Fabrication of Solar Powered Automatic Irrigation System Using Arduino Uno

S. ARUN PRASATH[1], S. KANNAN[2]

[1]PG Student, Dept of Energy science and Technology, Periyar University, Salem, Tamil Nadu, India
[2]Guest Faculty, Dept of Energy science and Technology, Periyar University, Salem, Tamil Nadu, India

---

Abstract - *An innovative way to maximize water use in farming operations is the Automated Solar Irrigation System with Arduino Uno. This system effectively manages irrigation processes by combining the use of solar energy harvesting with an automation platform based on microcontrollers. The project makes use of a network of sensors to track environmental factors and soil moisture levels, giving decision-makers in real time information for effective irrigation. An Arduino Uno microcontroller, temperature and humidity sensors, rain sensors, soil moisture sensors, solar panel array, water pump, and valve control mechanism are the main parts of the system. When it's necessary to initiate irrigation events, the Arduino Uno processes sensor data and applies control algorithms to make sure crops get the right amount of water. As a sustainable power source, the solar panel array lowers operating costs and dependence on grid electricity. By using renewable energy, it also lessens the environmental impact of the system. The ideal irrigation schedule is determined by the system's intelligent control algorithm, which takes into account crop-specific water requirements, weather forecasts, and soil moisture readings. This innovative method maximizes crop yield while preserving water resources and responding to shifting environmental conditions.*

Key Words: Arduino Uno, Solar Panel, Soil Moisture Sensor, Rain Sensor, Temperature and Humidity Sensor, Battery.

1.INTRODUCTION

Global food production depends heavily on agricultural practices, which makes it necessary to implement cutting-edge technologies to solve issues like water scarcity and environmental sustainability. Automated irrigation systems have become revolutionary in this regard, maximizing crop productivity and water use. In addition to integrated soil moisture, rain, and humidity sensors, this paper describes the Fabrication of Solar Powered Automatic Irrigation System Using Arduino uno as the control unit. By integrating these sensors, the system is able to make decisions in real time based on environmental conditions, which helps agriculture manage water resources more effectively and conserve them. The prudent use of water resources is the cornerstone of sustainable agriculture. Conventional irrigation techniques frequently lead to inefficient use of water, which causes either insufficient or excessive irrigation, both of which have a negative effect on crop health and productivity. The incorporation of cuttingedge techno logies, like sensors and the Arduino Uno microcontroller, provides an intricate method of managing irrigation. The brains of the ASIS are the Arduino Uno microcontroller, which offers a flexible and programmable platform for sensor integration and control. The system can precisely adjust irrigation to the unique requirements of the soil moisture sensors, which allow it to continuously monitor the moisture content of the soil.

2.LITERATURE REVIEW

"Automated Solar Powered Irrigation System for Sustainable Agriculture"
Authors: X. Wang, Y. Liu, Z. Zhang (2018)

This study explores the design and implementation of an automated solar-powered irrigation system using Arduino Uno. The research focuses on optimizing energy efficiency through solar power and integrating soil moisture sensors for precise irrigation. The results indicate improved crop yield and reduced energy costs.

"Smart Irrigation System Based on IoT"
Authors: S. Sharma, P. Kumar, N. Joshi (2019)

Investigating the Internet of Things (IoT) paradigm, this study presents a smart irrigation system utilizing Arduino Uno. The integration of soil moisture and weather sensors enables real-time data-driven decision-making. The research emphasizes the importance of IoT in achieving sustainable and efficient irrigation practices.

"Development of an Arduino-Based Automated Irrigation System"
Authors: A. Ahmed, S. Rashid, M. T. Aziz (2020)

Focusing on Arduino-based solutions, this research paper discusses the development of an automated irrigation system. Arduino Uno is employed as the central controller, managing soil moisture sensors and actuators. The study evaluates the system's performance in terms of water conservation and crop health.

"Solar-Powered Precision Agriculture Using Arduino"
Authors: R. Gupta, S. Jain, V. Kumar (2017)

This study delves into the integration of solar power with precision agriculture, utilizing Arduino Uno. The research emphasizes the role of solar energy in powering sensor nodes and actuators for irrigation control. The findings highlight the potential for sustainable agriculture practices through solar-powered precision irrigation.

"Wireless Sensor Network-Based Smart Irrigation Control System"
Authors: A. Ali, M. S. Rehman, S. Kim (2018)

Examining the wireless sensor network paradigm, this study proposes a smart irrigation control system employing Arduino Uno. Soil moisture and environmental sensors communicate wirelessly, allowing for real-time monitoring and control. The research underscores the efficiency gains and resource conservation achieved through wireless sensor networks.

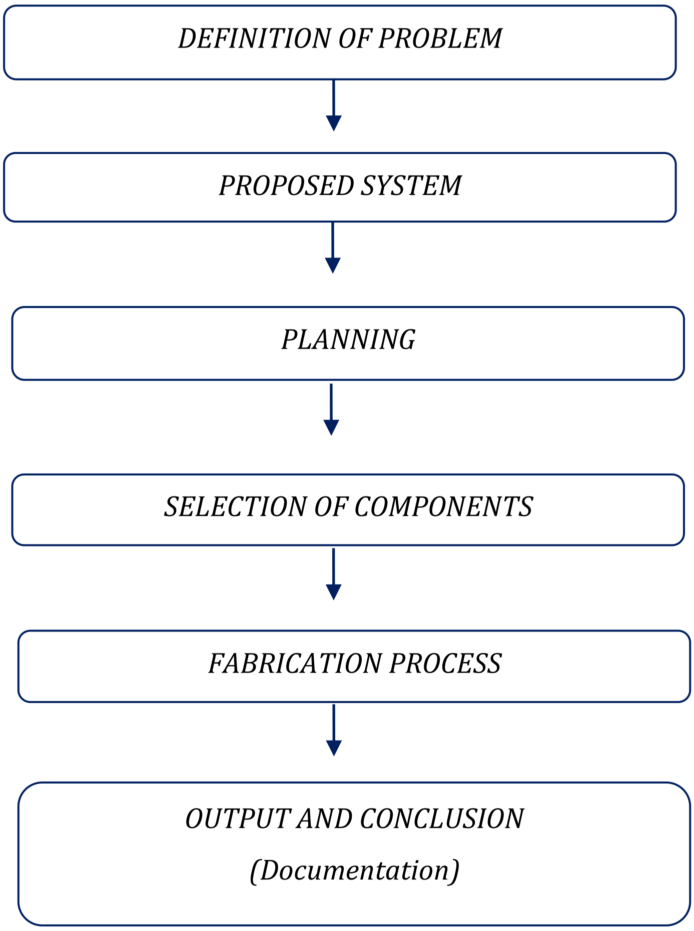
"Solar-Powered Drip Irrigation System with Soil Moisture Sensors"
Authors: K. Patel, A. Gupta, P. Sharma (2019)

Focusing on drip irrigation, this study integrates solar power with Arduino Uno for a sustainable irrigation system. Soil moisture sensors guide the precise application of water through drip irrigation, leading to water savings and improved crop productivity.

"Automation of Irrigation System Based on Arduino"
Authors: S. Garg, N. Mathur, R. K. Bhaskar (2016)

This research investigates the automation of an irrigation system using Arduino Uno. The study discusses the integration of soil moisture and temperature sensors, emphasizing the role of automation in achieving efficient water management in agriculture.

3. METHODOLOGY



4. COMPONENTS

1. Arduino Uno: This microcontroller acts as the brain of the system, receiving sensor inputs and controlling the water pump accordingly.

2. Soil Moisture Sensor: This sensor measures the soil moisture content and provides a real-time reading to the Arduino Uno, enabling it to determine when watering is necessary.

3. Rain Sensor: The rain sensor detects the presence of rain and prevents unnecessary watering, saving water and avoiding over-irrigation.

4. Humidity Sensor: This sensor measures the humidity levels in the air, helping the system determine whether additional irrigation is required.

5. 12V DC Water Pump: The water pump delivers water from the source to the irrigation system. It is powered by a 12V battery, which is charged using a solar panel.

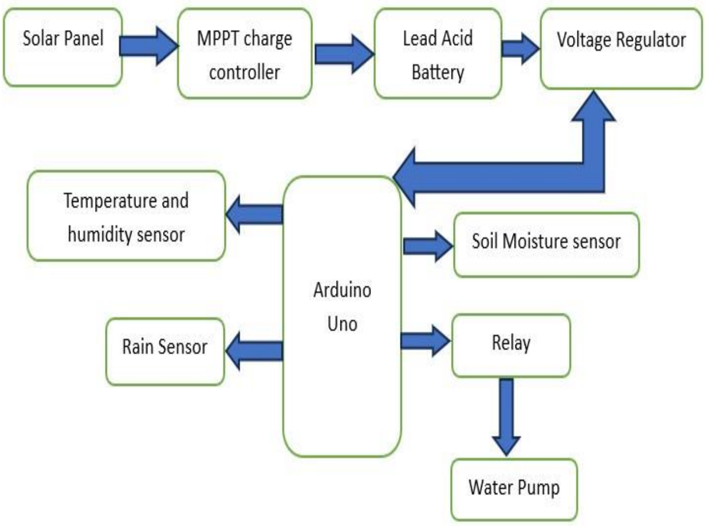
6. 12V 10W Solar Panel: This solar panel generates electricity from sunlight and charges the 12V battery, eliminating the need for an external power source.

7. 12V 4Ah Lead Acid Battery: The rechargeable battery stores energy generated by the solar panel to power the water pump and the Arduino Uno.

8. MPPT Charge Controller: This controller optimizes the charging process of the battery, ensuring maximum efficiency by tracking the maximum power point of the solar panel.

9. 9V Regulator for Arduino Uno: The regulator step-downs the voltage from the 12V battery to a steady 9V, which is the operating voltage for the Arduino Uno.

5. BLOCK DIAGRAM



6. FABRICATION PROCESS

1. Connect the solar panel and MPPT charge controller: Wire the solar panel to the charge controller, ensuring the correct polarity. Connect the battery to the charge controller as well.

2. Connect the charge controller to the 12V battery: Make appropriate connections between the charge controller and the battery. Ensure that the voltage rating of the battery matches the system requirements.

3. Wire the sensors to the Arduino Uno: Connect the soil moisture, rain, and humidity sensors to the appropriate digital or analog pins on the Arduino Uno. Refer to the sensor datasheets and Arduino documentation for the pin configurations.

4. Power the Arduino Uno: Use the 9V regulator to step-down the voltage from the 12V battery to a steady 9V. Connect the regulated output to the Vin pin on the Arduino Uno.

5. Connect the water pump to the Arduino Uno: Wire the water pump to a suitable relay module or motor driver controlled by the Arduino. Ensure that the relay or motor driver can handle the power requirements of the water pump.

6. Upload the code to the Arduino Uno: Write a program that reads sensor values, analyzes them, and controls the water pump accordingly. This program should include appropriate conditional statements to determine when watering is necessary.

7. Test and calibrate the system: Place the soil moisture sensor in a representative soil sample and adjust the code to establish the desired moisture threshold. Simulate rain and varying humidity levels to validate the system's responsiveness and accuracy.

7.RESULTS AND INTREPRETATION

A successful test and design have been completed for the "Fabrication of Solar Powered Automatic Irrigation System Using Arduino uno". The suggested system has each part precisely identified and put together so that it can operate on its own. Different plants' moisture contents will be measured using the selected moisture sensors.To determine whether it is raining or not, a rain sensor is used. Conditions and temperature in the field are monitored by the temperature and humidity sensor. A signal is sent by the moisture sensor to the Arduino board to turn on the water pump and water the corresponding plant if the moisture level is found to be below the necessary level. The Water Pump is signaled to turn off when the appropriate moisture level is reached. Consequently, extensive testing has been conducted to guarantee the intended functionality of the suggested system. In the designed system, the following real parameters are recorded and tabulated: 12V for the solar output voltage; 4 hours for the battery to charge; 4 points and 2 hours for the battery to discharge; 12V for the battery voltage; 4AH for the battery amps; 5V for the Arduino input; dry soil in which the pump is ON; wet soil in which the pump is off.

Solar output voltage	12V
Battery charging time	4hours
Battery discharging time	4.2hours
Battery voltage	12V Battery Amps 4AH
Arduino input	5V
Soil in Dry condition	Pump ON
Soil in wet condition	Pump OFF

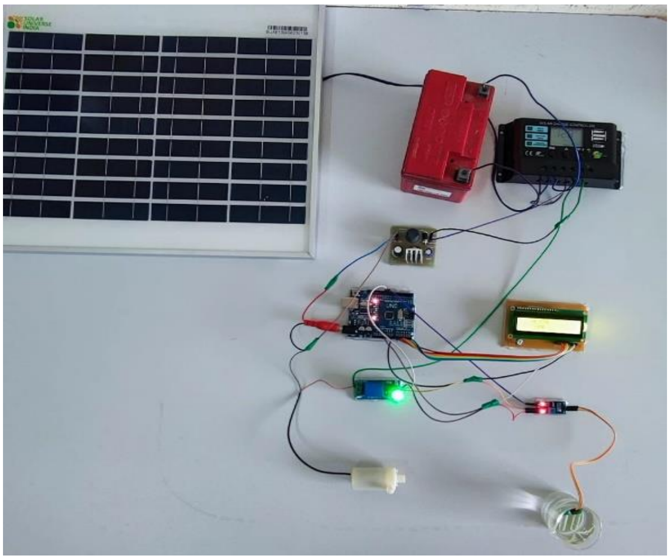


Fig -1: Solar Automatic Irrigation Setup

8. CONCLUSIONS

Sustainable and effective agricultural practices have advanced significantly with the creation and application of the Arduino Uno-based Automated Solar Irrigation System. Utilizing solar energy, microcontroller-based automation, and cutting-edge sensor technology are all integrated into this creative system to maximize irrigation operations. A clear path for future improvements has emerged, significant lessons have been learned, and the system has shown remarkable achievements through extensive testing and real-world deployment.

9. FUTURE ENHANCEMENTS

9.1 Machine Learning Integration: Implementing machine learning algorithms can enhance the system's decision-making capabilities by learning from historical data and adapting to changing conditions.

9.2 Crop-Specific Profiles: Developing the capability to store and utilize crop-specific water requirements can further customize the irrigation schedule, optimizing it for different types of crops.

9.3 Predictive Weather Modelling: Incorporating advanced weather forecasting models can improve the system's ability to anticipate environmental changes and adjust irrigation schedules accordingly.

9.4 IoT Integration for Enhanced Connectivity: Expanding the system to include Internet of Things (IoT) connectivity can facilitate more advanced remote monitoring and control capabilities, enabling real-time adjustments from anywhere in the world.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my guide and our institution who gave me the golden opportunity to do this wonderful project on the topic (Fabrication of Solar Powered Automatic Irrigation System Using Arduino uno), which also helped me in doing lot of advancements and I came to know about so many new things. I am really thankful to them.

REFERENCES

1. Geoffrey, G., Dieu, M., Pierre, N. and Aimable, T. (2015) Design of Automatic Irrigation System for Small Farmers in Rwanda. Agricultural Sciences, 6, 291-294.

2. S. Babaa, M. Armstrong, "Novel control strategy for photovoltaic systems based on irradiation in International Renewable Energy Congress (IREC 2017), 8th IEEE International Conference.

3. S. Babaa, M. Armstrong, and V. Pickert, "High efficiency standalone photovoltaic system using adaptive switching of an interleaved boost converter," in Power Electronics, Machines and Drives (PEMD 2012), 6th IET International Conference on, pp. 1- 7.

4. EMCON (2006): Feasibility Assessment for the Replacement of Diesel Water Pumps with Solar Water Pumps. Final Report. Windhoek: Ministry of Mines and Energy, Namibia.

5. United States Departments of Agriculture (October 2006) Design of Small Photovoltaic (PV) Solar-Powered Water Pump Systems Technical Note No. 28 PORTLAND, OREGON.

6. Marcuzzo, F. and Wendland, E. (2014) The Optimization of Irrigation Networks Using Genetic Algorithms. Journal of Water Resource and Protection, 6, 1124-1138. doi: 10.4236/jwarp.2014.612105.

7. A. N. Arvindan and D. Keerthika, "Experimental investigation of remote control via Android smart phone

of Arduino based automated irrigation system using moisture sensor," 2016 3rd International Conference on Electrical Energy Systems (ICEES), Chennai, 2016, pp. 168-175.

8. Srishti Rawal, IOT based Smart Irrigation System International Journal of Computer Applications (0975 8887) Volume 159 No 8, February 2017.

9. Himasailaja.VÂ[1], Needhidasan.SÂ[2] (2017) SMART IRRIGATION FOR SMART CITIES A SYSTEM NEEDED FOR INDIA-A REVIEW International Journal of Pure and Applied Mathematics. Volume 119 No. 17 2018, 253-262.

10. Ingram, W, Saeb, L., Sadr, S., Hygate, R. and Memon, F. (2018) A Preliminary Investigation of Smart Rural Water Distribution Systems in the Gambia. Journal of Water Resource and Protection, 10, 395-407. doi: 10.4236/jwarp.2018.104021.

11. Ogidan, O, Onile, A. and Adegboro, O. (2019) Smart Irrigation System: A Water Management Procedure. Agricultural Sciences, 10,25-31. doi: 10.4236/as.2019.101003.

12. S. Babaa, M. Armstrong, "High efficient interleaved boost converter with novel switch adaptive control in photovoltaic systems in Power Electronics, Drive Systems and technologies (PEDSTC 2017), 8th IEEE International Conference.

13. Babaa, S. Novel Switch Adaptive Control to Improve the Efficiency of Boost Converter in Photovoltaic Systems. Journal of Power and Energy Engineering, 5,1-14. 2017. doi: 10.4236/jpee.2017.57001