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Design and Development of a Remote Monitoring and Maintenance of Solar Plant Supervisory System

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Abstract: *In this Paper we are implementing Prototype solar PV monitoring and optimization includes a data acquisition system, Supervisory monitoring and control station at plant level and Decision Support System (DSS) at the Central Control Station. This Prototype System consist two plant level monitoring (PLM) systems and Central Control Station (CCS). One of Plant level system is for basic data acquisition from weather sensors related to sun energy and Sting Monitoring Units. Another plant level system will have features along with the solar tracker system. The CCS continuous on-line monitoring, control, storage, and reporting at plant level and collects data from PLM's via wireless module with time stamp for real time processing, storage, alarming, reporting and displaying. This system designed monitoring and analytics system.*

Keywords: *solar PV monitoring and optimization, data acquisition system, Supervisory monitoring, control station, Decision Support System (DSS).This system assists in reducing the cost of operation and maintenance.*

1. INTRODUCTION

As the world broadens its portfolio of power options to meet growing energy demands and increasingly stringent environmental concerns, solar power is emerging as an attractive option. Of all the routes for conversion of solar into useful energy, direct conversion of sunlight to electricity through solar photovoltaic technology is well accepted. Solar photovoltaic has been recognized as an important route for generation of substantial quantities of grid quality power by utilizing the light energy of solar radiation.

Benefits of grid connected solar PV power plant are Power from the sun is clean, silent, limitless and free and Generation of electricity from Solar PV is totally free of Green House Gas emission. New technologies are breaking into the solar market, easing issues related to interference and making installation simpler. In the power industry, remote controls make life more than just a little simpler. Remote monitoring allows a solar plant operator not only to control, but, in many cases, to track and monitor the plant from a distance. Meanwhile, the growth of the solar market is leaving some technology companies in search of a form of wire-free monitoring for growing numbers of solar plants. Solar arrays can also have a higher level of sophistication, in terms of optimizing their performance, extending their active life and increasing their residual value. Unfortunately, the technology to do this doesn't come with the basic package – but it's an option. Until recently, most new array owners have not been offered, or taken advantage of, these new monitoring and optimization options. However, the effectiveness, affordability and availability of these technologies are becoming much more attractive. We are approaching the point where large-scale solar assets will not be considered without it, just like you wouldn't be offered a car without engine management or anti-lock brakes, or dashboard warning lights.

Monitoring and performance analysis of solar PV plants have become extremely critical due to the increasing cost of operation and maintenance as well as reducing yield due to performance degradation during the life cycle of the plant equipments. This becomes essential to ensure high performance, low downtime and fault detection in a solar PV power plant. On-site weather data, production data from the panel strings, inverters and transformers are required to be continuously collected for monitoring and analysis of performance. Data acquisition from AC and

DC control panels are further required for operational monitoring and control of the plant and substation. A well designed monitoring and analytics system assists in reducing the cost of operation and maintenance.

2. BLOCK DIAGRAM & HARDWARE MODULES

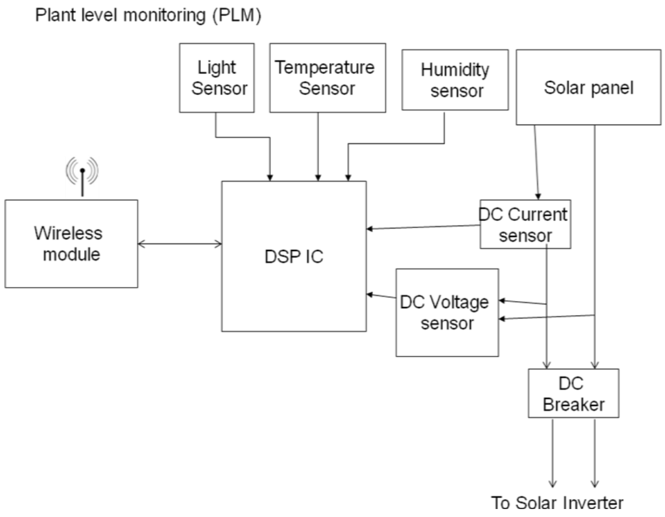


Fig 1: plant level monitoring

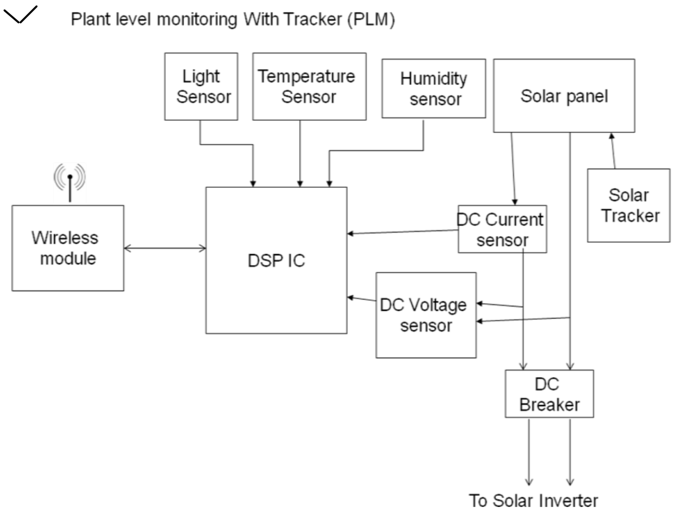


Fig 2: plant level monitoring with tracker

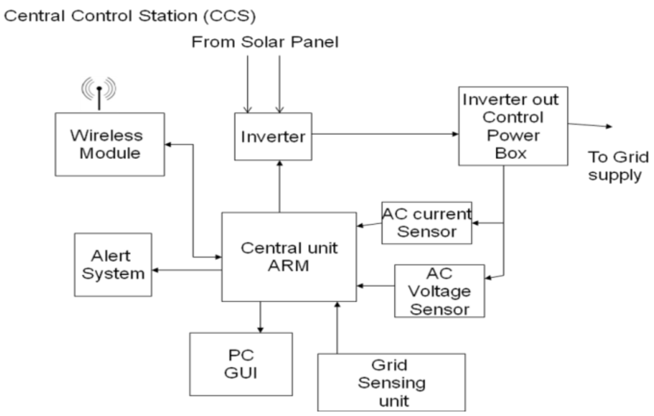


Fig 3 : Central control station

2.1 LPC2148 MICROCONTROLLER:

The LPC2148 microcontrollers are based on a 32 bit ARM7TDMI-S CPU with real time emulation and embedded trace support, that combines the microcontroller with embedded high speed flash memory of 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces the code by more than 30 % with minimal performance penalty.

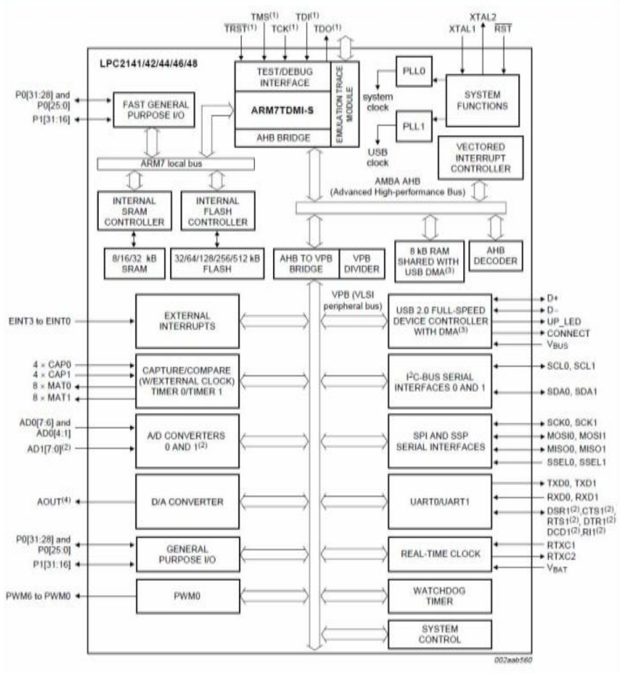


Fig 4: Block diagram of LPC2148

2.2 PIC18F452:

It is a 'C' compiler optimized instruction set architecture. It can operate up to 10 MIPS. Power consumed is 40 MHz osc/clock input and 4 MHz – 10 MHz osc/clock input with PLL active. It is of 16-bit instructions, 8-bit wide data path. Three external interrupt pins

2.3 ZIGBEE:

ZigBee is an open technology developed by the ZigBee Alliance to overcome the limitations of BLUETOOTH and Wi-Fi. ZigBee is an IEEE 802.15.4 standard for data communications with business and consumer devices. It is designed around low power consumption allowing batteries to essentially last forever. BLUETOOTH as we know was developed to replace wires and Wi-Fi to achieve higher data transfer rate, as such till now nothing has been developed for sensor networking and control machines which require longer battery life and continuous working without human intervention.

2.4 Solar cell and Solar panel:

A **solar cell** is a device that converts the energy of sunlight directly into electricity by the **photovoltaic effect**. Sometimes the term solar cell is reserved for devices intended specifically to capture energy from sunlight, while the term photovoltaic cell is used when the light source is unspecified. Assemblies of cells are used to make solar panels, solar modules, or photovoltaic arrays. Photovoltaic are the field of technology and research related to the application of solar cells in producing electricity for practical use. The energy generated this way is an example of solar energy (also called solar power).

2.5 Light Sensor:

A **Light Sensor** generates an output signal indicating the intensity of light by measuring the radiant energy that exists in a very narrow range of frequencies basically called "light", and which ranges in frequency from "Infrared" to "Visible" up to "Ultraviolet" light spectrum. The light sensor is a passive devices that convert this "light energy" whether visible or in the infrared parts of the spectrum into an electrical signal output. Light sensors are more commonly known as "Photoelectric Devices" or "Photo Sensors" because the convert light energy (photons) into electricity (electrons).A light sensor uses an LDR as part of a voltage divider.

2.6 Temperature Sensor (LM35):

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ˚ Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centi-grade scaling.

2.7 **Humidity sensor:**

Humidity sensors are gaining more significance in diverse areas of measurement and Control technology. Manufacturers are not only improving the accuracy and long-term drift of their sensors, they are improving their durability for use in different environments, and simultaneously reducing the component size and the price.

2.8 Current sensor:

Hall Effect Sensor

A Hall Effect sensor is a transducer that varies its output voltage in response to a magnetic field. Hall Effect sensors are used for proximity switching, positioning, speed detection, and current sensing applications.

2.9 Voltage sensor:

In electronics, a voltage divider (also known as a potential divider) is a simple linear circuit that produces an output voltage (Vout) that is a fraction of its input voltage (Vin). Voltage division refers to the partitioning of a voltage among the components of the divider.

A simple example of a voltage divider consists of two resistors in series or a potentiometer. It is commonly used to create a reference voltage, and may also be used as a signal attenuator at low frequencies.

3. IMPLEMENTATION

In this system Fig 1 is the block diagram of Plant Level Monitoring (PLM-1) consists of temperature sensor (LM35), LDR sensor, Humidity sensor (SY-HS 220), DC Voltage sensor, DC current Sensor. The power generated by the solar panel depends upon the availability and intensity of sun so the performance of the solar panel depends on weather conditions. Temperature, LDR, Humidity sensors are used for weather monitoring. The power generated by the solar panel can be calculated by using DC voltage Sensor and DC current Sensor. The sensors data, voltage and currents readings are updated to central station by wireless modules. New values shall be updated to the CCS in sub-seconds interval based on the response time capability the PLM. This system also control and prevent the short circuit of solar panel to inverter input level via control circuit.

Fig 2 is the block diagram of Plant Level Monitoring with tracker (PLM-2) having the same components as of PLM-1 with additional solar tracker. The solar panel tracks sun according to the time by using RTC peripheral. In this system we are calculating the amount of power generated by PLM-1, PLM-2, and compare to know which plant is more efficient. If any of solar panel is not working we can know directly by the values, which are updated from the plant to central station for every minute. In PLM we can prevent the short circuit between solar panel and inverter by DC breaker Circuit. As the values of the plant are updated to central station we can continuously monitor the plant from central station.

Central control Station consists of wireless module, Alert system, PC GUI, Grid sensing unit, AC voltage sensor, AC current sensor & Inverter. Central Control Station will process the data from PLM's and the availability of the Line Grip power it will start the inverter functionality. Load Monitoring Units measure the values of AC current, AC voltage and AC power which map to the Grid. All these information will send to the Monitoring for analysis purpose. The sensors data from the plant are updated to the central control station through wireless module and displayed in the GUI. The amount of power generated by the plant is calculated & displayed in GUI. Whenever grid wants the power supply, firstly it checks the status of the grid. If grid is available then central station on the inverter so that the solar panel generated power is fed to inverter which converts DC power to AC power. The amount of power supplied to the grid can be calculated by AC current sensor and AC voltage sensor. If the power supply required for the grid is not available then alert system i.e. buzzer is on and off the inverter functionality.

4. RESULTS

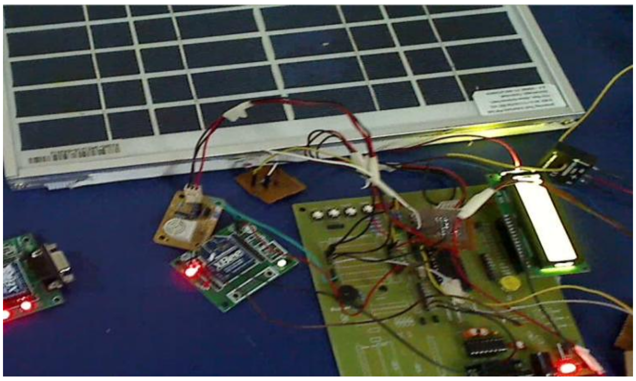
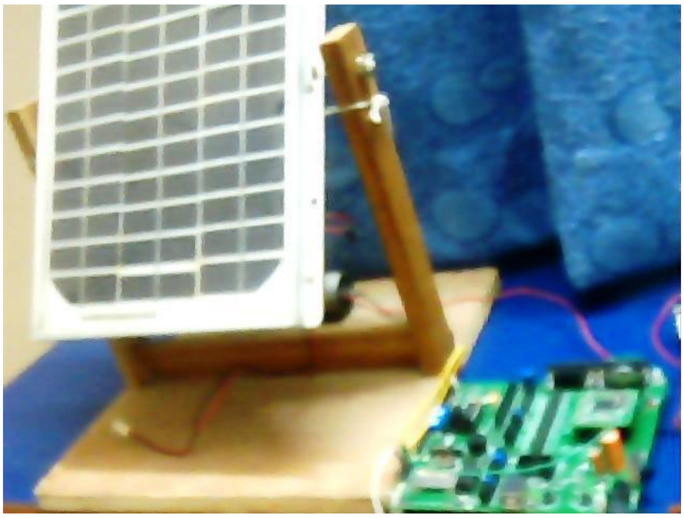


Fig 5: PLM-1



.Fig 6. PLM-2

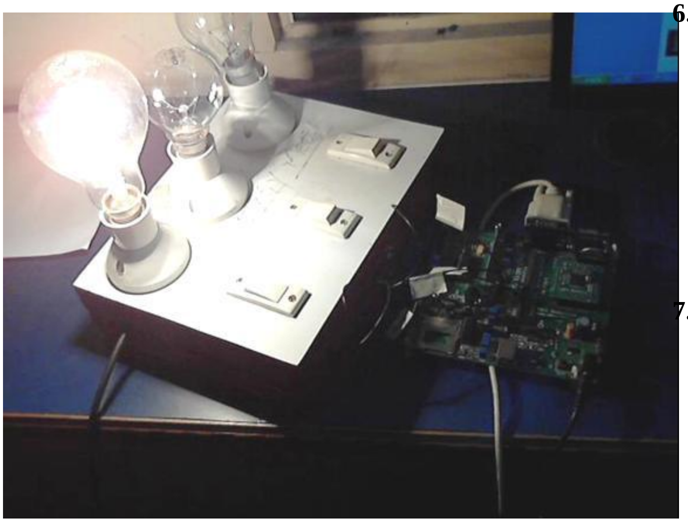


Fig 7. Central control station

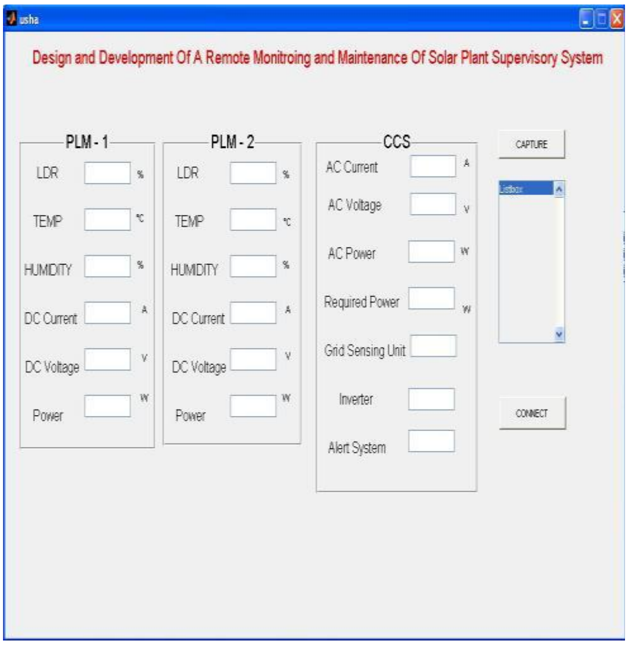


Fig 8. GUI at CCS

5. CONCLUSION

Panel monitoring provides unprecedented insight, but it also creates a fear of data overload and the ability for O&M teams to distill the mass of data, analyze performance and prioritize an action plan that can guarantee improved financial return. The next logical step in the evolution of large-scale array performance optimization is to couple panel-level data insight with advanced analysis and diagnostics tools that remove the need for human vigilance and interpretation. Arrays become self-analyzing and present actionable information to the O&M team driven by site-specific financial business rules. In effect, arrays become intelligent – self-adapting and optimizing where possible and informing the owners with precise details of when, where and how human intervention is required to maintain the asset at optimal performance over its full 25-year life.

6. FUTURE SCOPE

The output of a solar panel, essentially current and voltage, are stored in the memory of an inverter. These stored values are sent to a central control unit. In future we are using different means of communication channels like Ethernet, Internet, dial up access, GSM etc. the data is transmitted to a server from where alerts are status messages are sent to the users via SMS, email etc.

7. REFERENCES

1. E. Koutroulis and K. Kalaitzakis, “Development of an integrated data-acquisition system for renewable energy sources systems monitoring,” Renewable Energy, Vol. 28, 2003, pp. 139-152.
2. N. Watjanatepin and C. Boonmee,“ Development of Lab view Monitoring System for the Hybrid PV-Wind Energy Systen,” Tech Connect World Conference and Expo, 2010, California, USA.
3. S.C.S. Juca, P.C.M. Carvalho, and F.T. Brito, “A Low Cost Concept for Data Acquisition systems applied to decentralized renewable energy plants,” Sensors, Vol. 11, 2011, pp. 743-756.
4. K. Kalaitzakis, E. Koutroulis, and V. Vlachos, “Development of a data acquisition system for remote monitoring of renewable energy systems,” Measurement, Vol. 34, 2003, pp. 75-83.
5. R. Mukaro and X.F. Carelse, “A Microcontroller-Based Data Acquisition System for Solar Radiation and Environmental Monitoring,” IEEE Transactions on Instrumentation and Measurement, Vol. 8, No. 6, 1999, pp. 1232-1238.
6. A. Mahjoubi, R.F. Mechlouch, and A.B. Brahim, “A Low Cost Wireless Data Acquisition System for a Remote Photovoltaic (PV) Water Pumping System,” Energies, Vol. 4, 2011, pp. 68-89.
7. L. Wang and K.H. Liu, “Implementation of a Web-Based Real-Time Monitoring and Control System for a Hybrid Wind-PV-Battery Renewable Energy System,” International Conference on intelligent Systems Applications to Power Systems, 2007.