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A Review Paper on Solar Powered Based Irrigation System

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Abstract

This paper proposes a model for an irrigation system based on a variable rate automatic microcontroller. Solar power is the sole source of energy used to control the entire system. The sensor is installed on the paddy field, and it continuously senses the water level and sends a message to the farmer informing him of the water level without having to visit the paddy fields. As a result, low-cost solar energy may be the solution to all of our energy needs. The answer for the Indian farmer is solar-powered smart irrigation systems. This system consists of a solar-powered water pump and a moisture sensor-controlled automatic water flow control. For farmers, it is the most practical solution to the current energy crisis. This paper presents a model of an irrigation system controlled by a microcontroller. This paper proposes a model for an irrigation system based on an automatic microcontroller. Solar energy serves as the sole source of energy in this scenario. Sensors are installed on the field, which continuously sense the water level and send a message to the farmer, informing him of the water level without having to visit the paddy fields. This paper proposes a model for an irrigation system based on an automatic microcontroller. This system lowers costs while increasing output. This system saves electricity by reducing grid power consumption and water by reducing water losses. Solar power can provide a cost-effective solution to all of our energy needs. The answer for the Indian farmer is solar-powered auto irrigation systems. This system consists of a solar-powered auto tracker and a moisture sensor-controlled automatic water flow control. It is the proposed solution for Indian farmers' current energy crisis. This system saves electricity by reducing grid power consumption and water by reducing water losses.

Introduction:

With the increase in agricultural activity and competitive demand from various sectors, water conservation has become increasingly important. By using a sensor-based irrigation system, we can make better use of water. Different irrigation systems are now being used to reduce reliance on rain. Many times, crops in the manual control irrigation system are dry or flooded with water due to a lack of electricity and mismanagement. As a result, a sensor-based irrigation system is used to avoid this problem. Farmers control the electric motors in a manual system by visiting the sites and observing the soil, crop, and weather conditions. In all seasons, a soil moisture sensor-based irrigation system maintains the proper moisture level in the soil for growing plants. In this system, a sensor detects the moisture content of the soil and turns on or off the pump motor accordingly. The purpose of a soil moisture sensor is to determine whether the soil is wet or dry. If the soil is dry, the pump motor will pump water until the field is wet, which the microcontroller will monitor continuously. The main benefit of a soil moisture sensor is that it ensures precise measurements and eliminates the need for the farmer to visit his farm to operate the pump. At the same time, a microcontroller using GSM technology sends a message to the farmer's mobile phone about the pump's status. Pump motors require energy to pump water in a sensor-based irrigation system. There is an increasing demand for energy in everyday life, but existing fossil and fuel resources are being depleted. According to a 2011 survey conducted by the Bureau of Electrical Energy in India, there are approximately 18 million agricultural pump sets in use, with approximately 0.5 million new connections installed each year with an average capacity of 5 horsepower. The agricultural sector's total annual consumption is 131.96 billion KWh (19 percent of total electricity consumption). As a result, solar power is merely a response to the current energy crisis.

Soil moisture sensor, temperature sensors in the root zone of the plant, and an opening unit that handles sensor data and sends it to a web submission. A single algorithm was created to measure the threshold values of temperature and soil moisture sensors, which was then programmed into a microcontroller to control the amount of water used. A photovoltaic panel was used for power.

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Another fact is that cellular Internet interfaces can be used to programme data assessment and irrigation planning through a web page. The automatic system was put to the test for 30 days and found to save 90% more water than a modern irrigation system. The system has the potential to be valuable in a water-limited geologically isolated zone due to its energy autonomy and low cost.

In this paper, an acoustic-based technique for sensing soil moisture content was developed. The main goal of this technique is to develop a method for measuring soil moisture in real time. The method is based on the relationship between two quantities, namely the speed of sound and the degree of water permeation in soils. This experiment discovered that, depending on the type of soil, the speed of sound decreases as the moisture content rises. This paper proposes a microcontroller-based model of automatic irrigation with solar power as the sole source of power. A number of sensors have been installed in the paddy field. Sensors continuously monitor the water level and transmit the information to the farmer via cellular phone. Without entering the paddy field, the farmer can control the motor. If the water level rises to a dangerous level, the motor will be turned off without the farmer's consent.

Objectives:

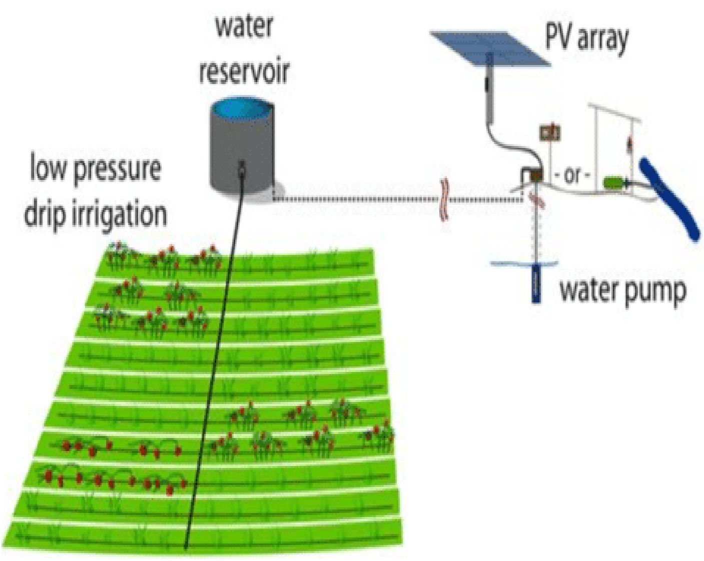
• Minimize the farmer's manual intervention.

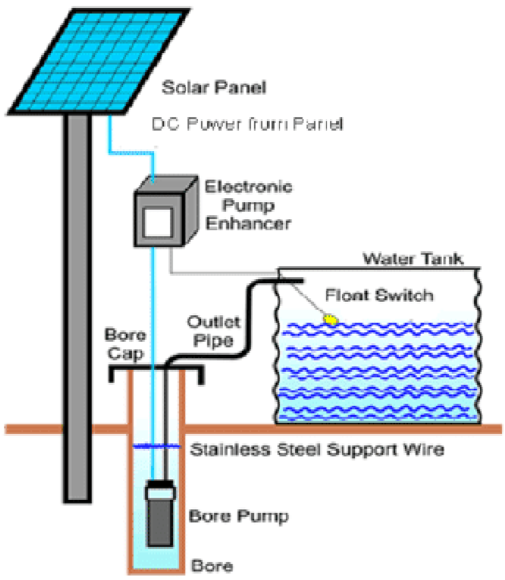
• To reduce the amount of water and electricity wasted.

• In order to increase crop production.

Literature survey:

PV technologies convert solar energy into electrical energy, which is then used to power an electric pump via an electric motor. A typical PV irrigation setup is shown in Figure 1. This system can be enhanced further based on the output requirement, charge regulation based on the pump's requirement (AC/DC), and the addition of a battery to counter the fluctuation of solar irradiation available throughout the day or even for irrigation at night, when lower water losses and higher irrigation uniformity are observed [5]. The water outlet from the irrigation system (depicted in Fig. 1) can be used either directly for irrigation or can be used to fill up a water storage tank.

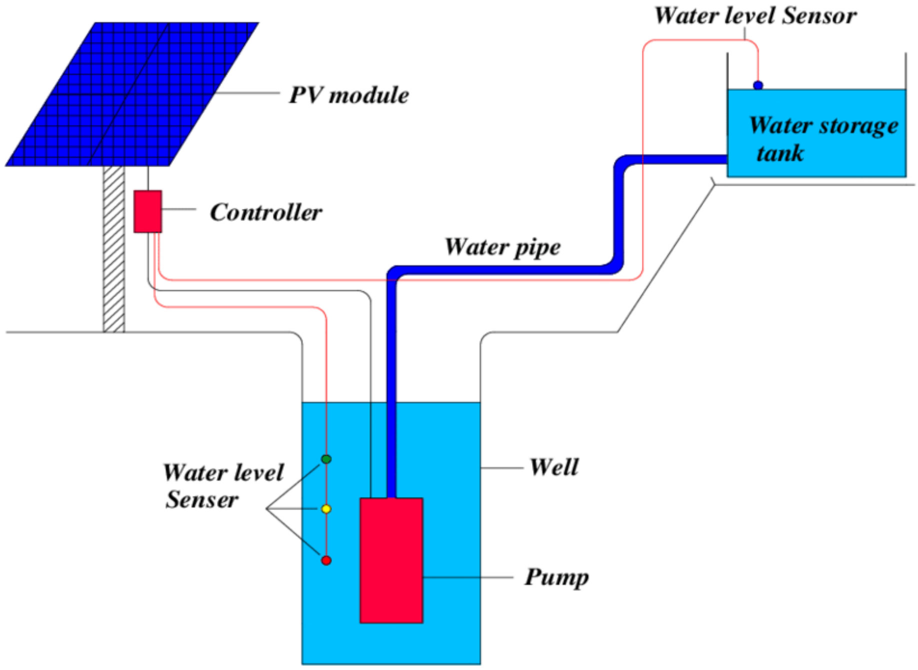




An advantage of the water storage tank is that it can be a substitute of the battery system, wherein the potential energy of the stored water can be utilised for drip irrigation. Photovoltaic systems are generally very simple to implement, and an adequately designed system is efficient and can compete with other systems when operational and maintenance costs are considered. However, the initial investment is often identified as a major turn off [7]. While PV systems are easier to maintain than most other renewable energy systems, there are a number of factors that limit their use, including inconsistency in solar irradiation, expensive tracking systems, reduction in efficiency due to overheating of panel systems, lower output due to energy conversion, and one of the most recent issues identified is the product's large environmental impact. Due to the lower cost of PV technology, many rural developments have been eager to use it. As a result, much research has been done on solar PV technologies for water pumping in recent years, to the point where photovoltaic irrigation systems have become synonymous with solar powered irrigation.

How does a solar irrigation system work?

Solar cells are used to power the pumps that transport the water. The solar energy absorbed by the cells is then converted into electrical energy by a generator, which then powers the pump via an electric motor. The majority of traditional pump systems rely on a diesel engine or the local power grid to operate. However, when compared to solar pumps, these two modes of operation have drawbacks. Access to the electricity grid is not always guaranteed in many rural areas, particularly in developing and emerging countries. Farmers cannot rely on the traditional irrigation system in this situation. As a result, using an independent and alternative energy system can help the farmer secure a reliable power source while also keeping the public grid from becoming saturated.



Because diesel pumps have more flexibility than AC pumps, they are slightly more efficient. However, one of the major drawbacks is that this system is reliant on fuel availability, which has a greater environmental impact. Although diesel-powered pumps are less expensive than solar-powered pumps, their operating costs are high and highly dependent on the price of diesel. Solar-powered systems work the other way around, in that, while the system is relatively expensive, the source of energy is free, so there are no operating costs after the amortization period (only the maintenance costs). As a result, solar pumps prove to be a sound long-term investment.

Access to water for agricultural purposes remains critical in some areas, such as arid regions of Africa and Southern Asia, as several studies, such as Atwater Solutions Project's Water for wealth and food security, have shown. Many Indian and African farmers use buckets to irrigate their fields, drawing water directly from wells or rivers. Farmers in those areas could increase their yield by 300 percent if they had access to a motorized pump.

As a result, R&D is now focusing on developing solar pumps that are affordable in arid areas. IBC SOLAR has collaborated with Siemens to develop a solution to replace diesel engines with solar-powered engines. In this case, the entire irrigation system, including the pump, can be left alone; only the diesel engine and the so-called "IBC pump drive controller" are replaced. A prototype of this system was tested in 2015 on a farm in Namibia and proved to be quite efficient, according to the manufacturer. The main benefit is that the acquisition costs are low because existing infrastructure is utilized.

Where is solar irrigation happening?

Solar pump installation is also a part of many development projects in arid regions such as Africa, India, and South America, with the goal of increasing local farmer productivity and, as a result, improving their living conditions. One successful example is a Physics teacher's initiative in a school in Blankness (Germany), where students developed two solar-powered pumping systems in collaboration with the Weddle-based company SET GmbH. They used these systems to pump underground water in two Nicaraguan farms. This project could also be realized with the help of the UNAN University in León, which specializes in solar energy. The project has been running for over ten years, and there are now 30 pumps in Nicaragua. It is managed by Nicolas, a Nicaraguan company that assists farmers with solar irrigation. Solar pumps allow them to produce all year, even during the dry season, increasing their income and strengthening their position in the local market.

Aside from the previously mentioned regions, solar irrigation systems are gaining popularity in Europe. A mobile solar drip irrigation system from Austria was just put into production a few months ago. This project was carried out by the Austrian company Wien Energies, and it has a dual goal: on the one hand, it aims to reduce CO2 emissions by using solar energy, and on the other hand, it aims to save 30% of water by using drip irrigation instead of traditional sprinkler irrigation. The principle of the drip irrigation method is quite simple. Water drips slowly and at regular intervals to the roots of the plants using various valves, hoses, and pipes. In contrast to a sprinkler system, where water evaporates into the air or seeps into soils where no plants grow, there is no water waste because water goes directly where it should go. As a result, drip irrigation allows more crops to be grown with less water, making it a highly efficient irrigation method.

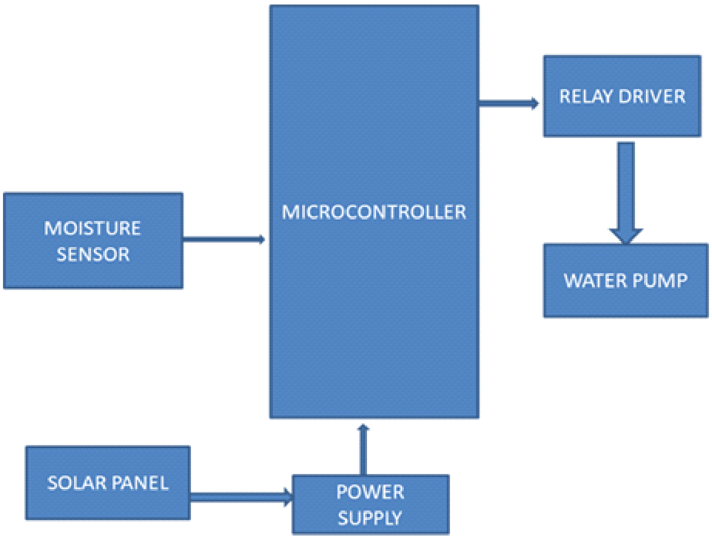
A mobile solar energy system with photovoltaic modules (up to 3kW) is connected to a wheeled pump that can pump from wells or rivers in the Wien Energies solar irrigation system. You can calculate the amount of energy produced by the system using an app on your Smartphone. The water is then distributed directly to the crops by the solar-powered pump via hoses. This system is now ready for production after a successful test on a 3.5-hectare organic cornfield in Guntramsdorf, Austria. As a result, in countries with high temperatures and limited water resources, the drip irrigation system could help to improve water management. This is especially important because farmers face three challenges: conserving water, money, and energy. Mobile solar drip irrigation systems will prove to be the ideal solution to these problems. Despite the fact that these systems are still quite expensive and difficult to set up, many R&D projects are working on democratizing the use of solar power in agriculture, which could play a critical role in the management of the food and energy crises in the future (and even now).

Positive displacement pumps, diaphragm pumps, and progressing cavity pumps were capable of pumping efficiencies of up to 70%, boosting the system's efficiency even further. By converting the high voltage from the DC output of the PV panels to a lower voltage for charging the batteries, a Maximum Power Point Tracking [12] system could be used to improve the efficiency of the PV water pumping system. The power degradation in PV modules as a result of prolonged field exposure has been determined to be 0.8 percent per year, and more research is needed [13]. Device et al. [22] designed and developed a solar PV-powered drip irrigation system for a project in Turkey that covered 1000 m2 and contained over 100 trees and required 1450 l of water per day. The site was irrigated twice a day with an automatic timer from June to October. Using a Maximum Power Point Tracker (MMPT) to increase PV conversion efficiency to operate at the maximum power point of the I-V curve, the PV panels (generating 132 Who/day using two 10 W PV panels to generate 12 VDC) charged a battery (14 Ah, 12 VDC) buffer throughout the day during available sunlight. The batteries provided consistent voltage to the DC pump, resulting in optimal pump performance. While other research considers the battery to be the cost driver, Device et al. argue that using the battery reduces the overall cost of the system by 63 percent, ensuring a better payback and thus making the system cheaper in the long run. This could make PV technology more affordable.

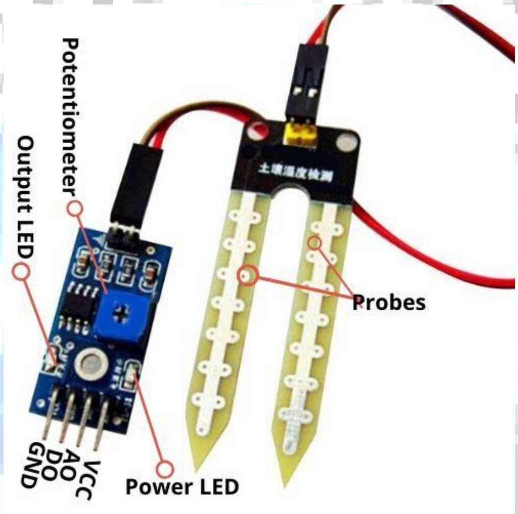
Figure 4 shows a context diagram to help you better understand the system's characteristics. Setiawan et al. [23] designed a solar-powered water pumping system for an Indonesian village. The systems used 32 panels to generate 3200 We and two Lorentz PS1800 HR-05HL submersible pumps to provide a flow rate of 0.4–0.9 l/s and a total head of 218.34 m. Each pump was fed by two stacks of eight solar cells connected in series, with two stacks connected in parallel. To provide the maximum head, the pumps are connected in parallel. The Ministry of Research and Technology of the Republic of Indonesia, in collaboration with the Ministry of Public Works, funded the project; however, the system's costs were not disclosed. The system was ideal for providing clean water to the village, which had previously relied on rainwater storage for survival. Devised a novel optimisation process for optimising PV water pumping systems for irrigational purposes on a budget. A simulation was created that took into account the availability of groundwater, water supply, investment costs, and crop sale revenue. The simulation was applied to an existing PV water pumping system to demonstrate the effectiveness of this approach, and the results showed a positive impact in terms of ensuring continuous operation, reducing PV array size, and thus lowering the investment and thus lowering the payback period.

Working Principle:

The Adriano Uno is used to control the motor in this project. The Adriano IDE software is used to program the Adriano Board. Two moisture sensors measure the moisture level in the soil, calculate the average moisture value, and send a signal to the Adriano if watering is necessary. The plants are watered by the water pump until the desired moisture level is reached. The solar panel is used to recharge the rechargeable battery, which provides the required power source. The soil condition is sensed by a moisture sensor, which determines whether the soil is wet or dry, and the input signals are sent to the microcontroller, which controls the entire circuit. When the soil is dry, the microcontroller sends a command to the relay, which turns on the motor and supplies water to the field. If the soil becomes wet, the motor is turned off.



Sensor probe:



Conclusion:

Farmers, in particular, are having major difficulties watering their agricultural fields these days. It's because they have no idea when the power will be turned on so they can pump water. Even after that, they must wait until the field has been properly watered, which necessitates the cessation of all other activities. Here's an idea that can help not only farmers but also gardeners by sensing soil moisture and automatically switching the valve on when the power is turned on. The paper outlined a method for tracking the sun's position using a solar tracking system. Through software-based solutions, the solar tracker also provides a lucrative solution for third-world countries to integrate it into their solar system at a relatively low cost. Even though the prototype has limitations in terms of hardware as a starting point, it still provides a way to improve the design methodology in the future. The system has several advantages and requires less manpower to operate. Only when the soil humidity falls below the reference level does the system supply water. Water conservation occurs as a result of direct water transfer to the roots, which also helps to keep the moisture-to-soil ratio at the root zone constant to some extent. As a result, the system is effective and adaptable to changing conditions.

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