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FPGA BASED MONITORING SYSTEM FOR AGRICULTURE FIELD USING SMART SENSORS

D.PREETHI[1],K.S.MURUGESAN[2]

PG Scholar, Department of ECE, Velalar College of Engineeering and Technology, Tamilnadu, India[1]
Assistant Professor, Department of ECE, Velalar College of Engineering and Technology ,Tamilnadu, India[2]

Abstract- **Today, it is clear that desertification due to global warming caused removal of nutrient contents of the soil, making land infertile and unusable for arable farming. To get rid of this problem, it is possible to use renewable energy to pump water and irrigate the fields. Continuous monitoring of temperature, soil moisture, water level of wellness and nutrient contents manually and regularly gives information to the grower to better understand, how each factor affects growth and how to manage maximal crop productiveness. The current paper highlights the development of mineral and soil moisture that can be placed at suitable locations on field for monitoring of moisture and nutrient contents of the soil. This project presents FPGA based monitoring for agricultural field using smart sensors for betterment of agricultural yield.**

***Index Terms*:** Photovoltaic,FPGA, Energy storage, irrigation, Pumping motor, Relay.

I. INTRODUCTION

In most country's economy, agriculture has been playing a vital role. In developing countries, uneducated farmers tend to use more water than the required water, hence wasting then soil moisture sensors are used in such situation to indicate to the farmer where it is needed to cultivate the field.. Nowadays agriculture field suffers from different climatic conditions such as drought, flood, etc., it caused a loss in agriculture protection. In agricultural applications, the photovoltaic pumping is by far the most used. The photovoltaic pumping system consists of a solar panel, control unit and pump unit. A solar PV cell converts photon energy to electricity, but the problem with solar cell technology is low efficiency and non-linear I-V characteristics [1].

However, it is not enough just to have a photovoltaic pumping system to solve the impact of desertification, but an efficient power management system is needed to make good decisions for better utilization of the available energy [4] [7]. An efficient management system is needed to make decisions for battery use of energy. An automated irrigation system was developed to optimize water use for agricultural crops [8]. The solar powered water pump along with an automatic water flow control using a moisture sensor and mineral sensor is the proposed solution to the present energy disaster for Indian farmers [9]. The smallest element of a PV panel is the solar cell. Each solar cell has two or more specially prepared layers of semiconductor material that produce direct current (DC) electricity when exposed to light. This DC current is collected by the wiring in the solar panel. It is then supplied either to a DC pump, which in turn pumps water whenever the sunshine or stored in batteries for later use by the pump [16].

The paper is organized as follows: Section II describes the system description. In the Section III, proposed methodology is presented. Hardware design is detailed in section IV. Experimental results are discussed in section V; some of the concluding remarks are presented in section VI.

II. SYSTEM DESCRIPTION

The photovoltaic pumping system comprises of a photovoltaic subsystem consisting of a photovoltaic panel of 1kw, a power DC-DC buck converter and MPPT controller, and it contains short term energy storage

subsystem, i.e. electrochemical batteries of 275.92Ah; the pumping system is composed of permanent magnet DC motor (PMDC) coupled with the centrifugal pump and it contains a tank to stock the water. Instead of batteries, the water tanks are preferred storage option in PV pumping system. The centrifugal pumps are usually preferred for PV water pumping system due to the simplicity.

A. Photovoltaic Energy Conversion System

Photovoltaic will produce electricity only
When the sunlight is available, therefore stand-alone system obviously needs some amount of backup energy storage, which makes them available through the night or bad weather conditions. Solar cells are assembled to form a module. The converter technology has a significant impact on efficiency and effectiveness. In buck converter, continuous output current gives the less output voltage ripple. The input voltage and output voltage can be calculated as:

Maximum Duty Cycle: D= Vout/Vin

Where V_{out} is the output voltage and $V_{in}$is the input voltage.

B. Water Pumping System

DC pumps are set as either displacement or centrifugal pump, and can be either submersible or surface types. The motor converts the electrical energy into mechanical energy. This pump converts this mechanical energy into hydraulic energy.

The water pumping can be done using various electric motors. One of the most suitable motors is PMDC motor. This water pumping system consists of the PV array, DC-DC converter and PMDC motor connected to a water pump as shown in fig. 1. Pumping system having brushed PMDC motor coupled to centrifugal pump is the simplest and most commonly used. Hence, in this project, the system considered in the fig. 1 is PMDC motor driven centrifugal pump connected to PV panel through MPPT converter.

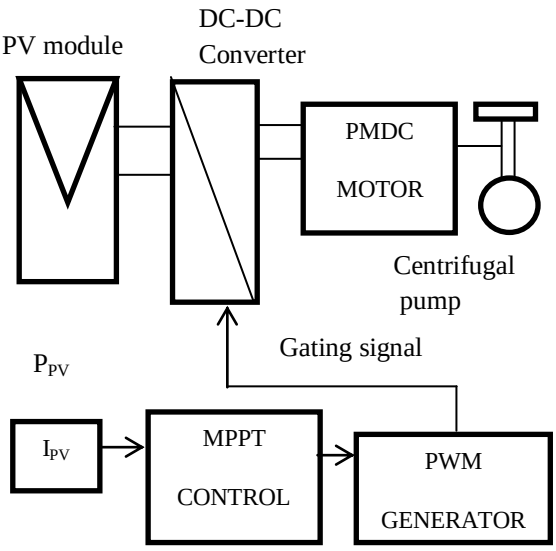

Fig. 1 Block diagram of PMDC Pumping system

III. PROPOSED METHODOLOGY

A. Working of the system

The area which is to be cultivated will be
classified into a large number of discrete zones of possible different soil condition, where each zone includes at least one sprinkler head, or other water disposing device and a solenoid valve having an "on" state and an "off" state for controlling the flow of water to such device for that zone and which consists a moisture sensor disposed in the soil in each of the cones and, when interrogated, produces an electrical signal proportional to the level of moisture in the soil proximate that sensor and mineral sensor that monitors the nutrient contents in the soil. The mineral sensor and moisture sensor are connected to the FPGA. The FPGA is connected to relay 1 and relay 2. The relay that receives or retransmit the information to pump motor and solenoid valve.When the solenoid is not

energized, then the valve is termed normally open. Similarly, when the solenoid is energized, then the valve is termed normally closed.

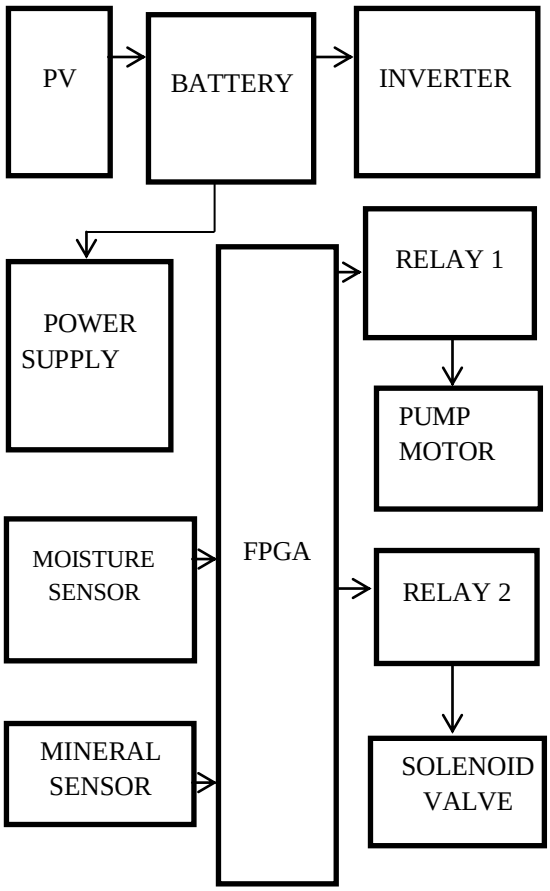

Fig. 2 Block Diagram of FPGA based monitoring system for agriculture field using smart sensor.

B. Components

1) Solar PV module

The PV array consists of an array of solar

Cell modules to provide the desired DC voltage and current.A photovoltaic system consists of an array of photovoltaic modules, an inverter, a battery bank model for storage, interconnection wiring and solar tracking mechanism as shown in fig. 2. It can produce only a limited amount of power. The solar irradiance received on the surface of the PV cells is connected into electric power by PV effect.

The photovoltaic energy conversion is a physical process that directly converts sunlight into electricity. The basic element of a photovoltaic system is the photovoltaic cell. To produce more power, solar cells are assembled to form a module. In order to extract maximum power from solar panel, a maximum power point tracker (MPPT), which is a DC/DC converter, is normally connected between the load and the panel.

2) Battery

The energy generated through the solar

panel will be send to a DC battery. The battery will store the energy for future purposes. Now we are connecting a water pump to the battery so that the motor run on the power generated by the solar panel. The pump will supply the water automatically when the land needs it.The battery that is connected to the inverter and power supply.

A 60V, 275.92Ah lead acid battery bank is used as the electric energy storage system. The battery bank model is considered as an ideal voltage source. In this paper, the most commonly used technique is adopted for the state-of-charge calculation.

3) Inverter

The pump controller prevents the pump from high or low voltage conditions and it increases the amount of water pumped in less than ideal conditions. A DC electricity from the solar panel is converted into AC electricity to operate the pump, and will automatically regulate output frequency according to sun radiance intensity, maximally realize MPPT tracking function. The battery is connected to the inverter to convert the DC electricity to AC electricity. The inverter does not produce any power and the power is provided by the DC source. The output of solar cell modules is changeable according to solar radiation intensity and the solar cell module's temperature. As the voltage of solar cell modules decreases when the current increases, thus there is a good point of maximum power.

4) Solenoid Valve

A solenoid valve is an Electro-Mechanically operated valve.In a two-port solenoid valve the water flow is switched on or off and in three-port solenoid valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a water pipe. For example, a two-way valve has 2 ports. If the solenoid is open, then the two ports are connected and fluid may flow between the ports. If the valve is closed, then ports are isolated. When the solenoid is not energized, then the valve is termed normally open. Similarly, when the solenoid is energized, then the valve is termed normally closed. A 3-way valve has 3 ports, it connects one port to either of the two other ports. The relay that passes the information to pump motor and solenoid valve.

5) Soil moisture sensor

Soil moisture sensor measure the Volumetric content in soil and temperature at different levels of the earth's atmosphere. Choose an area that needs to be watered the most frequently. Place the sensor within that area, in a particular area that receives an average of slightly less than average water from the irrigation system. It is controlled by many factors, including incoming solar radiations, humidity and altitude. It measures the water content in the soil. Measuring soil moisture is very important in agriculture to help farmers manage their irrigation system more efficiently. Farmers able to generally use less water content to grow a crop, they are able to increase yields and the quality of the crop by proper management of soil moisture during critical plant growth stages.

6) Mineral sensor

Soil nutrient testing is a managementtool that can accurately determine the nutrient contents in the soil and guide the efficient use of fertilizers with the increasing awareness of fertilizer effects on environmental and soil quality. Soil tests have been instrumental in determining where insufficient or excess nutrient levels occur. Nutrient contents in the soil can be analyzed by using mineral sensor and it will make the agriculture more profitable. The design of the system that may monitor the farm by installing mineral sensors at the boundary of thefarm. The use of mineral sensor helps in deploying it in any type of environment for monitoring, making it flexible and robust. Nutrient contents in the soil can be analyzed by using mineral sensor and it will make the agriculture more profitable. It will lower the risk of water contamination by nitrate.

IV. HARDWARE DESIGN

Many studies have been conducted on the use of FPGA for co-simulation, implementation and control systems. In this section, we present the hardware description in VHDL language of the best power management strategy to implement it in an FPGA. We start with the design of the power management algorithm is translated into VHDL for being synthesized. The software used for FPGA based monitoring system using smart sensors in VHDL ISE Xilinx ISE Design Suite 8.1i as shown in fig. 3. After the development of code, it can be simulated in a computer to verify the correct operation of the circuit and can be synthesized to a physical device.The pumping motor will pump the water into the field by until the field is wet which is continuously monitored by the FPGA. The system used Xilinx ISE Design Suite to automate the process of water pumping in an over-head tank storage system and has ability to detect the level of water in a tank, switch on/off the pump accordingly and display the status on an LED.We create a special program, known as a test bench. The test bench is composed of three parts [6]
(Fig. 4)

- A test vector generated
- The system to be tested
- A monitor to examine the responses of the simulation

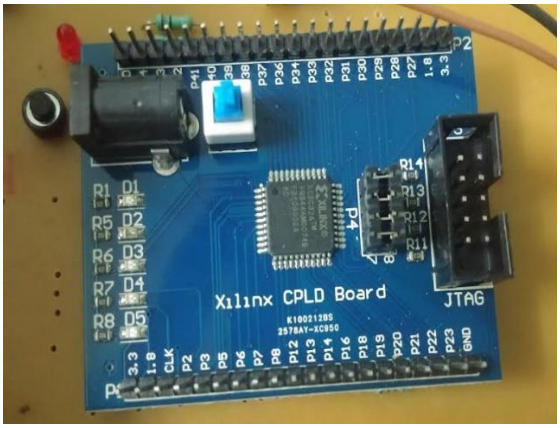

Fig. 3 Xilinx CPLD Board

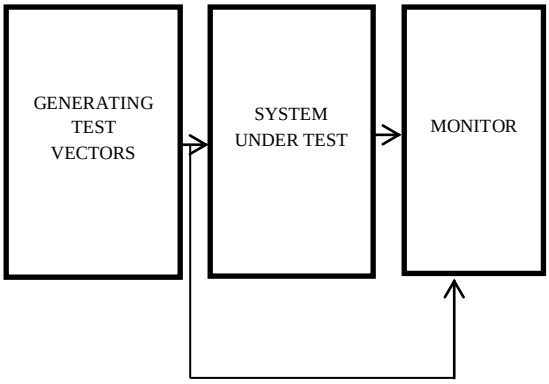

Fig. 4VHDL Code verification process

V. EXPERIMENTAL RESULTS

Fig. 5 Hardware Arrangement

The hardware arrangement for the FPGA monitoring system for agricultural field using smart sensors is shown in fig. 5. The mineral and moisture sensors are connected to the FPGA and the relay that sends the

information to a solenoid valve and pump motor. If any of the moisture or mineral contents is low, LED will be turned on.

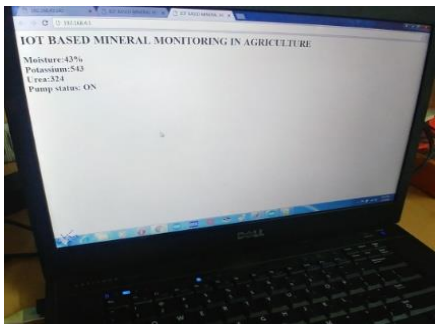

Fig. 6 Simulated Result

The simulation results are shown in fig. 6. Depending upon the simulation results the pump motor will be turned on or off.

- If there is insufficient mineral and soil moisture contents in the soil, LED will be turned on.
- IOT is used to indicate the exact scenario. The pump motor status will be displayed by using IOT.

VI. CONCLUSION

The result is a scalable, implementable technology that we have tested and validated numerical in the field. By using this sensor, we can find whether the soil is wet or dry and test the nutrient contents in the soil. The prospects of mineral sensors for real-time mapping of important soil chemical and physical properties to facilitate precision soil nutrient management and monitoring are promising. In future days to come, we can apply food nutrients to the plant and crop by air mixed with very less water content, with very less water content, with better monitoring and processing. The developed technology can also transfer fertilizer and the other agricultural chemicals to the agricultural fields by adding new sensors and valves.The system can act as an early warning system for upcoming problem, a monitoring system constantly reporting on the status of farms or livestock. It is claimed that such a system is relevant in the network security and that there is sufficient technical knowledge to provide its implementation not only feasible, but also cost effective.

REFERENCES

[1] A. Ahmed and A. Hefez, "Autonomous Photovoltaic Water Pumping System", Journal of Electrical Engineering, vol.12, pp. 1-6, 2012.

[2] A. Urtasun, E.L. Barrios, P. Sanchis, L. Marroyo, "Frequency-based energy management for stand-alone system with distributed battery storage", IEEE Trans. Power Electron., vol. 30, no. 9, pp. 4794-4808, 2015.

[3] C. Guzman, A. Cardenas, K. Agbossou, "Load Sharing Strategy for Autonomous AC Microgrids Based on FPGA Implementation of ADALINE&FLL", IEEE Trans. on Energy Conversion, vol. 29, no. 3, pp. 663-672, Sept. 2014.

[4] Devbratta Thakur, "Power Management Strategies for a wind energy source in an isolated microgrid and grid connected system", Doctoral Thesis, University of Western Ontario, May 2015.

[5] E. Padilla, K. Agbossou, A. Cardenas, "Towards Smart Integration of Distributed Energy Resources Using Distributed Network Protocol over Ethernet, IEEE Transactions on Smart Grid, vol.5, no. 4, pp. 1686-1695, July 2014.

[6] Eduardo Sanchez, Le language VHDL, Ecole Poly technique Federale de Lauanne.

[7] F. Nejabatkhah, W. L. Yun, "Overview of Power Management Strategies of Hybrid AC/DC Microgrid", IEEE Trans. Power Electron., vol. 30, pp. 7072-7089, Dec. 2015.

[8] Gutierrez J, Villa-Medina J F, Nieto-Garibay A and Porta-Gandara M A, 'Automated irrigation system using a wireless sensor Network and GPRS module', IEEE Transactions on instrumentation and measurement, 2013.

[9] Harishankar S, Kumar R, Susharsan K P, Vignesh U and Viveknath T, "Solar Powered Smart Irrigation System", Advance in Electronic and Electric Engineering, Volume 4, Number 4: 341-346, 2014.

[10] J.T. Bialasiewicz, "Renewable Energy System with Photovoltaic Power Generators: Operation and Modeling, "IEEE Transaction on Industry Electronics, vol. 55, pp. 2752-2758, July 2008.

[11] M. Bouzguenda, T. Salmi, A. Gastli, and A. Masmoudi, "Evaluating solar photovoltaic system performance using MATLAB", First International Conf. Renew.N Energies Veh. Technol., pp. 55-59, March 2012.

[12] Marcelo GradellaVillalva, Jonas Rafael Gazoli, and E.R. Filho, "Comprehensive Approach to Modeling and Simulation of Photovoltaic Arrays, "IEEE Transaction on Power Electronics, vol.24, pp. 1198-1208, 2008.

[13] N. Femia, G. Petrone, G. Spagnulo, M.Vitelli, "Optimization of perturb and observe maximum power point tracking method" IEEE Trans. Power Electron., vol. 20, no. 4, pp. 963-973, Jul. 2005.

[14] P. Abarnaa, Mrs.S.P.G. Bhavani, "A Solar Powered PV Based Induction Motor Drive in Water Pumping System Using Flc", International Journal of Scientific & Engineering Research Volume 5, Issue 4, April 2014.

[15] Pooja V N, Pooja P H, Savitri G C, Megha M S, Prof. Nirosha H, "Design and Implementation of Agricultural System Using Solar Power", International Journal of Scientific and Research Publications, Volume 7, Issue 6, June 2017.

[16] Prof. Mangesh R. Dhage, Prof. Vaibhav S. Girnale, Prof. Chectan P. Patil, "Review on Solar Photovoltaic Water Pumping System", International Journal for Scientific Research & Development, Vol. 5, Issue 01, 2017.

[17] Sanjukumar and Krishnaiah R V, "Advance Technique for Soil Moisture Content Based Automatic Land Purpose", International Journal of VLSI and Embedded System – IJVES, Volume 4, Article 09149, September 2013.

[18] Sudip Das, Biswamoy pal, Partha Das, Milan Sasmal, PrabuddhamoyGhosh, "Design and Development of Ardino based Automatic Soil Moisture System for Optimum use of Water in Agricultural Fields", International Journal of Engineering Reearch& Science, Vol-3, Issue-5, May-2017.

[19] Y. Kim, R.G. Evans, W.M. Iversen, "Remote sensing and control of an irrigation system using a distributed wireless sensor networks", IEEE Trans. Instrum. Meas., vol.57, pp.1379-1387, Jul.2008.

[20] Z. Zhang, Y. Cai, Y. Zhang, D. Gu, Y. Liu, "A distributed architecture based on micro-bank modules with self-reconfiguration control to improve the energy efficiency in the battery energy storage system", IEEE Trans. Power Electron., vol. 31, no. 19, pp. 304-317, Jan. 2016.