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Solar Panel Energy with Smart Irrigation System

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Abstract— In today's climatic conditions such as unprecedented amounts of rain and frequent heat waves, cultivating has become a tedious task. Predicting nature's next move is not easy but what we can do is minimize its effect on the yield. There are so many regions that receive excessive rainfall, suffer frequent flash floods and scorching heat. To adapt to these conditions, sensor networks can be deployed in the fields and the available resources should be used as efficiently as possible. In order to fulfill this requirement, power storage capable of storing energy efficiently from solar panels and an irrigation controller which monitors the land, be it for farm, gardening or horticulture with little to none intervention in certain aspects. The existing products in the market have proprietary parts, features and they don't endorse cross-compatibility with other products. Keeping the design open source and easy to work promotes recycling and reparability something essential in the current time of global silicon shortage.
Farmers or gardeners often don't know the amount of water and the intervals of irrigation for many exotic and domestic species of plants, they then end up growing crops such as wheat and rice which need flooding of the field, the cultivation of these species can be promoted and be made easy with the project. Telemetry and connected technologies are part of every system these days. The project monitors various parameters and depending on the conditions, will carry out necessary action such as irrigation in only amounts required by the field. This is possible through PWM control of motors coupled with valves.

Keywords: Telemetry, conservation of resource and clean energy

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1. Introduction

The current situation of agriculture in India is the same as it was years ago. Solar energy that is affordable may be the solution to all of our energy problems. Smart irrigation systems powered by solar energy are the solution for Indian farmers. The world's most plentiful energy source is solar energy. In addition to being a solution to the current energy issue, solar power is also a clean kind of energy. These days, solar panels are frequently utilized to power household appliances, water heaters, and street lighting. Solar panels are becoming more and more affordable, which promotes their use in a variety of industries. Farmers in India's current energy crisis may find a viable option in solar-powered irrigation systems.

This technology is employed in agricultural irrigation systems as one application. Traditional methods are still being used in the agro industry [1] which in today's world are starting to become inadequate. The reason is the present weather conditions. Even though the technology implemented in the agriculture industry is evolving, the cost of these technologies is also rising [2]. So due to this inflation in prices, a daily farmer or gardening enthusiast cannot afford the advanced equipment causing them to follow the traditional methods only [3]. Or even if they can, they are limited and mostly rebadged generic products. Once a small investment is made, this green method of energy

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production offers free energy. Therefore, the project we are building is with the help of inexpensive parts and components making it an affordable affair. Not only its affordability is an advantage, but its ease of use, smart operation and usage of solar panels guarantees simplicity, retrofit capability and use of clean energy.

The world's most abundant source of energy is solar energy. Solar energy is not only an eco-friendly source of energy but also a remedy for the energy crisis of today. The use of solar energy results in decreased long-term operational costs because there is no need for the variable costs associated with using fuels. Solar energy is a renewable energy source that benefits the environment and has no harmful or adverse effects on it. It is among the finest energy sources because no greenhouse gases are produced into the atmosphere.

2. System Implementation

The project is split into two parts, a power storage unit which harnesses solar energy and the other is the irrigation controller, which carries out irrigation activities in the farm Solar panels will be used to charge the lithium batteries stored in the power storage unit [4]. The charging regulation, delivery, power telemetry data will be obtained from this module. The batteries are few stacks of recycled lithium-ion cells which are designed in such configuration that they will make up a power storage house which then will act as backup in case there isn't enough power provided by the panels or the grid itself for the operation. The unit is designed such that it is weatherproof and can be easily wall mounted. It also has tamper protection, meaning if anyone fiddles with it or tries to open the unit, a notification will be sent to the app and output power will be cut off for safety. Apart from this, it also presents with the daily power usage, energy left until the next sunrise, etc.



Figure 1. Irrigation Controller with Sensor

A controller (consisting of a microcontroller - ESP32) (Figure 1) is going to be in position which will control and monitor the irrigation [5]. It will be connected to the power storage unit to meet its power requirements. Sensors such as moisture, liquid flow and temperature sensors are being used. These sensors will provide information directly to the irrigation controller depending on which the controller will decide how much water is to be irrigated by commanding the relays [6] to switch the valves on or off and the pumps placed in the fields.

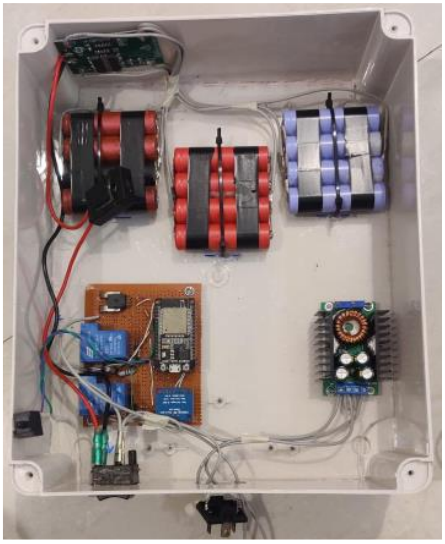


Figure 2. Power Unit Internals



Figure 3. Power Unit Logic Board

2.1 Solar Panels & Batteries

The solar energy produced by the panels will be stored in the lithium-ion cells form the power unit [7]. Solar fan cap also helps farmer to increase the work activity [8].These batteries will power up the controller with the energy. Since the solar panels will only be able to produce energy during daytime there will be no power supply at night. So, the storage house, while processing the solar energy, will also be storing that energy as backup and for powering anything up at night. There will be a voltage regulator connected in between the panels and the batteries to regulate and bring the voltage down to approximately 12.6V which is suitable for the current chosen battery configuration. The battery configuration implemented is 3s4p (3 in series and 4 in parallel) (Figure 2) at the moment which can be increased as our model is modular. The cells in series increase the voltage whereas more cells in parallel increase the Ah capacity. Voltage sensors are connected to the batteries and the solar panels which will monitor the voltage and the current flow (Figure 3). This current and voltage information will be sent to the user in real-time. Relays are used in the connections because if there is any form of irregularities like over-charge/discharge the relays can quickly cut the connection.

2.2 Irrigation Controller

Now a days automated robot are used but the robot have certain issues [9].The power from the batteries is supplied to the irrigation controller [10]. The controller will be connected with a moisture sensor, temperature sensor and a motor. It will retain information from the sensors and depending on that information will learn what the current temperature is and how moist the soil is [11]. If the soil is very moist, the sensor will sense it and provide the information to the controller. The controller will then shut the valves which will cause the flow of water to stop. If the soil is less moist and it needs more water depending on the requirement the sensor will notify the controller and further the controller will open the valves to allow the flow of water. It will send live updates about the amount of water used for irrigation to the connected user devices. The way the field is irrigated is unique, here comes the PWM control of the motors in each zone in action. The PWM control allows precise amounts of water to be delivered to each zone, reducing wastage and putting out just the amount required, if the sprinkler head is changed, periodic or sprinkle irrigation is also possible, something quite vital in gardens, lawns and in stadiums. There is an on-board microcontroller (Figure 4) which will be connected to the user's device as it will forward the necessary information to that device which will help the user to know what the contemporary situation is.

2.3 Zone wise Irrigation

The zone-wise approach allows the land to be covered effectively, every green piece of land expands over a few acres, some patches may have different crops all together having different water needs, the zone approach promises scalability and effective coverage of land. The irrigation controller in each zone will have its own array of sensors and a sprinkler head, reporting the conditions to the user interface

3. Result and Discussion

This project we are able to achieve fully automated irrigation using internals of irrigation controller Figure 4. In the current technology we are only able to see only timer enabled irrigation systems but this project adds an innovative touch to this by adding such smart integrations for unpredictable rainfalls. The energy obtained is from a clean source and acts as a fail-safe in case of power loss from the grid. Introducing new technology such as lithium cells and pwm control of irrigation motors. The zone-based approach is fulfilled by the modular architecture of the system thus making future upgrades an ease. Thus, reducing the burden amongst other farm activities.

The project uses all generic pins and connections making user upgrades and expansion of battery capacity an easy task, something that's not seen if off the shelf hardware, they all use manufacturer specific standards to discourage third party repairs and modifications. The user-interface will display many parameters like solar panel power output, solar energy generated, weather, battery on/off state, zone-based irrigation where one can toggle the sprinkler on and off in Figure 5. The end user will also receive daily notifications of how much power was consumed on that specific day.

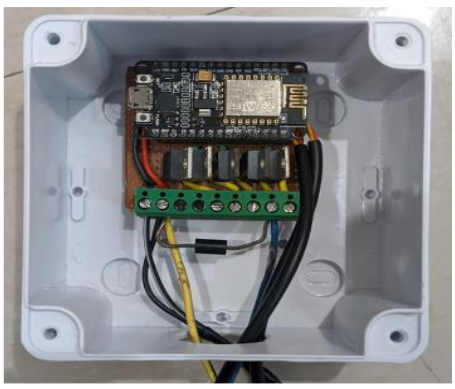


Figure 4. Internals of Irrigation Controller

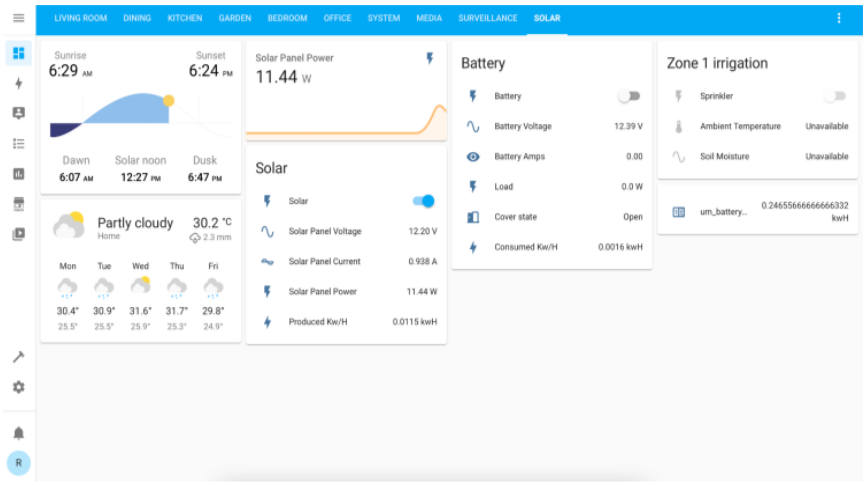


Figure 5. User Interface

4. Conclusion

The model is eco-friendly not only due to the use of solar panels but also because we are using recycled lithium-ion batteries. This system can prevent over-irrigation which occurs a lot in the agriculture world due to unpredictable weather conditions and lack of information. This is achieved by the information collected from the soil sensor and weather data. If the user acquires more land and wants to expand the solar panel area, it can be upgraded seamlessly. The government and the farmers stand to gain from the proposed system's implementation in a number of ways. An energy crisis solution is suggested for the government. The suggested approach for irrigating fields is simple to use and environmentally favourable. Overall gains are substantial, and this approach is cost-effective over time. Therefore, we can say that our project possesses modular and scalable characteristics which enables the users to expand or decrease the number of batteries or change many other parameters according to their requirement which endorses repairability and reuse instead of opting for another product entirely.

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