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Automated Solar Powered Irrigation System

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Abstract:

The projected population of India being 1500 million by 2050 and agriculture remaining as the primary source of livelihood in rural areas, the focus should be on the increase of productivity. Though our country claims to have developed in terms of science and technology, erratic power supply or complete breakdown for hours together has almost become routine today. Solar power is being increasingly utilized worldwide as a renewable source of energy. India has huge untapped solar off-grid opportunities. This paper gives information about development procedure of an embedded system for Off-Grid irrigation system. The design projects on developing an intelligent controlled mechanism for best possible utilization of resources for irrigation. The farmer (user) can water the fields from any place using GSM technique which provides an acknowledgement message about the job status. The main advantage of this project is optimizing the power usage through water resource management and also saving government's free subsidiary electricity. This proves an efficient and economy way of irrigation and this will automate the agriculture sector.

Index Terms: Off-Grid, Solar, GSM, Irrigation

I. INTRODUCTION:

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 16.6% of the GDP in 2009, about 50% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broadbased economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India.

In India most of the power generation is carried out by conventional energy sources, coal and mineral oil-based power plants which contribute heavily to greenhouse gases emission. Setting up of new power plants is inevitably dependent on import of highly volatile fossil fuels. Thus, it is essential to tackle the energy crisis through judicious utilization of abundantly available renewable energy resources, such as biomass energy, solar energy, wind energy, geothermal energy and Ocean energy.The projection for irrigation water demand basically depends on irrigated area, cropping pattern, effective rainfall, and soil and water quality. India's current population is 1100 million is expected to stabilize at some stage. The projected population is 1500 million by 2050 with agriculture remaining as the primary source of livelihood in rural areas. Though our country claims to have developed in terms of science and technology, erratic power supply or complete breakdown for hours together has almost become routine today. If this be the case for urban dwellers, think about the farmers living in remote villages. They need power for irrigating their crops, or lighting their cattle sheds. What can they do? The reasons for having large gap between requirement and consumed energy could be the wastage of electrical energy. The foremost reason can be that the power supplied for agricultural needs is during the night hours. Farmers Switch on the pump motor and leave it 'on' for the whole night. Farmers do not bother to switch off the pump motor when the land is filled with sufficient water level. This is the main source of wastage of electrical energy from the grid.

II. OFF-GRID SOLAR POWER IN INDIA:

Providing adequate and quality power to domestic and other consumers remains one of the major challenges before the country. There is also an increasing concern to reduce reliance on fossil fuels in meeting power needs and opting for cleaner and greener fuels instead.

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With about 300 clear sunny days in a year, India's potential for producing solar power is far more than its current total energy consumption.

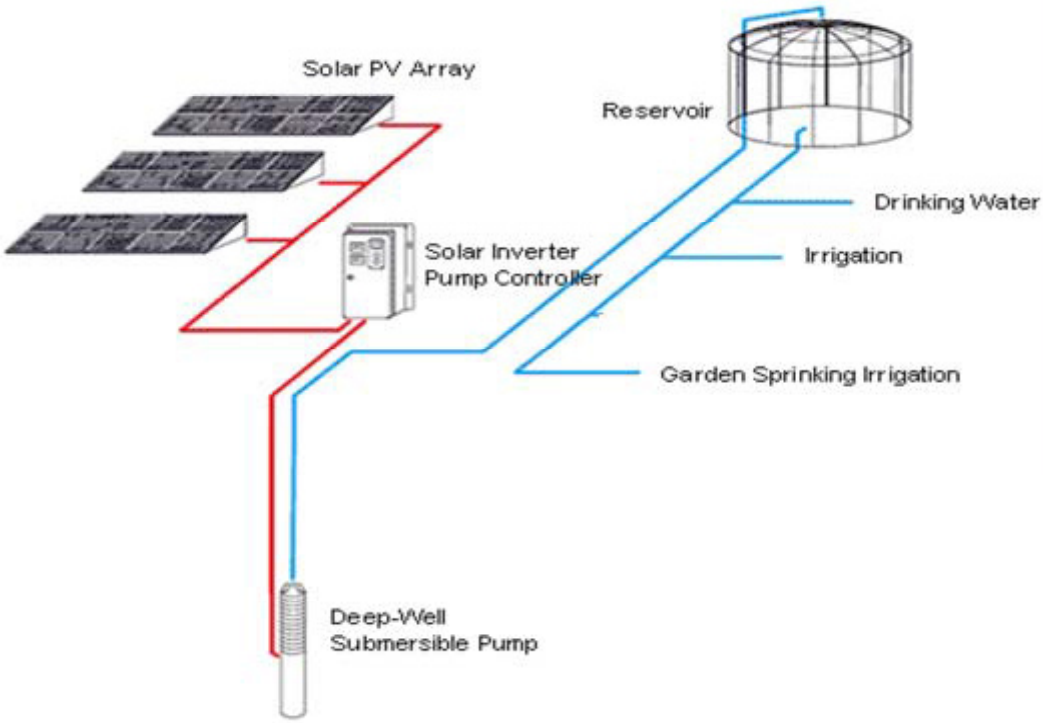

Fig.1 Solar Power Based Irrigation system

However, presently the amount of solar energy produced in India is insignificant compared to other energy resources. Therefore, solar power is being increasingly utilized worldwide as a renewable source of energy. India has huge untapped solar off-grid opportunities, given its ability to provide energy to vast untapped remote rural areas, the scope of providing backup power to cell towers and its inherent potential to replace precious fossil fuels. The solar PV off-grid opportunities in India are huge, given the fact that over 400 million people do not have access to grid connected electricity. The off-grid opportunities are significant, given the cost involved in off-grid applications when compared to huge financial investments to be made to set up grids.

Moreover, specific government incentives to promote off-grid applications, rapid expansion of wireless telecom and telecom companies' desire to reduce operating cost for base stations are also expected to prompt growth in off-grid opportunities. The potential of replacing huge usage of kerosene used for lighting rural homes makes off-grid applications desirable. Off-grid PV application examples include remote village electrification, power irrigation pump sets, telecom towers, back-up power generation, captive power generation and city, street, billboard and highway lighting.

III. SOLAR POWER UTILIZATION FOR WATER PUMPING:

Water is the primary source of life for mankind and one of the most basic necessities for rural development. The rural demand for water for crop irrigation and domestic water supplies is increasing. At the same time, rainfall is decreasing in many arid countries, so surface water is becoming scarce. As these trends continue, mechanized water pumping will become the only reliable alternative for lifting water from the ground.

Diesel, gasoline, and kerosene pumps have traditionally been used to pump water. However, reliable solar (photovoltaic [PV])are now emerging on the market and are rapidly becoming more attractive than the traditional power sources. These technologies powered by renewable energy sources (solar), are especially useful in remote locations where a steady fuel supply is problematic and skilled maintenance personnel are scarce.

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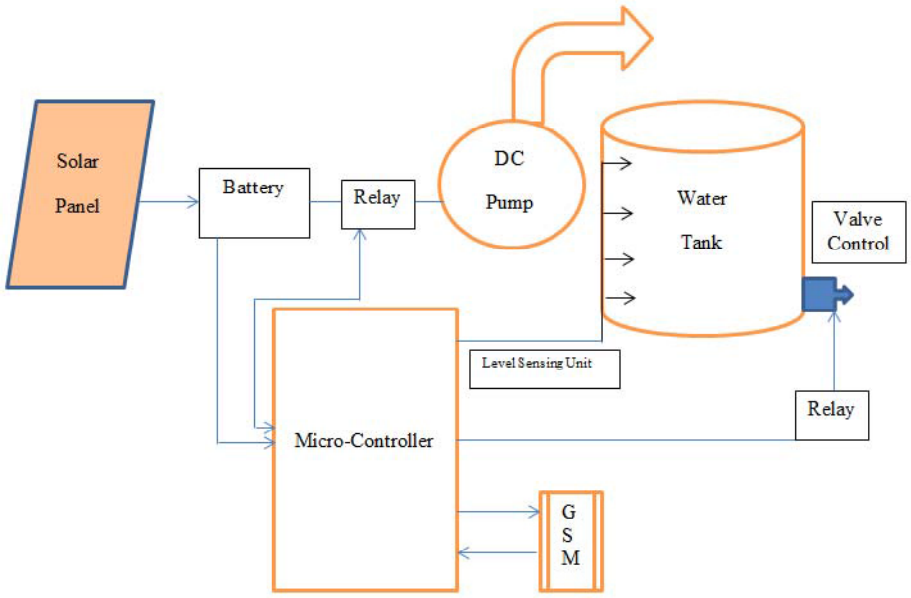

Fig.2 Overview of the proposed system

IV. DESIGN METHODOLOGY:

This project objective is to supply water for the fields in alternative way by generating electricity (through solar-panels) in order to save 22% of the total power production in India. Here, we introduce an advanced technique of control through GSM module. The components required for the project is solar panel, battery, relay, dc pump, GSM module, microcontroller, water tank. When the sunlight falls on the solar panel, it liberates the electrons within the material which then move to produce a DC current. This dc power is stored in the battery so that the pump can operate even in the night time by discharging the battery. The other end of the battery is connected to the relay and relay is connected to DC PUMP.A water tank is present in order to store the water for watering the fields.Water tank consists of 4 sensors in order to sense the level of water in the tank and send it to Atmel microcontroller (AT89C52) and water tank is also having valve and this valve action is controlled by small servo motor. The GSM module is used which is a hardware component that allows the capability to send and receive SMS to and from the system. If the user (farmer) sends the text message via mobile phone as [@.ONX] it checks the level of tank and depending on the level of tank the operations takes place. We can know the level of water with the help of level sensors. If the task is completed then the GSM module sends the simple message as "WATERING IS DONE" to the user. If the task is not completed it sends message as "JOB NOT DONE LAGGING RESOURCES".

The state of charge of the battery is sensed by charge sensor and sends it to Microcontroller and the level sensor sense the level of water in tank and send it to the micro controller.

HARDWARE DESIGN METHODOLOGY

PV Sizing:

Different size of PV modules will produce different amount of power. To find out the sizing of PV module, the total peak watt produced needs. The peak watt (WP) produced depends on size of the PV module and climate of site location. To determine the sizing of the PV modules, calculate as follows:

STEP 1: Calculation of Total Load Connected Total Load Connected =[D.C Pump Power Rating * Time of usage] + [Remaining Components Power Rating* Time of usage]

STEP 2: Calculation of Total PV Panels Energy Needed Total PV panels energy needed= Total Load Connected + Losses

STEP 3: Calculation of Total Wp Of PV Panel Capacity Needed Total Wp of PV Panel Capacity Needed = Total PV panels energy needed/ No of Illumination hours

STEP 4: Calculation of No. of PV Panels Required No. of PV panels = Total WP of PV panel capacity needed / Rating of the PV Panel

Battery Sizing: The Amp-hour (Ah) Capacity of a battery tries to quantify the amount of usable energy it can store at a nominal voltage. All things equal, the greater the physical volume of a battery, the larger its total storage capacity.

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STEP 1: Calculation of total Load Connected Total Load Connected = Sum of all appliances (power rating of each device * Time of usage)
STEP 2: Calculation of Battery (Ah) Total Load Connected*Days of Autonomy / Battery Losses*Depth of Discharge* N.B.V

Valve Control: A valve is outlet of the tank. The valve opening and closing will be done by user through GSM. Whenever User sends a message to the GSM module, it transfers the message to the Micro-Controller. The Micro-Controller will check for the syntax and opens the valve if the resources of the system are sufficient and doesn't open the valve if the syntax is not correct or the resources of the system are not sufficient. For driving the valve, a servo motor is used for opening the valve. For opening the valve, the motor has to rotate in clockwise direction and for closing it has to rotate in the reverse direction. This operation is controlled by Micro-Controller whenever user sends a message to GSM module.

SOFTWARE DESIGN METHODOLOGY:

Algorithm Description for Initial Step

Step1:-start
Step2:-Verify for the Water level in the tank
Step3:- If full, wait for the farmer initiation
Step4:- If not full, verify SOC of the Battery
Step5:- If SOC is full, start watering
Step6:-If tank full, go to step 3

Algorithm Description Watering

Step1:-Verify the syntax of the message sent
Step2:- If yes, check the water level
Step3:-If water level is full, open the valve
Step4:-If, below 1/3 of the level, SOC full, Open valve and On-Motor and go to step 6
Step5:- If, below 1/3 of the level, SOC not sufficient, Send message for job not done and got step7
Step6:- If water is done for specified time, send message "Watering done "and got to step7
Step7:- Stop the process and go to step one in Algorithm1.

V. RESULTS AND VALIDATION:

The system described above is tested using ISIS 7 PRO version software. The given below scenarios shows the working of the system in various modes of operation. The simulation block consists of AT89C52 controller constant run the program for the below stated conditions.

Case Scenario-1

Input: If User sends the message (@.ONX) for system operation.
Assumption: Assume the level of the Tank is full and SOC is sufficient to operate the system.
Operation: Whenever the user sends the message to GSM module, water level is checked. In the fig.3, all the switches are in closed position and it indicates of water tank is fully loaded with water. Glowing LED fig.3 indicates the valve being opened. When the valve is opened, the controller continuously monitors the level of the tank and checks whether the duration is completed or not. As the tank is completely filled the system can supply the water to the fields for the duration specified by the user. After watering the fields for certain duration, the controller gives a command to close the valve of the tank and gives a command to the GSM to send a message that "Watering is done".

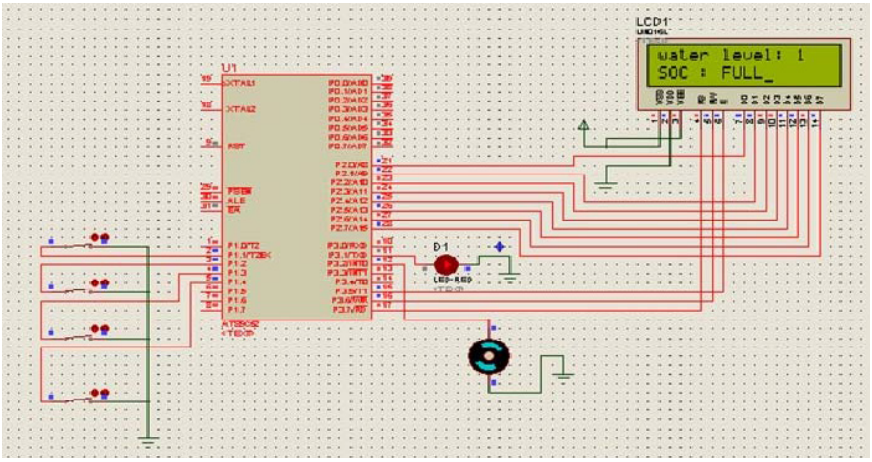

Fig. 3 Simulation of Scenario 1

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Case Scenario-2

Input: If User sends the message (@.ONX) for system operation.

Assumption: Assume the level of the Tank is less than 2/3 level of the tank and SOC is sufficient to operate the system.

Operation: The controller will open the valve and also on the motor for filling the tank simultaneously. This scenario is shown in the fig.4,

where the switches 1, 2 are open indicating the level of the water is below 2/3. Motor and valve are in running condition.

During the watering process, controller will check the SOC of the battery for avoiding the drying up resource. After the duration is completed, controller closes the valve and gives a command to the GSM to send a message that "Watering is done".

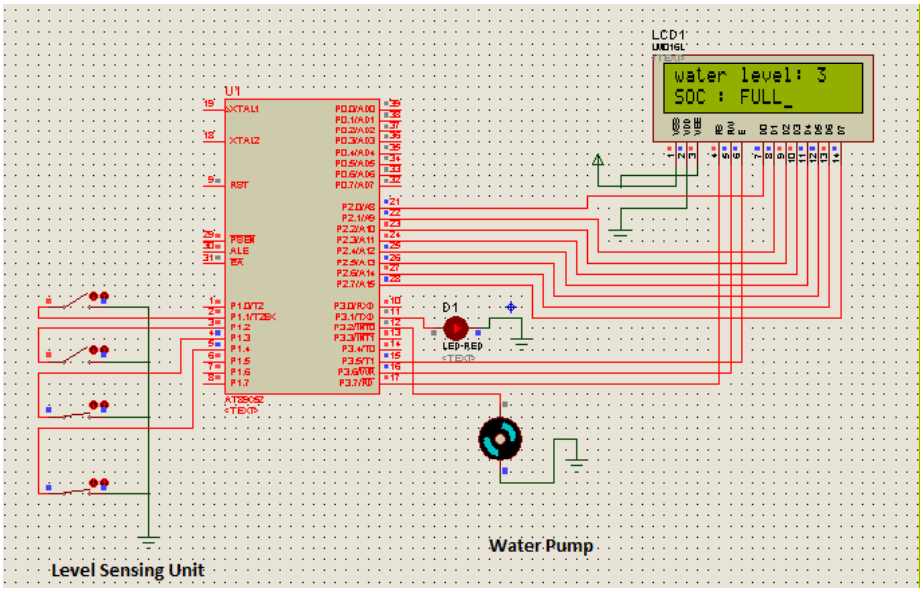

Fig. 4 Simulation of Scenario 2

Case Scenario3

Input: If User sends the message (@.ONX) for system operation.

Assumption: Assume the level of the Tank is zerolevel and SOC is not sufficient to operate the system for the duration specified by the user.

Operation: As shown in Fig. 5, switches 1, 2, 3 were open and SOC of the battery is not sufficient to run the motor. Also if the status of the LED is observed in fig. 5, it is in OFF condition. This shows the controller had closed the valve of the tank. So, a message is sent to the user stating " Job not done"

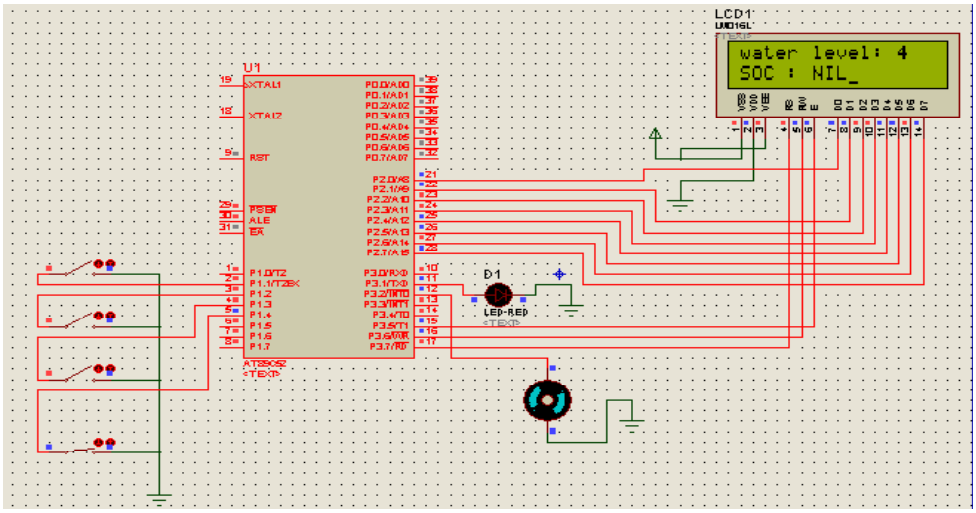

Fig. 5 Simulation of Scenario 3

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VI. CONCLUSION:

The history of agriculture dates back thousands of years, and the development has been driven and defined by greatly different climates, cultures and technologies. The main contribution of this paper is to develop possible model which can help the remote villages meet the requirement of water for agriculture. The project also projects with off-grid application prototyping for catering needs of the farmer.With the growing technology, automation has been added to the model through GSM Technology. The project has been tested with primary test scenarios and code was simulated for results. The further development will happen with few more test cases like lack of signal transmission. This is primary cause of concern.

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