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Solar-Powered Smart IrrigationMonitoring System Using IoT

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Abstract: *Water and food are the basic necessities of human being to survive life. Along with several environmental concerns and climate change, water scarcity and food security are growing concern in today's society. Water irrigation remains the biggest water usage globally and creates a lot of water wastage. With the advancement of technologies nowadays, several strategies are developed in order to minimize the negative impacts on the environment. Using renewable resources and IoT technology, it can generate a sustainable and responsible conservation system over time. Today the farmers are finding it difficult to monitor the field about its moisture content and temperature of the field. Hence the project is created for monitoring the farm lands using the concept of Internet of Things and Image processing.*

Keywords: Internet of Things, renewable resource, Irrigation.

I. INTRODUCTION

Agriculture has a significant role in our Economy. Over the years multiple developments and innovationshave come across to minimize the rapid depletion of natural resources in the environment. Basic necessitiessuch as food and water are an integral part of everydaylives on Earth. Water has a significant role in theenvironment. Globally, 70% of water comes from natural resources such as groundwater systems, lakes etc to support irrigation practices and feeding of the livestock. With irrigation systems, it is important to maximize plant productivity, efficient energy consumption, and reduce wastage of water.[5] Severalprocesses have been done by the people on how to improve the irrigation systems. This method can be used in watering systems as it's a way of producing clean energy for the environment. Investing in zero-carbon dioxide emissions and using energy-efficient products. The most abundant source of energy is the sun.[2]Investing in zero- carbon emission and using energy-efficient products. The Solar-Powered Smart Irrigation System is a technological solution designed to help farmers optimize crop growth while conserving water resources. Traditional irrigation systems are often inefficient, leading to overwatering or underwatering of crops, which can reduce crop yields and waste water resources. This smart irrigation systemaims to solve this problem by utilizing the power of IoTtechnology to monitor soil moisture, weatherconditions, and water usage in real-time.The system collects data from multiple sensors installed , such as soil moisture sensors, temperature sensors, and rainfallsensors. This data is transmitted to a central control unitusing IoT technology, which processes the data and makes decisions on irrigation scheduling and water usage. The system can also be controlled remotely using a mobile application or web interface.[1]One of the key features of this system is its use of solar powerto reduce energy consumption and increase sustainability. The solar panels are used to power the sensors and control unit, making the system self- sufficient and reducing the reliance on external power sources.By providing farmers with accurate data and control over their irrigation systems, this solution aimsto increase crop yields while conserving water resources. The Solar-Powered Irrigation System has the potential to revolutionize agriculture industry by giving a sustainable and efficient approach to irrigation..[3]

II. PROBLEM DEFINITION

IoT includes the development of an integrated system that can collect and analyze data from various sources, including weather sensors, soil moisture sensors, and crop health sensors, to provide real-time information on crop conditions.[1], Using a mobile device or computer, we ensure that water is delivered efficiently, effectively, and in the right amounts.

The challenges involved in designing a solar irrigation system using IOT include selecting the right sensors and communication Technologies, Designing the system to be low-power and robust, and integrating the various components of the system. Another Challenge is to ensure that the system is simple to use and maintain, and it can be customized to meet the specific needs of different crops and growing conditions.[2] Overall, the problem definition of solar irrigation using IOT involves designing and implementing a system that can provide farmers with accurate and timely information on crop conditions.IoT aims to address is the inefficient use of water resources in agricultural irrigation.Traditional irrigation systems often rely on fixed schedules or manual monitoring which can lead to overwatering or under-watering of crops resulting in reduced crop yields and increased water waste.To solve this problem the solar powered smart irrigation monitoring system utilises the IOT technology to monitor soil moisture,weather conditions and water usage in real time.[3]This system can automatically adjust irrigation schedules and water usage to optimise crop growth and reduce water waste. This system also uses solar power to reduce energy consumption and increase sustainability. By providing farmers with accurate data and control over their irrigation systems this solution aims to increase crop yields while conserving water resources.

II. LITERATURE SURVEY

The system aims to provide an efficient solution to irrigation control problems by sending messages using GSM and ensuring that sufficient amounts of water aregiven to the fields, thus overcoming issues such as under-irrigation and over-irrigation that may result in soil quality degradation. The proposed system uses therain gun technique, which is highly efficient comparingto the drip system, as it leads to less soil erosion and wind erosion while increasing yields.

"IoT-based solar-powered smart irrigation system for precision agriculture" by Z. Bao et al. (2021): This paper projects an IoT-based solar-powered irrigation system for precision agriculture, which combines IoT and solar energy to optimize the irrigation process. The system includes soil moisture sensors, weather sensors, and a microcontroller that uses the collected data to control the irrigation schedule. [1]

"Design and Implementation of Solar Powered Irrigation System using IoT" by S. S. Kadam et al. (2021): This paper proposed a solar-powered irrigation system , which is designed to reduce waterconsumption and improve crop yields. The system includes soil moisture sensors, a solar panel, a battery, and a microcontroller that uses the collecteddata to control the irrigation schedule. [3]

"Solar-Powered Irrigation System Using IoT for Sustainable Agriculture" by A. N. Muazu et al. (2020): This paper proposed a solar-powered irrigation system using IoT, which is designed to improve crop yields and reduce water consumption. The system includes soil moisture sensors, weather sensors, a solar panel, a battery, and a microcontroller that uses the collected data to control the irrigation schedule. [2]

"Solar Powered Smart Irrigation System using IoT" by D. M. Verma et al. (2019): This paper presented a solar-powered irrigation system , which utilizes solar energy and IoT technology to optimize the irrigation process. The system includes soil moisturesensors, a water pump, and a microcontroller that can be controlled remotely using a mobile application. [4]

Overall, these papers demonstrate the potential of solarirrigation using IoT to improve the efficiency and effectiveness of irrigation, reduce water consumption, and improve crop yields, all while using renewable energy sources. However, there is still much research needed to optimize and refine these systems for different crops and growing conditions.

IV. PROPOSED METHODOLOGY

Design and Planning: The first step is to design andplan the solar irrigation system based on the irrigation requirements of the crops. This involves identifying the crop types, soil types, and weather conditions to determine the amount of water needed for irrigation.

Component Selection: The next step is to select theappropriate components for the solar irrigation system. This includes selecting the solar panels, battery, controller, and sensors based on the specific requirements of the system.

System Integration: Once the components have been selected, the system needs to be integrated. This includes installing the solar panels, batteries, and sensors, and connecting them to the controller.

IoT Integration: After the system has been integrated, it needs to be connected to the IoT network. This involves integrating IoT devices andsensors, such as soil moisture sensors and weather sensors, to collect and transmit data to the controller.

Data Analytics: The data that is collected from thevarious sensors is analyzed to determine the amount of water needed for irrigation. Thecontroller uses this data to determine the irrigationschedule and to control the water pump.

Monitoring and Maintenance: The solar irrigation system needs to be monitored regularly to ensure if it is working properly. This also requires checking the battery levels, solar panel efficiency,and sensor readings. Maintenance is required to replace any faulty components.[5]

Our process to develop the System consisted of the following steps:

Identify the Irrigation Requirements: The first step is toidentify the irrigation requirements of the crops, whichincludes determining the amount of water needed, the irrigation schedule, and the type of irrigation system required. However, conducting user research can present several challenges. Here are some of the problems and that we faced:

As researchers, we recognize that our own preconceptions and biases can potentially influencethe results of our research. To mitigate this, we employed an innovative approach in developing ourresearch questions. Furthermore, we also employeda diverse group of participants in our research to ensure that a variety of perspectives and experiences were included in our findings.

To address the potential limitations of our study's small sample size, we explored alternative research methods and conducted additional researchsessions. By expanding our research methods, we were able to obtain a more comprehensive understanding of the topic and draw more confident conclusions about our findings.[4]

Despite the increasing popularity of smart irrigationsystems, a significant proportion of people stillprefer to rely on traditional methods of solar irrigation. This preference for conventionalirrigation methods may be influenced by factors such as familiarity, ease of use, and perceived effectiveness..

Defining the System Features: We identified the features and functionality that the System should include. For example, features could include temperature reading, Humidity, Soil Moisture.

Solar Panel: The system is powered by a solarpanel, which provides a clean and renewable energysource(As shown in Figure 6).

Sensors: The system includes various sensors suchas soil moisture sensors, weather sensors, and waterflow sensors. These sensors collect data on the environment and crop conditions, which are used to optimize the irrigation schedule and conserve water..

Microcontroller: It is the brain of the system, whichreceives and processes data from the sensors and sends commands to the water pump or valve. It mayalso communicate with a remote control device or amobile application.

Water Pump/Valve: The water pump is controlled by the microcontroller and is used to deliver water to the crops according to the optimized schedule(Asshown in Figure 6).

Remote Control: The system may include a remotecontrol device, such as a mobile application, whichallows the user to monitor and control the system from a distance(As shown in Figure 4).

Energy Storage: The system may include a battery or other energy storage device, which allows the system to operate even when there is no sunlight available.

Automatic Shut-off: The system may include anautomatic shut-off feature, which turns off the pumpor valve when the soil moisture level reaches acertain threshold, preventing over-irrigation.

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Real-time Monitoring: The system may include a real-time monitoring feature, which provides theuser with up-to-date information on the status of the system, including soil moisture levels, water flow rates, and energy levels.

Designing the User Interface: Designing a system for solar irrigation using IoT involves combining different components and technologies to optimize water usage and crop productivity. Here is a high-level overview of the components and technologies involved in such a system.

Battery: A battery will be required to store the electricity generated by the solar panels for use during periods of low sunlight or at night.

IoT platform: An IoT platform will be used to collect and analyze data from the sensors, control the irrigation system, and provide real-time feedback to the farmer(As shown in Figure 4).

Control system: The control system will be responsible for turning the irrigation system on andoff based on the data received from the sensors andthe decisions made by the IoT platform(As shown in Figure 1).

Communication system: A communication system will be needed to connect the IoT platform to the sensors, the control system, and the farmer's mobiledevice.

Mobile app: A mobile application would be developed to allow the farmer to monitor the system, receive alerts, and control the irrigation system remotely(As shown in Figure 1).

Development of the System: We started writing the code to implement the features and functionality of the System. Developing a system for solar irrigation using IoT involves combining the use of solar energy and IoT technology to provide an efficient and sustainable method of irrigation for crops.[3] The system can be designed to automate the irrigation process by using sensors to detect soil moisture levels and transmit the data to a central control unit. Some of the problems thatwe faced during the System development process were:

Power Consumption: Since the system relies on solar power, there might be issues with power consumption. The system needs to be designed to ensure that it operates efficiently and conserves power.

Connectivity: The IoT devices used in the system need to be connected to the internet to function. The connectivity issues can arise, and it is essential to ensure that the devices remain connected to the internet.

Data management: The system needs to collect, analyze, and store data. The system should be designed to handle large amounts of data and manage it effectively.

Compatibility: The IoT devices used in the system need to be compatible with each other. It is important to ensure that the devices cancommunicate with each other seamlessly.

User Interface: The user interface of the system should be intuitive and user-friendly. Users should be able to operate the system easily and understandthe data presented to them.

Testing the app: We conducted thorough testing to identify and address any bugs or technical issues that could have come. We used a variety of testing methods, including Functional Testing, Connectivity Testing, and user acceptance testing (UAT). Here are some of the problems that we faced while testing our app:

Environmental factors: The solar irrigation system relies on the sun for power. Therefore, the weather conditions can affect the performance of the system. Testing the system during different weather conditions can help to identify potential issues.

Network issues: The IoT devices used in the systemneed to be connected to the internet to function. Network issues can arise, and it is essential to test the connectivity of the devices under different network conditions(As shown in Figure 3).

Data accuracy: The system collects data about the soil moisture, temperature, and other parameters. Testing the accuracy of the data collected by the system is essential to ensure that the system functions correctly.

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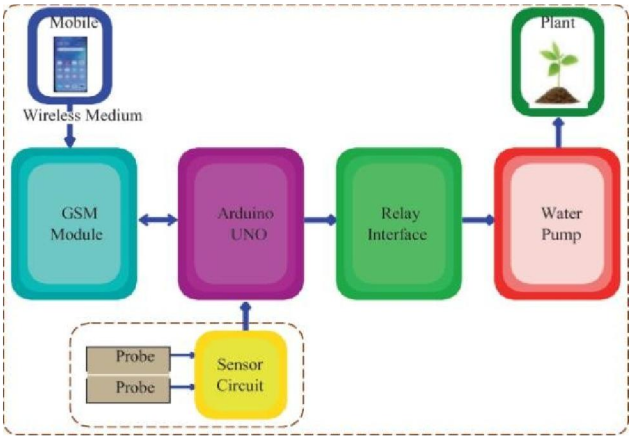

Fig 1. Proposed methodology

As illustrated on Figure 1, it shows the work breakdown structure for the development of the Solar Powered Smart Irrigation System. It consists of four main phases and its subactivities.

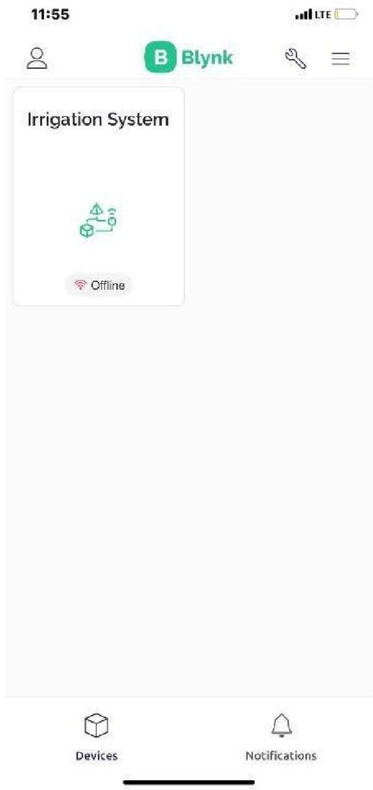

Fig 2. Login Page

The login page for the application, shown in Fig. 2, that's where user inputs and stores one's personal data.

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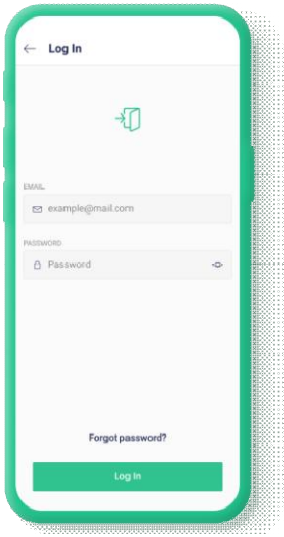

Fig 3. Device Connectivity Page

Fig. 3 depicts the device connected to the application andprepared to take action.

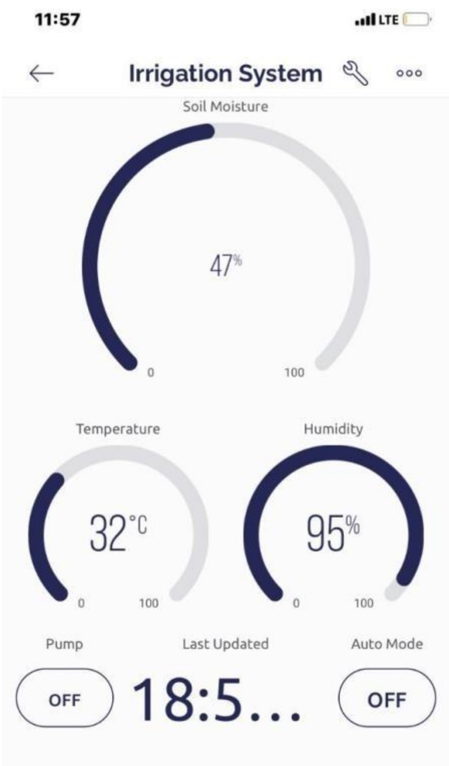

Figure 5. Auto mode

Fig 4 and 5 shows the interference of the application which is Mobile App made on Blynk IoT the product componentsare structured concerning triggers from the data and enacting pins for the yields and speaking with servers from cloudthrough the web. An important part with respect to the product is making a deferral for the water system siphon to be ON for arequired time.

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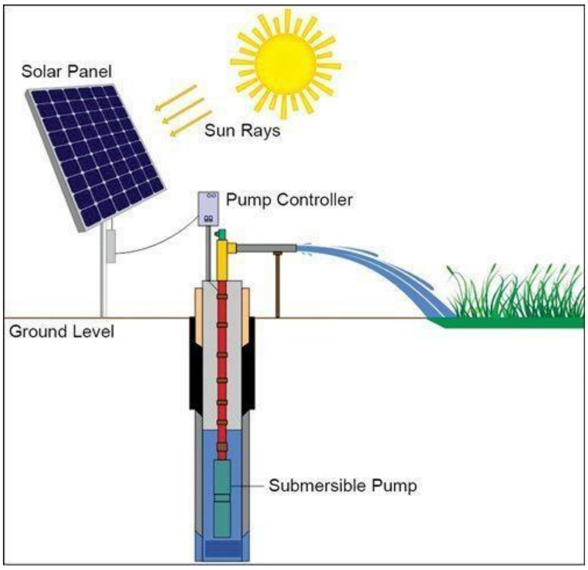

Figure 6. Working Of System

Fig. 6 represents the system's basic operation. Since these tiny modules will be placed in various locations across the agricultural field, the entire project will run on a separate power supply. The design is created in a way that it can be utilized for indoor precision agriculture and drip irrigation.

V. SCOPE OF THE PROJECT

The scope of a project on solar irrigation system IoT canbe quite broad, depending on the goals and objectives of the project. Here are some key areas that could be addressed in a project of this kind:

Design of the system: The first area of focus ina project on solar irrigation system IoT would be the design of the system itself. This would involve identifying the key components neededto create an effective solar-powered irrigation system, such as solar panels, pumps, sensors, controllers, and actuators. The project would need to specify the technical requirements for each of these components and select the most appropriate ones based on factors such as cost,efficiency, and reliability.[2]

Integration with IoT technology: The second area of focus would be the integration of the irrigation system with IoT technology. This would involve incorporating sensors and controllers into the system that could communicate with other devices over the internet. The project would need to specify the protocols and interfaces needed to enable this communication, as well as the data formats andsecurity measures required to ensure us theintegrity of the data.

Developments of the web applications: Thethird area of focus would be the development ofweb applications that could be used to monitorand control the irrigation system remotely. Thiswould involve designing user interfaces that are easy to use and intuitive, as well as developing backend systems that can handle the processingand storage of data generated by the system.[4]

Testing and validation: The fourth area of focuswould be testing and validation of the system toensure if it works as intended and meets the requirements specified to us . This would involve conducting a range of tests to assess theperformance of the system under different conditions and identifying any issues or bugs that need to be addressed.

Deployment and maintenance: The final area of focus would be the deployment and maintenance of the system once it is ready for use. This would involve installing the system on the target site and ensuring that it is operating correctly. Ongoing maintenance would be required to keep the system running smoothly and to address any issues that arise over time.

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Overall, a project on solar irrigation system IoT has the potential to address a range of challenges related to sustainable agriculture and water conservation. By leveraging the power of IoT technology and solar energy, it is possible to create a more efficient and sustainable irrigation system that can help farmers to increase crop yields and reduce water usage.[2] Integration of multiple sensors such as soil moisturesensor,temperaturesensor proximity sensor and microcontroller is established to increase performance and efficiency. The paper is focused on using renewableresources and introducing solutions.

FUTURE SCOPE

The future scope of a solar irrigation system IoT projectis quite promising. As technology continues to advance,