.

1) Mobile Unit 2) Base Unit

Fig. 7. The mobile weather station installation

a) The monitoring result of humidity and temperature vs time:

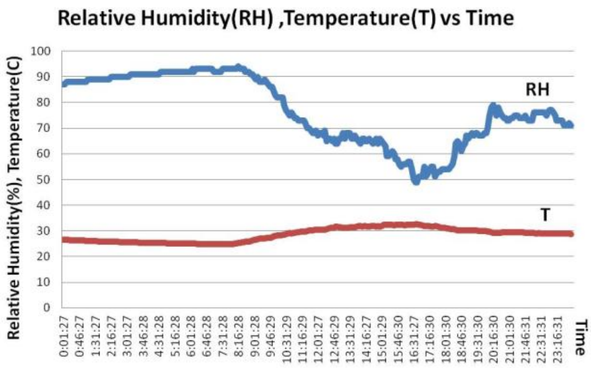

Fig. 8. The Graph of Humidity and Temperature vs TimeJanuary 29, 2012

According to fig. 8, the monitoring results of the relative humidity and temperature vs time on January 29, 2012 are shown. The graph shows that the relative humidity at mid-day will be lower than that of the night time and morning time. The lowest of humidity is equal to 49% at 16:36:30, and highest is equal to 93% at 5:56:28. However, the trends of the temperature will be the opposite with humidity. The lowest of temperature is equal to 24.888 °C at 7:56:28, and the highest is equal to 32.66 °C at 16:36:30.

b) The monitoring result of solar radiation vs time:

The Fig. 9 above shows, that the Solar Radiation vs Time measured on January 29, 2012. The highest solar radiation is equal to 645 W/m^2 at 12:36:29. This is because it was a cloudy day.

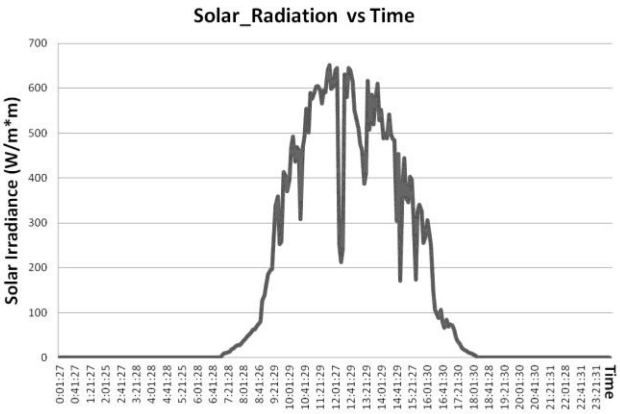

Fig. 9. The Graph of Solar Radiation vs Time: January 29, 2012.

c) The monitoring result of the wind direction vs time:

Fig. 11. The Graph of Wind Direction vs Time: January 29, 2012.

Fig. 11 shows the monitoring results of the wind direction vs time on January 29, 2012. The wind direction can be observed by the degrees in the circle as follow:

- 0^o or 360^o means North (N),
- 90^o means East (E),
- 180^o means South (S),
- 270^o means West (W)
- 45^o means North-Earth (NE)
- 135^o means South-East (SE)
- 225^o means South-West (SW)
- 315^o means North-West (NW)

Consequently, we can analyze that from 00.01 to 09.21, the Wind direction is 60^o from North-East. Moreover, during 09.21 until 16.41, the wind direction will change to 250^o from South-West and 310^o from North-West.

d) The monitoring result by average day:

This graph shows that the comparison of the temperature and humidity from nine days (20 to 29 of January 2012). The average humidity on 26 January is the highest which is about 86.2395%. In addition to that, the temperature is lowest which is equal to 26.7019°C in the very same day. On the other hand, the highest of the average temperature is on 23 January; at 29.205°C, and the lowest average humidity is equal to 66.8159% in the same day. From the measuring result from the weather station, we can display and create the research information.

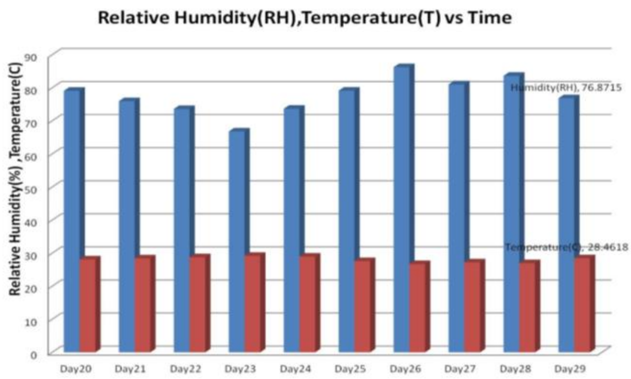

Fig. 12. The average day graph of Humidity and Temperature vs Time: January 20 to 29, 2012.

B. Discussions

The results as shown the performance of the monitoring software that the author developed by using LabVIEW 2009. This software could display and monitor the weather parameters. Then it can make the research information report that will be appropriate for uses with the Automatic Mobile Weather Station. However, we founded some more improvements that should be made for further development. For example, the Report Generating Program cannot make a wind-rose diagram. Another question is that the sampling time of this software depended on the sampling time of the Console/Receiver (Product of DAVIS Instruments). This means that the lowest sampling time is per 70 seconds; therefore, the author cannot choose the sampling time period lower than 70 seconds. In some cases, more accuracy and precision will be needed, thus, this limitation will have to be explore for further development as well.

As for the hardware, when the author conducting the experiment placed the Mobile Unit away from the Base Unit (this was installed inside a building) for about 60 meters, it was found that the transmitting radio signal could not work. This is because the antennas of the transmitting and receiving device are small 5-inches poles. This type of antenna provides a radio signal in the form of a ring diffusing as a circle, so it only works for a short distance. Obstacles, such as trees or buildings, are also concerns that should be figured out in the future.

V. Conclusion and Future Work

The mobile weather station is the instrument that has a lot of benefits for the experimental research in the Solar Energy Research and Technology Training Centre of Faculty of Engineering and Architecture. However, this is appropriate for the wind energy system, PV energy system, or other renewable energy system power plant. The Monitoring Program, the data acquired and record Program, and the Report Generating Program were also developed. It can monitor and display any parameter in real time of graph and numerical data. It could also make a report in the format of research information. The research information could be created well-suited for the Microsoft Office.

This weather station will be more beneficial if we take them to use in the remote areas, because they have a PV energy supply with battery storage. This means that we have to design the next experiment by installing the mobile unit and base unit together. Then take them to measure the weather at remote area by using the power supply from the photovoltaic energy system.

However, we have to design the next research in order to develop this software to have a higher performance and analyze different ways to try to reduce the sampling time of the hardware. This development could help the researcher create high quality weather parameters information.

Future researches should develop a new kind of antenna, for instance, Yagi antenna's transmitter and receiver, to increase the transmitting distance between the Mobile Unit and Base Unit, for a research that might calls for the distance of 2-3 kilometers to raise the efficiency bar for the Weather Station. This might also be improvised to display the results of the data onto the Electronics Display Board, which was already installed in front of the campus to share beneficial information to the people and community.

Acknowledgment

Thank you for research budgets from the research funding of Rajamangala University of Technology Suvarnabhumi (RMUTSB) on the year 2011. Also thanks for the Solar Energy Research and Technology Training Center (SERTT) of RMUTSB that supported the laboratory room and equipments.

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