A Solar Photovoltaic Cell Automated Irrigation System

Prof.Mrs. Mulani A. T.
Department of Electronics & Telecommunication Engineering
AITP, Vita Maharashtra

Abstract—It presents the design, implementation, and testing of an automatic irrigation system, which can optimize the usage of water and at the same time provide cost effective and efficient operation. This system utilizes photovoltaic cells to generate the electricity directly from the sun's rays to run the whole control system.

Key words: Vpp is the voltage at peak power, Ipp is the current at peak power, Vcc is open circuit voltage, Isc is short circuit current, and L, W, T, are the length, width, and thickness of the PV panel

I. INTRODUCTION

The water needs of India are met by desalination water plants, which are located in the coastal regions of the Country. The cost of potable water is very high due to the costs of production and transportation in major cities the water is transported through water pipelines. This water cannot be used for irrigation purposes due to the high costs. The fields are developed and the water is either pumped from the ground or through scarcely available natural water streams. At present these fields are irrigated through a network of canals, which are operated manually to provide water to farmers according to their needs. Sometimes these fields are over irrigated and sometimes under irrigated. There is a need to optimize this source of water through the usage of affordable technology. This study presents the design, implementation, and testing of an automatic irrigation system, which can optimize the usage of water and at the same time provide cost effective and efficient operation. This system utilizes photovoltaic cells to generate the electricity directly from the sun's rays to run the whole control system. Automation has become essential to provide optimal and efficient usage of the devices and systems, and to conserve resources. It uses microcontroller- based charge controller for stand-alone photovoltaic systems to improve the efficiency of the system and to protect the storage batteries with special reference to automotive batteries.

II. SETUP

A setup consists of four major parts, viz.: solar power supply, controller, input devices, and output devices

A. Solar Power Supply:

The solar power supply used consists of two photovoltaic (PV) solar panels and two back up batteries. Each PV solar panel consists of 36 solar cells. The specifications of the solar 20 panels are shown in Table 1. In Table 1, Vpp is the voltage at peak power, Ipp is the current at peak power, Vcc is open circuit voltage, Isc is short circuit current, and L,W, T, are the length, width, and thickness of the PV panel, respectively. Each solar panel generates a maximum of 17.5 V DC. A regulator is used to adjust the cell output to 12 V DC. Two PV panels were connected in series to Generate a total of 24 V DC that is required to supply the 24 VDC controller's power supply. The two 12 V batteries, which are used as backup supply in the absence of sunlight due to overcast skies or rain, are rechargeable, sealed, and lead – acid type. The batteries are charged from the PV cells. A blocking diode is used to safeguard the system from excessive voltage. Fig. 1shows the basic block diagram of the solar power supply system that was used in the study. The load in the figure refers to the controller and the input/output devices.

V_{pp} (V)	I_{pp} (mA)	V_{cc} (V)	I_{sc} (mA)	Dimensions (cm)			Weight kg (lb.)
				L	*W*	*T*	
17.2	1860	21.1	2010	60	50	3.0	3.5 (7.7)

Table 1: Solar Panel Specifications

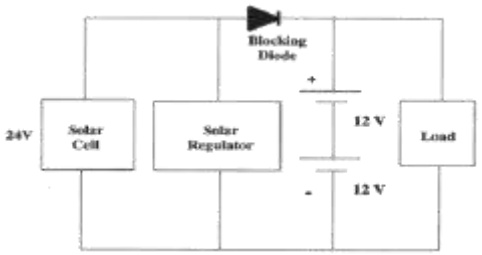


Fig. 1: Solar Power Supply Layout

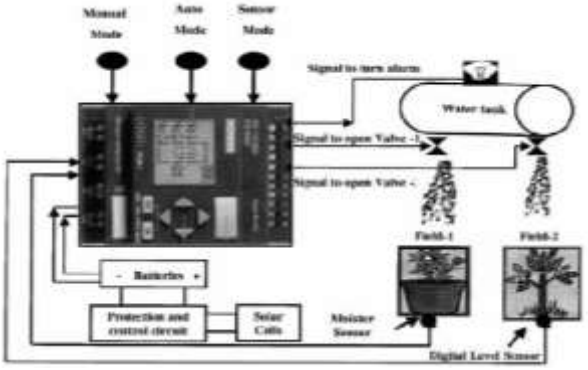
B. Controller

It provides control functions, operating and display unit, power supply, 6 inputs and 4 outputs and interface capability with a personal computer (PC).The control functions that are utilized are On/Off delay, real-time clock, counters, latching relays, and series/parallel functions. The most important function is the real-time clock, which is programmed to energize and de-energize any output at any time of the day or any day of the week based on the input from the field. Amodule 24RC is used which operates on 24 V DC. It has 6 digital inputs and 4 digital outputs, consumes 3 W of power, and switches up to 10 A load at 24 V DC rate.

C. Input and Output Devices

Input assignments		Output assignments	
I-1	Manual mode	Q-1	Valve-1 (Field-1)
I-2	Auto mode	Q-2	Valve-2 (Field-2)
I-3	Sensor mode	Q-3	Emergency light
I-4	Level sensor No. 1 (from Field-1)	Q-4	Spare
I-5	Moisture sensor (from Field-2)		
I-6	Level sensor No. 2 (from water tank)		

Table 2 shows the input/output assignments.



All rights reserved by www.ijsrd.com

Fig. 2 shows the system hardware layout and connections used in the prototype built in the laboratory.

- Three input operation switches are used to operate the system in three different modes, viz. manual, auto and sensor mode.
- One digital level senor is used to feed the logo with the water level of Field-1 and operate as a digital sensor.
- One analog moisture sensor is used to feed the logo with the soil moisture of Field-2 and operate as an analog sensor.
- One digital level sensor is used to feed the logo with water level in the reservoir tank.
- Output number 1 is connected to the valve that irrigates Field-1
- Output number 2 is connected to the valve that irrigates Field-2
- Output number 3 is connected to the alarm lamp to indicate when the water level in the reservoir water tank becomes less than the pre-specified water level.

D. Working of Prototype

The system is designed and prototyped to irrigate two fields (Field-1 and Field-2). Field-1 is to be irrigated by opening valve-1 via the logo output No. 1 and the water level in the field is sensed by a digital level sensor that is connected to the logo input No. 1. Field-2 is to be irrigated by opening valve-2 via the logo output No. 2 and the water humidity in the field is sensed by the analog moisture sensor that is connected to the logo input No. 2.The analog moisture sensor is connected via a comparator circuit that can be adjusted manually for the required moisture level depending on the season by the farmer or user. The third output is used to indicate the water level in the reservoir tank, which flashes the light on/off when the water level in the tank goes below a predefined level. A feedback from the tank is sent via a digital level sensor to the logo input. The system has four modes of operations i.e. manual, auto, sensor and emergency modes.

1) Manual Mode:

In this mode, the farmer or the user can irrigate both fields (Field-1 and Field-2) by switching on this input. The water valves of both fields will be activated as long as this switch is on. Turning this switch off manually will shut off both valves.

2) Auto Mode:

In this mode, the real-time clock of the logo, which is programmed to turn the water valves on/off at specific times and days, operates automatically with the real time clock. It can also be programmed to turn any of the valves independent of each other. The built-in real-time clock is capable of working at any time of the day and any day of the week and for any desired period. The farmer or the user can change the time, period and day/s of the week using the built-in key-pad and display system.

3) Sensor Mode:

This mode has two feedback signals coming from the fields (Field-1 and Field-2). Field-1 is designed to operate based on the water level in the water storage tank and Field-2 is designed to operate using an analog sensor that measures the soil humidity. The water will flow to any field based on a signal from the corresponding sensor and stay on until the digital level sensor trips or the moisture sensor gets wet enough.

4) Emergency Mode:

The emergency mode operates based on the water level in the reservoir tank. If the water level falls below the predefined level, the lamp will start to flash on-off and turn on the irrigation system for automation mode, but for 15 min only, rather than the predefined time which was programmed in the normal auto mode. Fig. 3 shows the system algorithm flowchart. The ladder diagram of the software program developed and used in this prototype is shown in Fig. 4.

Fig. 5 shows the actual prototype that was built in the laboratory.

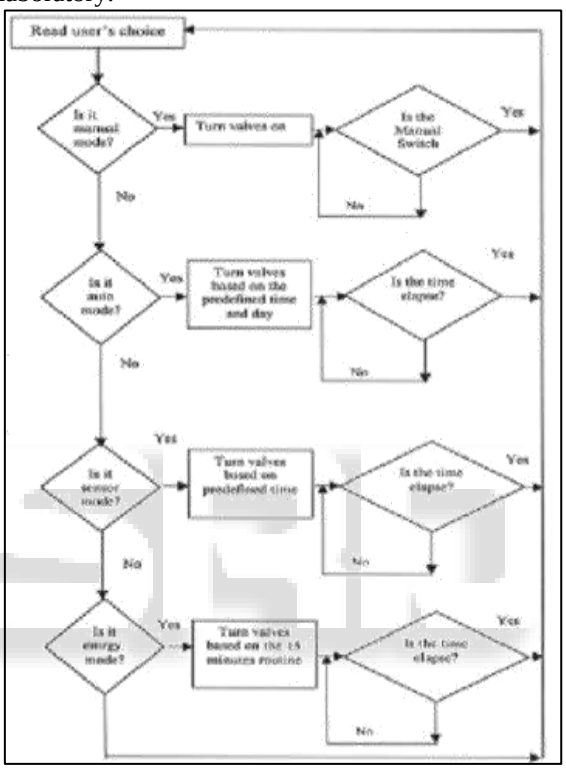


Fig. 3: System Software Flowchart

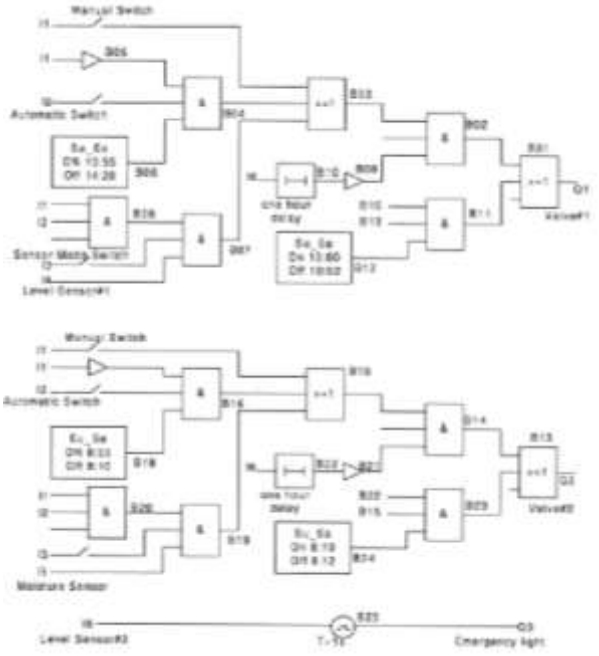


Fig. 4: System Software ladder Diagram

All rights reserved by *www.ijsrd.com*

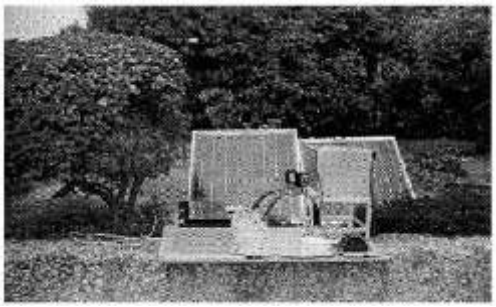


Fig. 5: Actual Prototype systems as built in the lab

III. CONCLUSION

A fully automated irrigation system is designed, built and tested using solar PV cells and a digital controller. The system is economical, reliable, portable, and compact. Savings in electricity bills and water bills can justify the initial cost, which may be a bit more than the conventional system, over a period of time. It causes less damage to the environment and releases the public utility from an extra load. It can be used in small or big farms, gardens, parks and lawns. Also, it can be used as a universal solar-based-controller to control building doors, water heaters, and air-conditioning control systems.

REFERENCES

[1] 2004. Gipe, Paul. Wind Power: Renewable Energy for Home, Farm, and Business. Chelsea Green Publishing Co. White River Junction, VT, 512 pp.
[2] 2003. Vick, B.D., Neal, B.A., Clark, R.N., Holman, A. Battery Charging witha Small Downwind Horizontal-Axis Wind Turbine, AWEA Windpower 2003 Proceedings, May 18-21, Austin, TX, 10 pp.
[3] 1997. Vick, B.D. and Clark, R.N. Performance and Economic Comparison of a Mechanical Windmill to a Wind-Electric Water Pumping System. Aug. 10-14, Minneapolis, MN, ASAE Paper No. 97-4003, 12 pp.
[4] 2003. Migliore, P., van Dam, J., and Huskey, A. Acoustic Tests of Small Wind Turbines. NREL/CP-500-34662. Oct., 2003. 14 pp. (Also presented at 2004 ASME Wind Energy Symposium, Reno, NV, Jan. 5-8, 2004.)
[5] 2004. Huskey, Arlinda. Private communication, e-mail dated June 9, 2004 .
[6] 1999. Vick, B.D., Clark, R.N., Ling, S. One and a Half Years of Field Testing a Wind-Electric System for Watering Cattle in the Texas Panhandle. AWEA Windpower ’99 Proceedings, June 20-24, Burlington, VT, 10 pp.
[7] 2002. International Electrotechnical Commission, Wind Turbine Generator Systems – Part 11: Acoustic noise measurement techniques. IEC 61400-11:2002(E), 43 pp.

All rights reserved by www.ijsrd.com