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Monitoring and Controlling of Solar Watered Pumping using Arduino – LabVIEW

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Abstract

Energy is a major input for economic development of any country. The prices of the fossil fuels steeply increasing, So Renewable energy sources plays a vital role in reducing the consumption of Conventional energy sources and its environmental impacts for water pumping applications. Solar Energy provides great potential from all the sources of renewable energy. Solar energy can be obtained in two ways, using Solar thermal collectors and Solar Photovoltaic System. In Solar thermal collectors the heat energy is converted into electrical energy, where as in case of Solar Photovoltaic System the Light energy is converted into electrical energy through Photovoltaic effect. In Photovoltaic effect when photovoltaic cell is exposed to sunlight it generates voltage or electric current flows. PV Array is a combination of PV modules in series and parallel. It produces direct current (DC) when exposed to sunlight. This DC current is supplied either to a DC pump, which pumps water whenever the solar energy available or stored in batteries for later use by the pump. The rate of flow of the water pumped is determined by both the intensity of the solar energy available and the size of the PV array . It can be widely used in domestic installations and systems installed by utility companies where they have found that a PV solution is the best solution for remote agricultural needs such as Water Pumping for Crops or Livestock and it also helps in distribution of Water from Overhead Tank . A solar powered Water Pumping is made up of two components. These are PV Panels and Motor Driver for Pumping. In overhead tanks, the speed of the flow of water is controlled based on the load demand. The required DC voltage is supplied to the pump controller from the battery. The pump controller limits the starting currents and gives the required amount of DC voltage to motor pump. This project uses microcontroller Arduino to control the automatic switching off or switching on of the motor based on the water level in over head tank. Monitoring and controlling of the system are done using LabVIEW. This control algorithm runs in loops and verifies the tank on each iteration until the required operation is done.

I. Introduction:

Energy is described as capacity for doing work. Among all the energies, Electrical Energy plays an importance role due to the presence of Convenient and Efficient transmission, Cleanliness, Greater flexibility and Versatile form. All energy sources used in today can be

classified into two groups. They are Renewable and non-renewable. After some centuries non renewable resources are exhaustible and are extracted faster than the rate at which they formed. The prices of the fossil fuels are exorbitant, So Renewable energy sources plays a vital role in reducing the consumption of Conventional energy sources and its environmental impacts for power generation, space heating, drying of crops, desalination, water pumping applications etc. Renewable Energy is generated by using natural resources such as Solar, Wind, Tides, Waves, Geothermal heat, and Biomass including agricultural and animal waste. These sources are renewable or inexhaustible and does not cause any harm to the environment. Solar Energy comes to the earth from the sun. This energy keeps the temperature of the earth above that in colder space, causes current in the atmosphere and in ocean causes the water cycle and generate photosynthesis in plants. Solar energy creates with the thermonuclear fusion reactions occurring in the sun. Solar Energy provides great potential from all the sources of renewable energy. Solar energy can be utilized in two ways, using Solar thermal collectors and Solar Photovoltaic System. In Solar thermal collectors the heat energy is converted into electrical energy, where as in case of Solar Photo voltaic System the Light energy is converted into Electrical energy using Photovoltaic effect.

II. Photovoltaic Effect:

In the 19th century, it was observed that the solar energy strikes certain materials it generates detectable electric current. It laid the foundation of solar Cells. Alexandre Edmond Becquerel created the world's first photovoltaic cell and discovered the photovoltaic effect. In his experiment, carried out in 1839, Becquerel placed two platinum electrodes in a container with silver chloride in an acidic solution. It illuminates voltage and current flows through the electrodes. The birth of the modern solar cell occurred along with the silicon transistor. These Silicon solar cells are composed of two different types of semiconductors p-type and an n-type, joined together to create a p-n junction. By joining these two types of semiconductors, an electric field is formed in the region of the junction as electrons move to the positive p-side and holes move to the negative n-side. This field causes negatively charged particles to move in one direction and positively charged particles in other direction. This effect is known as photovoltaic effect.

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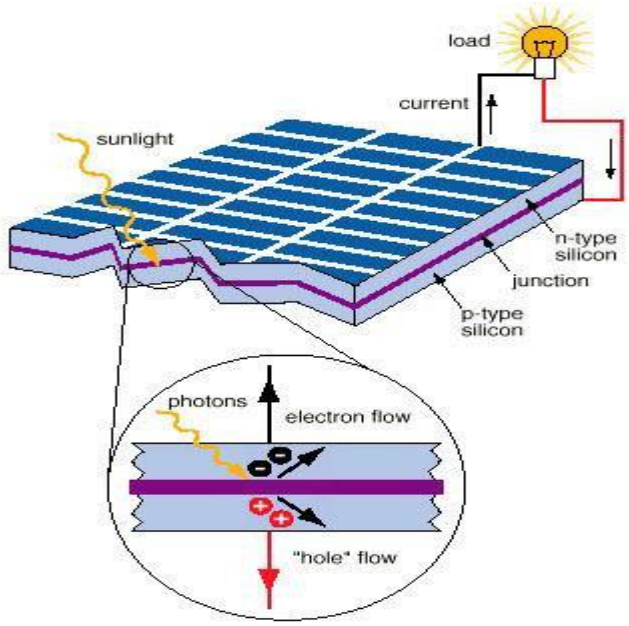

Fig 1: Photovoltaic Effect

III. Components Required for Modeling and Controlling :

1. Solar Panels
2. DC Motor Water Pump
3. Arduino Uno
4. Float sensor
5. Current sensor
6. Voltage sensor
7. LDR sensor
8. Water Sump
9. Overhead Tank
10. LED
11. Resistors
12. Lab VIEW Software

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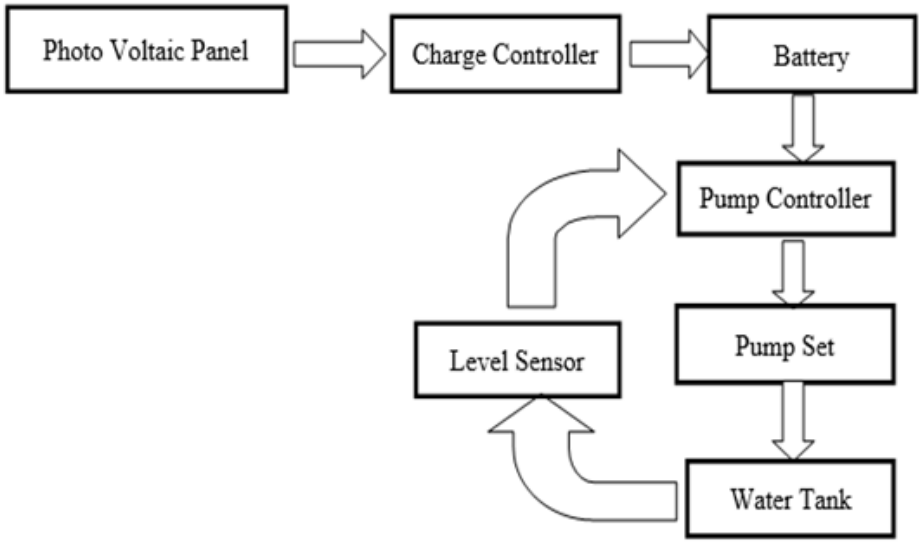

Fig 2: Block diagram of Proposed System

IV. Solar Array /Panels:

Solar PV cells are connected in series and parallel to form a PV Module. The number of solar cells in series indicate the voltage of the Panel(Module) and the number of parallel cells indicate the current. PV Array is a combination of PV modules in series and parallel. Solar PV panel/Array is the major building block of a PV system and number of panels can be connected together gives the desired electrical output. To protect from breakage and atmospheric conditions these are encapsulated with transparent front sheet and back sheet. Mono crystalline solar panels are mainly used for large scale solar applications, such as commercial and residential solar installations. Thin film solar cells are made by depositing one or more thin layers, or thin films of photovoltaic material on a substrate, such as glass, plastic or metal. Thin film solar cells are flexible, and lower in weight but less efficiency compared to Crystalline Si cells.

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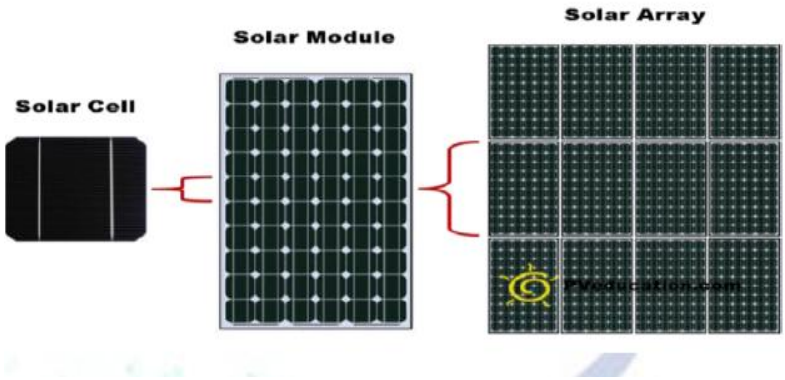

Fig 3: Difference between Solar cell, Module and Array

Fig 4: Crystalline Si Cells

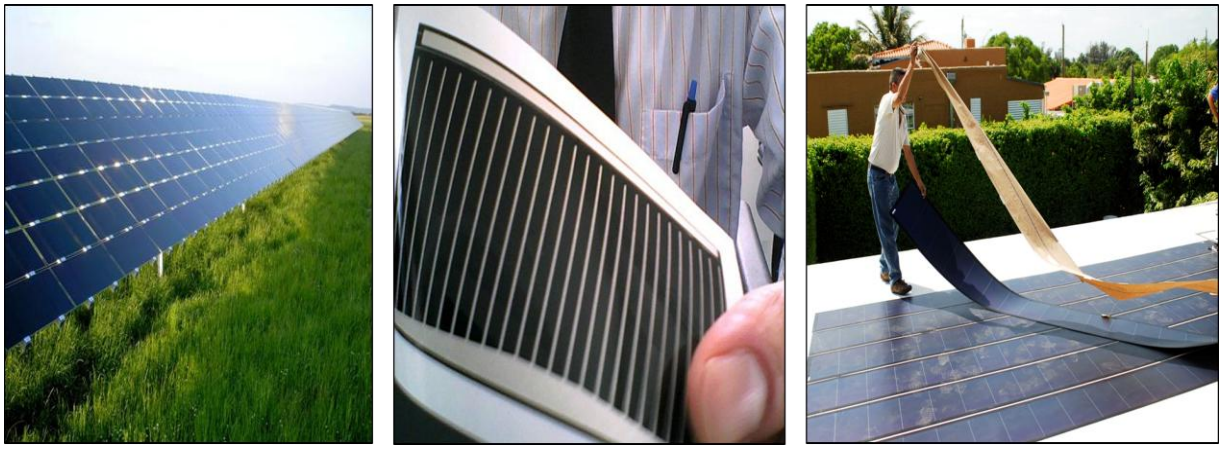

Fig 5: Thin film Cells

V. Solar Water Pumping System:

Solar Water Pumping System produces direct current (DC) when exposed to sunlight. This DC current is supplied either to a DC pump, which pumps water whenever the solar energy available or stored in batteries for later use by the pump. The rate of flow of the water pumped is determined by both the intensity of the solar energy available and the size of the PV array. It can be widely used in domestic installations and systems installed by utility companies where they have found that PV solution is the best solution for remote agricultural needs such as Water Pumping for Crops or Livestock and it also helps in distribution of Water from Overhead Tank. This system does not require any fuel to operate can be installed in remote areas, easy to operate as compared to a conventional pump. The main components are solar modules, motor pump set, electronic controls or a controller device to operate the pump, required hardware and other items like inverters, batteries, etc.

Solar water pumps are four types. These are submersible pumps, surface pumps, direct current (DC)pumps and alternate current (AC) pumps. A submersible pump is located when depth is below the ground level and remains submerged under water. The surface pumps remains out of water and in the open tank. The motor of DC pump works with direct current, no battery or inverter is required. The motor of AC pump works with an alternating current, The direct current getting from solar panels is converted into alternating current using the inverter. DC pumps have an advantage over AC pumps in terms of higher efficiency and no need of an inverter but the cost of DC pumps is higher and also the repair and maintenance of DC pumps are difficulty especially in rural and remote areas. A 2 HP pump can serves nearly two acres of land and a 7.5 HP serves nearly 10 acres of land, but this data vary depending on the groundwater levels and the type of irrigation used for a particular crop. The motor pump set should be in the range of 0.1 HP to 5 HP for irrigation and domestic purpose. The average discharge depends on solar intensity, location, season and other factors. The tentative cost of the solar water pumps based on the capacity and type is given below: 5 HP AC solar pump set system: Rs 4,90,000, 3 HP AC solar pump set system: Rs 3,20,360, 5 HP DC solar pump set system: Rs 5,40,000, 3 HP DC solar pump set system: Rs 3,84,015.However, if the pump

sets are beneficiary funded, they receive the MNRE subsidy which is Rs 32, 400 per HP

for AC pumps and Rs 40, 500 per HP for DC pumps.

Fig 6: Solar water pumping system

VI. Ardunio Uno:

In overhead tanks, the speed of the flow of water is controlled based on the load demand. The required DC voltage is supplied to the pump controller from the battery. The pump controller limits the starting currents and gives the required amount of DC voltage to motor pump. This project uses microcontroller Arduino Uno to control the automatic switching off or switching on of the motor based on the water level in overhead tank.

Fig 7: Ardunio Uno

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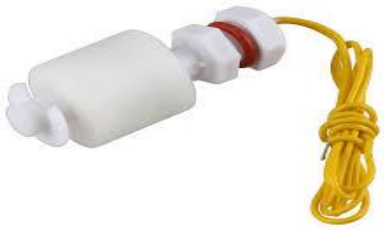
VII. Float Sensor:

A float sensor is a level sensor mainly used to detect the level of water within a tank. The



switch may be used to control a pump, as an indicator, an alarm, or to control other devices.

Fig 7: Float Sensor

VIII. Current sensor:

A current sensor detects electric current flows in a wire and generates a signal proportional to the current. The generated signal may be analog voltage or current or it may be a digital output.

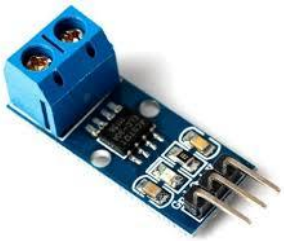


Fig 8: Current Sensor

IX. Voltage Sensor:

A voltage sensor is a sensor is used to calculate and monitor the amount of voltage in an object. Voltage sensors can determine both the AC voltage or DC voltage level.

Fig 9: Voltage Sensor

X. LDR Sensor:

A Light Dependent Resistor (LDR) is basically a photocell that works on the principle of photoconductivity.

Fig 10: LDR Sensor

XI. Water Sump:

A sump is an underground tank used for large water tank storage. It is a part of a rainwater harvesting system, where the rainwater gets allowed into the tank and utilized later for off-season.

XII. Overhead Tank:

Overhead tanks to store water. The size should be based on the pumping required and depending on the availability of sunlight.

XIII. LED:

A light-emitting diode (LED) is a semiconductor light source to emit light when current flows through it.

XIV. Resistors:

Resistors are used to reduce current flow and to lower voltage levels within circuits. High-power resistors dissipates watts of electrical power as heat, may be used as part of motor controls.

XV: Introduction to Lab VIEW:

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a graphical programming environment place a crucial role in research labs, academia and industry. It is a powerful and versatile analysis and instrumentation software system for measurement and automation. Using LabVIEW, the user can originate exactly the type of virtual instrument needed and programmers can easily view and modify data or control inputs.

There are three steps to create our application in the software environment:

- Design a user interface
- Draw the graphical code
- Run the program

Monitoring and controlling of the system are done using LabVIEW. This control algorithm runs in loops and verifies the tank on each iteration until the required operation is done.

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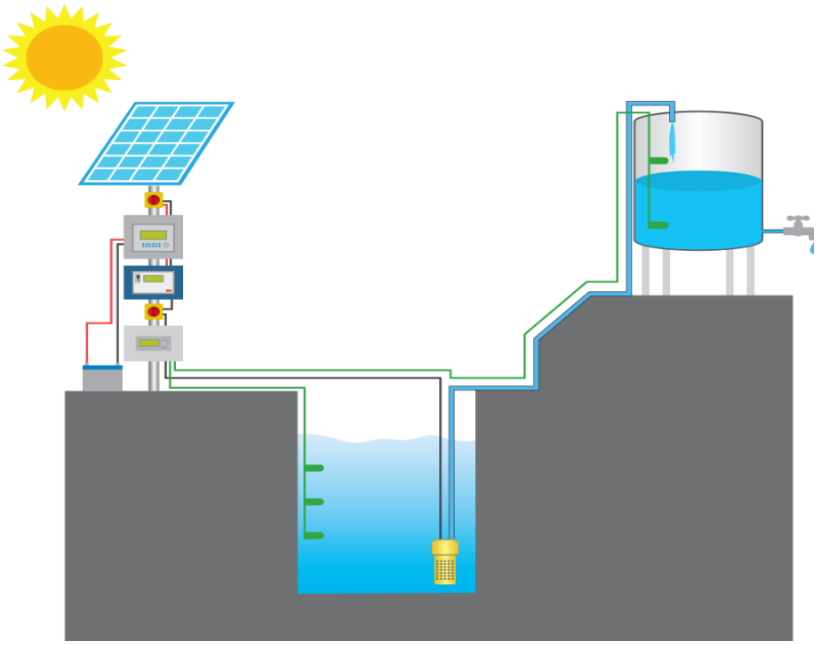
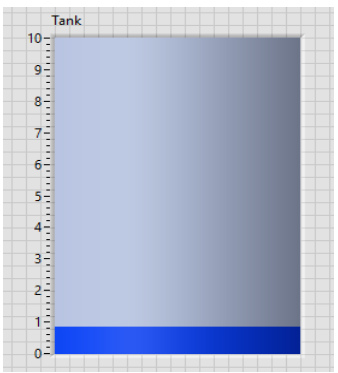
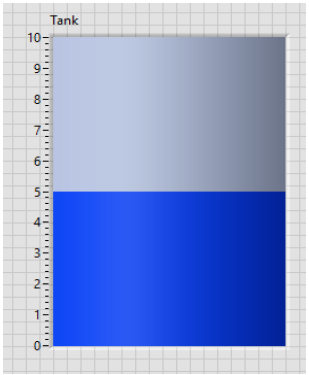


Fig: Flow diagram from Solar panel to Overhead Tank





XVI. Water Level Outputs:

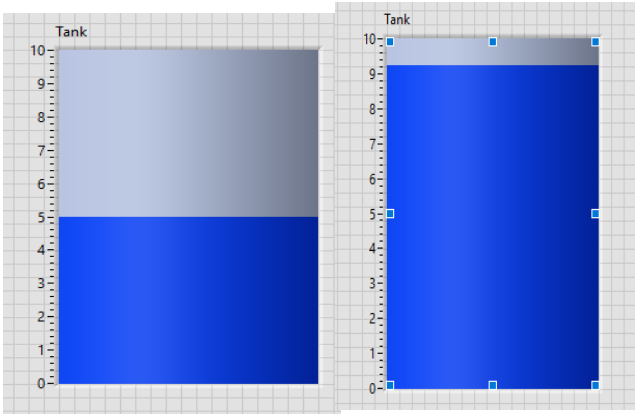


Fig : Water at different levels in Overhead Tank

XVII . Conclusion:

This project can be used in overhead tanks and also used for domestic purpose. The energy needed to the water pump and controlling system is mainly by solar panel. By using solar energy, we can reduce the energy crisis problem. Itaids the government in promoting renewable energy utilization. Based on the water level in an overhead tank the switching on and off mechanism is done by using Ardunio LabVIEW. Here control algorithm runs in loops and verifies the tank on each iteration until the required operation is done.It reduces the time consumption and eco friendly as no fuel is required. To further enhance the daily pumping rates, solar trackers can be implemented. It reduces the time consumption and eco friendly as no fuel is required.

XVIII. Future Enhancement:

The proposed system is beneficial to the farmers and also useful to the government in tackling solution for energy crisis as one of the major problem. By this automatic irrigation system the sensor clearly indicates how much water needs for the soil. According to the sensors and commands by farmer, the irrigation system detects the moisture level of the crop.

Automatic irrigation system is used to optimize the usage of water by reducing wastage and reduces the human intervention.

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Mrs. B. Sujatha had 15 years of teaching Experience. Presentlyshe working as an Associate Professor in BVRIT HYDERBAD College of Engineering for Women, Nizampet, Hyderabad. Her areas of interest are Optimization Techniques, PWM techniques, Application of Power Converters in Renewable Energy Sources and Energy Management.

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