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Solar Powered Agricultural Water Pumping with Auto Tracking

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ABSTRACT

Now a days people use electric pumps to irrigate and where does not have grid electricity, they use fuel-powered pumps. However, the problem of energy is a big issue, and both fuel and electricity prices are rising. Another problem is sometimes it is hard to get fuels in rural or hilly areas. Most of the farmers are poor. To overcome these problems the project is made. It would be implemented in everywhere. The most important renewable energy source is solar energy. Light energy is converted into electrical energy by the solar panel. Agricultural technology is rapidly evolving. Farm equipment, farm structures, and manufacturing facilities are all being improved on a regular basis. There are a variety of agricultural applications for photovoltaic (PV) solutions. Person installations and systems built by utility providers when they discover that a PV solution is the best solution for a remote agricultural need like water pumping for crops or livestock. Two easy way of components make up a solar-powered water pumping system. PV panels and pumps are the items in question. The solar cell is the smallest component of a PV plate. When exposed to light, each solar cell has two or more particularly arranged layers of semiconductor material that directly generate current (DC) electricity. The panel's wiring detects this DC current. It's then either fed into a DC pump that pumps water whenever the sun shines, or it's retained in batteries for use by the pump at a later stage. In this paper, Whenever the soil get dry condition the pump can automatically on once the soil get sufficient amount of water the pump can automatically off.

Keywords: Solar Energy, Auto tracking Control, low power consumption, Soil moisture Sensor, LDR Sensor.

I. INTRODUCTION

With the global energy crisis worsening, all countries are struggling to find a solution to this serious issue. One choice is to look for new sources of energy and make use of renewable sources [1]. Another choice is to take advantage of modern energy-saving technology in order to reduce energy usage and maximize energy use efficiency. [3].

Solar energy is the most direct, clean, and popular energy that we have discovered so far on our planet. The cumulative solar energy used by the Earth in a year is around 3,850,000 exajoules (EJ), which is more than twice as much as all the non-renewable resources found and used by humans, such as coal, oil, natural gas, and uranium. Solar resources can appear to be endless [7].

In agricultural activities, diesel is commonly used to fuel generators. Although these systems can provide power where it is required, they have a range of disadvantages, including: Fuel must be transported to the generator, which may be quite a distance away over some difficult roads and terrain. Their noise and smells can cause livestock to be disturbed. Fuel costs add up, and spills will pollute the environment [10]. Generators need a lot of maintenance and, like all mechanical systems they break down and need spare parts that aren't necessarily readily accessible. Transportation to the heat source, fuel expense, and safety issues all come into play when using propane or bottled gas to heat water for pen cleaning or crop processing applications, or to heat air for crop drying [12].

Solar energy is an option for many agriculture uses. Solar systems that are new, well-designed, and easy to manage will supply the energy that is necessary when and where it is required. These are technologies that have been tested and proved to be cost-effective and efficient all over the world, and they are now rising agricultural production. Solar systems can be divided into two categories: those that convert solar energy to D.C. electricity and those that convert solar energy to heat. Both types have a wide variety of uses in agricultural environments, making life simpler and improving production.

Photovoltaic (solar-generated electricity) is the first (or PV). Photovoltaics are solar cells that convert sunlight into direct current electricity. Solar cells in a PV module are made of semiconductor materials [11]. As light radiation hits a cell, electrons are expelled from the material's atoms. Electrical conductors attached to the positive and negative sides of the material capture electrons in the form of a D.C. current. This energy can be used to run a load, such as a water pump, or it can be stored in a battery. PV modules generate electricity only while the sun is shining, so devices that run at night will need some form of energy storage. When it is required after dark. A battery will be required to store the energy provided during the day for use in electrical applications at night. Photovoltaic is a well-known, well-proven technology with a global business network. PV electricity costs about $7 per peak watt. Local supply conditions, such as transportation costs and import duty, may differ and raise the price. PV systems are a cost-effective way to provide power to farms, ranches, orchards, and other agricultural operations.

A “remote” PV system is a cost-effective way to supply power to farms, ranches, orchards, and other agricultural operations. A "remote" position may be as much as 15 metres away from a power source. In applications such as electric fence, area or building lighting, and water pumping, PV systems can be much less expensive than constructing power lines and step-down transformers – either for livestock watering or crop irrigation.

The remaining of this paper is organized as follows. Section II briefly describes the architecture of the proposed design. Section III describes the proposed work. Section IV describes the Results and Section V describes the conclusion.

II. ARCHITECTURE

Fig. 1 shows the complete architectural information of the proposed design.

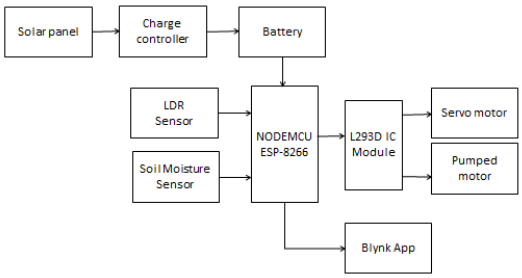

Fig.1. Block diagram of the proposed design

The solar cell is placed in front of the sun to collect and trap the sun's rays. The solar rays from the sun light will enter the contact stage on the topmost array in the plate, trapping the photon energy from the sun lights and incident to the electron to interest toward the junction. The chain reactions of transforming solar energy to electrical energy were modeled as a chain link mechanism before the maximum amount of light radiation was obtained. A solar charge controller can be thought of as a regulator. It connects the PV array to the system's loads and the battery bank. When the battery bank is nearly full, the device decreases the charging current to maintain the necessary voltage to adequately charge and maintain the battery, and a solar charge controller prevents the batteries from both overcharging and undercharging. The power produced by the PV solar cell is stored and deposited in a battery. The consumed energy is sent to the pump's engine, which powers it. A sensor is attached to the panel to determine the moisture level, and another is attached to the panel to trace the sun's ray dropping angle.

A control unit connects them all. The Soil Moisture Sensor is used to determine how much water is in a given amount of soil. The Solar Trackers are used to constantly guide the solar panel against the sun's rays, thus increasing the system's potential. Because of the improved direct exposure to the sun rays, this system effectively monitors the sun's location in the sky and produces more energy than its predecessors. Solar trackers are divided into two types: single axis and dual axis trackers. Solar trackers deliver more energy in about the same amount of space as fixed tilt devices, making them suitable for land protection. Also very necessarily, it emphasizes on not only on increasing the production of energy, but also ameliorates the way power output is delivered.

For NodeMCU, an open source firmware, there are open source prototyping board designs available. The term "NodeMCU" refers to the firmware, not the accompanying development kits. The pump and Servo motor connected to the control unit through the driver board. Whenever the soils get dry condition the pump can automatically on once the soil get sufficient amount of water the pump can automatically off.

III. PROPOSED WORK

The proposed system consists of many sections. In this section, the Solar panel, the Battery, the Controller, and the Sensors are briefly introduced.

A. Solar panel

The solar panel is the main part of the proposed system which changes the sun's radiant energy to electrical energy and then conveys through the controller to be stored in the battery[7].

In sunny areas, the Polycrystalline silicon solar cell is extra appropriate, since the price of the Polycrystalline silicon solar cells is lesser than the Monocrystal silicon solar cells. But in the more-rainy-days areas when sunlight is relatively not very adequate; it is better to select the Monocrystalline silicon solar cells because the optical conversion efficiency of the monocrystalline silicon solar cells is higher.

B. Battery

The requirements of the battery on the proposed system are: slower discharge rate and the long discharge time, it was decided that we usually chose the large-capacity lead-acid batteries, thus the high-energy and maintenance-free valve-regulated lead-acid batteries (VRLA) is a better choice. The VRLA battery has a one-way exhaust valve (also called a valve-regulated cap) on the battery cover which can vent surplus gas in case of unusual circumstances.

Therefore it is called "maintenance-free" is regularly compared with maintenance of the traditional lead-acid battery. The VRLA batteries do not require adding water or acid during service life and it is not necessary to check the electrolyte level.

Nowadays there is a lot of supportive battery products on the marketplace which are considered for the solar lighting system, we should discover the proper battery through associating and testing.

1) Capacity calculation of battery

The batteries are the core components in the proposed system; they can store energy which is generated by the solar cell during day time, and meet the power consumption of lighting at night and lighting needs in consecutive rainy days. Inversely if the battery capacity is too large, we need large solar panels to ensure the battery is fully charged in a limited time during the day. The over-large panels and battery will cause an increase in cost and also waste. If the solar panel is not large enough, the battery cannot be fully charged in a limited period during the day, it will always be in a state of power deficit, this is a bad effect of the battery life [5].

The capacity of the battery can be calculated by the following formula 2.

$$C = \frac{Q * (D + 1)}{K1 * (1 - k2)} \quad (1)$$

In the formula

C = Standard capacity of the battery.

Q = Power consumption per day of the lamps.

D = Maximum number of continuous rainy days.

k1 = Depth of discharge (DOD), generally the DOD of VRLA is 0.75.

k2 = Loss of electricity of the battery's self-discharge. (10%)

C. Servomotor

A Servo Motor is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. The angular orientation of the shaft changes as the coded signal changes. In radio-controlled aero planes, servos are used to position control surfaces such as elevators and rudders. They are also used in radio-controlled cars, puppets, and of course, robots. Servos are extremely useful in robotics. The motors are small, have built-in control circuitry, and are surprisingly efficient. The torque of a regular servo like the Futaba S-148 is 42 oz/inches, which is impressive for its size. It also draws power proportional to the mechanical load. As a consequence, a lightly loaded servo consumes very little energy. Figure 2 depicts the insides of a servo motor. The control circuitry, the engine, a collection of gears, and the case are all visible. The three wires that link to the outside world are also visible. One wire is for power (+5 volts), the other is for ground, and the white wire is for control.

Fig.1. Servomotor

D. Light Dependent Resistor (LDR)

LDR is a Light Dependent Resistor (Fig. 3 a) whose resistance is dependent on the light impinging on it. The resistance offered by the sensor decreases with the increase in light strength and increases with the decrease in light strength [2]. This device is used for the detection of day-time and night-time because when sunlight falls on it, it will consider as day-time, and when there is no sunlight falls on it, it will be regarded as night, as shown in Fig. 3.b. These are very beneficial, especially in light/dark sensor circuits and help in automatically switching ON /OFF the street lights.

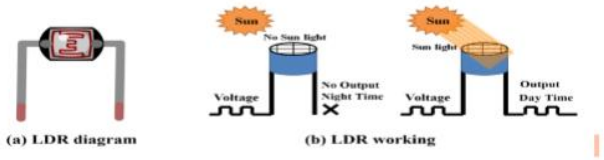

Fig.3. LDR symbol and its working phenomenon

E. NODEMCU-ESP8266

As shown in Fig.4 ESP-12E module on the NodeMCU ESP8266 production board includes an ESP8266 chip with a Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor runs on an adjustable clock frequency of 80MHz to 160MHz and supports RTOS. To store data and applications, the NodeMCU has 128 KB of RAM and 4MB of Flash memory. It is suitable for IoT ventures due to its high computing speed, built-in Wi-Fi / Bluetooth, and Deep Sleep Operating features. The NodeMCU is operated by a Micro USB jack and a VIN pin (External Supply Pin). It has interfaces for UART, SPI, and I2C.

Fig .4. NODEMCU-ESP8266

F. Soil Moisture Sensor

One type of sensor used to determine the volumetric content of water within the soil is the soil moisture sensor as shown in Fig.5. Since the straight gravimetric component of soil moisture must be eliminated, drying and sample weighting are needed. These sensors calculate the volumetric water content indirectly, using other soil laws such as dielectric constant, electrical resistance, otherwise neutron interaction, and moisture content substitution. The relationship between the measured property and soil moisture can be modified and can change due to ecological factors such as temperature, soil type, otherwise electric conductivity. The microwave emission which is reflected can be inclined by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology. These sensors usually used to ensure volumetric water content, and another group of sensors calculates a new property of moisture within soils named water potential. In general, these sensors are named as soil water potential sensors which consist of gypsum blocks and tensiometer.

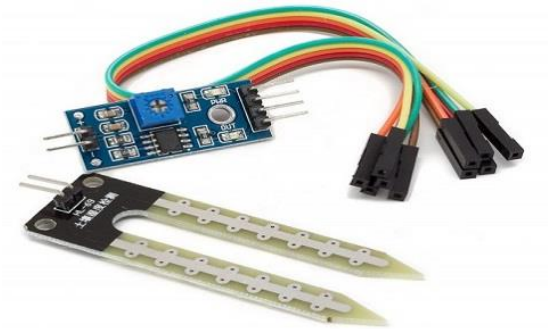

Fig.5. Soil Moisture Sensor

G. Pumping Motor

The water pump can be defined as a pump which uses the principles like mechanical as well as hydraulic throughout a piping system and to make sufficient force for its future use. Because of early civilization, they have been roughly in one structure or another. These pumps are currently used in a variety of

applications including housing, agricultural, municipal, and manufacturing. A water pump's operation is primarily based on the positive displacement theory and the use of kinetic energy to push water.

For energizing the water pump's motor, these pumps use AC or DC fuel, while others may be powered by other types of engines, such as gasoline or diesel. The water pump is a lightweight, compact device that can be used for a variety of household tasks. These pumps transport large amounts of water from one location to another. A water pump's primary feature is versatility. A good pump, carefully chosen, can be ideal for draining water from a low-lying flooded area, refilling the swimming pool and bathtub, and circulating pesticides and fertilizers. Since there is such a broad selection of water pumps, it is important to consider the requirements when choosing one that is both powerful and consistent.

Fig.6. DC Pumping Motor

H. Motor driver

The L293D IC is normally bundled in a 16-pin DIP case (dual-in line package). With only four microcontroller pins, this motor driver IC can handle two small motors in either direction: forward or reverse (if you do not use enable pins).

Fig.7. Pin diagram of L293D

IV. RESULTS

In this paper Solar Powered Agricultural Water Pumping with AutoTracking, based on the soil moisture sensor value, pump may be either switched On or OFF. If the soil is wet, then the controller will send the signal to motor pump to switch OFF immediately. Similarly if the soil is in dry condition, the soil moisture sensor will send the signal to controller. Based on that the controller will give signal to the motor to switch ON immediately. Those corresponding outputs are shown below. Here the supply for motor is taken by using solar panel. This method will be very useful for agriculture.

Fig 8. Hardware Setup

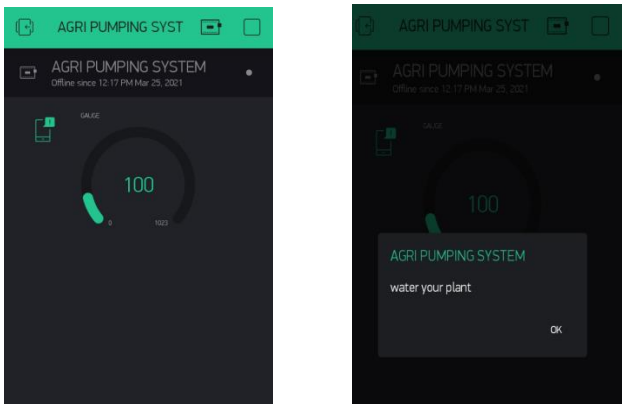

Fig 9 Result when soil get dry condition

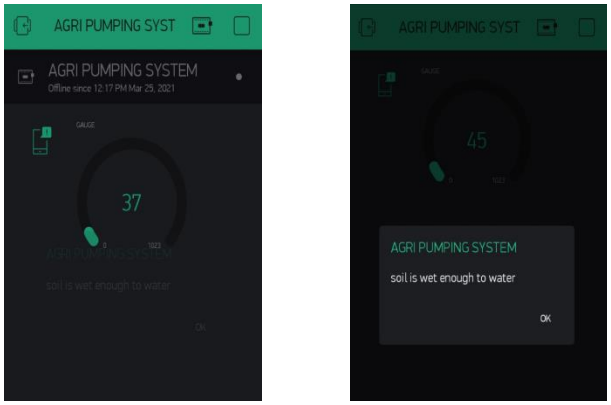

Fig 10 Result when soil get wet condition

V. CONCLUSION

Solar energy produces enough electricity to fuel the machine. The proposed model could be a feasible solution to eliminate the need for electricity and simplify the irrigation system for our farmers. The developed solar tracker system could follow the sun's progress in both directions. As compared to the performance of a panel without tracking, the power obtained by solar tracking is almost constant over time. The solar tracker system that was developed and is a functioning example of the main system. Microcontroller (NODEMCU), OPAMP as comparator (LM358), Servo Motor (4SHG-050A 5IS 5V, 5), Solar panel (Module type-SS3P), Stepper Motor Pilot, and Moisture Sensor and DWT11 Moisture and temperature sensor are among the components included in the tracker. Fault indicators may be applied to improve the system's reliability. The use of multiple sensors will boost the hardware much more. Since we used a NODEMCU as a programmable microcontroller and the Blynk app in combination with the NODEMCU for tracking, the model we built is an integrated device. Despite the fact that the device lacks a boot loader and needs an inbuilt boot loader, the system's performance would be determined by the size of the farm in operation. Solar energy produced by solar panels can also be fed into the grid with minor device modifications, providing a source of income for farmers and the local community while also promoting profitable farming and technological innovation. In India and same time giving a solution for energy crises.

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