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Smart and Efficient Irrigation Management System

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Abstract:- The ongoing requirement to monitor over-irrigation is one of the many issues that farmers encounter in their regular farming tasks. The farmer needs frequent travel.The distance to their crops and irrigation pumps was several kilometers. Therefore, a farmer spends a significant amount of time and effort each day irrigating the field when this time may be better spent on other farms, such as animal husbandry, which requires much more constant monitoring and care.In this paper, a project is put out that involves developing a system to fully automate irrigation so that little to no human involvement is needed. The aim is to install a wireless sensor network in the field that will gather information about soil moisture and send instructions to activate the water pump if the level falls below a predetermined threshold.

Keywords:- Smart irrigation; solar power; moisture sensor; energy crisis.

I. INTRODUCTION

As we know that irrigation is a very important element of farming practice all over the world, now talking about India is anagriculture-based country nearly 70% of the people are dependent on agriculture, and about three fourth of the cultivated land is used for food production. India is the second largest producer of wheat and rice in the world such crops use a vast amount of water for irrigation in a particular soil type. Many times farmers must travel great distances to reach their field daily through dangerous paths, sometimes the weather condition is extremely odd and farmers still go just to ON the pump. In case of adverse weather conditions such as extreme heat which affects the field, In such cases, improper watering may destroy the crop which is a major loss to the farmer in the monsoon or winter season irrigating on consecutive days may not be necessary and the farmer just have to check the soil floor. Traveling to the field for inspection of the soil (moisture or floor) or just turning the pump ON consumes a lot of time for the farmer. To overcome these problems farmers used to learn new agriculture techniques. Larger crops field across the area are uneven, due to improper inspection and understanding of the water necessary for irrigation affects the crop yield with unequal production from different parts[10]. This paper aims to present a system that can relieve the farmer from continuous inspection of the field which reduces the human involvement in irrigation. This also helps the farmer by ensuring good quality crop yield. Precise sensing technology can be used to accurately monitor and manage water usage, helping to prevent wastage and conserve this precious resource. This can be particularly important in areas where water scarcity is a growing concern, such as India. Thus maintaining the proper amount of water level in the soil is the requirement to harvest a good crop. Rain plays a key role in deciding the future of these crops as well as the farmer’s every year. The overutilization of water in past years can be stopped by using rainwater also known as rainwater harvesting[11]. Many cases are heard by the farmers on the ground reporting that motors or pumps are theft, but if we apply some modern knowledge of sensors we can sense the motion across the system and the sensor activates a buzzer so that stealing can be avoided[8]. All these functions need fuel to operate such as petrol and diesel which causes a lot of pollution to our environment and also these resources are conventional/non-renewable, to overcome such problems we can use sunlight as the ultimate source of energy[9]. Through the proposed system the farmer will not have to worry about monitoring the field as irrigation happens automatically as and when required. To set up the network to do the job a wireless sensor network will be used. The communication is established by the system across the field and various nodes[1]. Solar energy is the main source of energy in this network and to prevent theft antitheft alarm was also set up across the system[9].

Here are some of the potential applications of the proposed solar-powered irrigation system:

- Minimizes water waste and improves plant growth and the circuit is designed to paint automatically therefore, there's no want for terribly much less human intervention.
- The equal system or in standard the identical idea may be used in conjunction with sensors of temperature (DHT11 or LM35), solar exposure, pH cost, and mineral content material of the soil within the discipline for example in fertilizer spraying for flora: using sensors which degree the range of different minerals within the soils will suggest that are poor inthesoilsuchasmagnesium.
- It can be implemented in the process of spraying pesticides.
- Remote farming areas: In remote areas where access to the farm is difficult or the farmer is unable to visit the farm frequently due to various reasons, the automatic irrigation system can be highly beneficial. The system can monitor the soil moisture levels and irrigate the crops accordingly, reducing the need for constant human intervention.[10]
- Water conservation: With the increasing demand for water resources and the need for sustainable farming practices, an automatic irrigation system can help in conserving water. The system can accurately measure the moisture levels in the soil and irrigate the crops accordingly, preventing the wastage of water.
- Improved crop yield: By providing the right amount of water to the crops at the right time, an automatic irrigation system can improve the quality and quantity of the crop yield. This can lead to higher profits for the farmer and contribute to food security.

II. LITERATURE SURVEYAND BACKGROUND STUDY

The use of solar-powered smart irrigation techniques is a viable solution for farmers in India, especially in the agricultural sector where electricity consumption is high. There are a large number of agricultural pump sets in India, and with the increasing demand for new connections, the energy crisis is a growing concern. The use of solar-powered irrigation systems can help address this issue, as they provide a reliable and sustainable source of energy for farmers. These systems use solar panels to capture energy from the sun, which is then used to power irrigation pumps and other agricultural equipment. With the help of this farmers reduce their reliance on grid electricity by using solar power, which can be costly and unreliable in some areas. In addition to being more sustainable and cost-effective, solar-powered irrigation systems also be more efficient than traditional systems. Smart irrigation techniques are incorporated into these systems, using sensors and other technology to monitor soil moisture levels and adjust irrigation accordingly. This help to optimize water usage, reduce waste and improve crop yields. Overall, the use of solar-powered smart irrigation techniques is an effective solution for farmers in India, helping to address the energy crisis and promote sustainable agriculture practices.[7]

The report describes an automatic irrigation system that utilizes a soil moisture sensor to monitor the water level in the root zone of plants. The sensor data is transmitted to a web application through a cellular internet interface, allowing farmers to remotely monitor the moisture level of their crops and program irrigation schedules[10]. The system is powered by a solar panel, making it energy autonomous and cost-effective[9].The automatic irrigation system allows farmers to remotely monitor and control the irrigation process without physically being present in the field. The system automatically turns off the motor when the water level reaches the required level, preventing the wastage of water.[3]

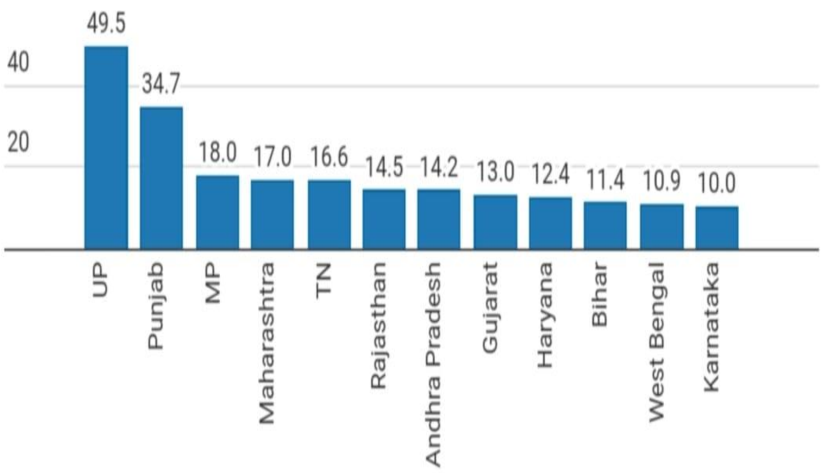

Fig. 1: Total water Used annually(Unit of water is billion cubic meters)[Image from livemint.com]

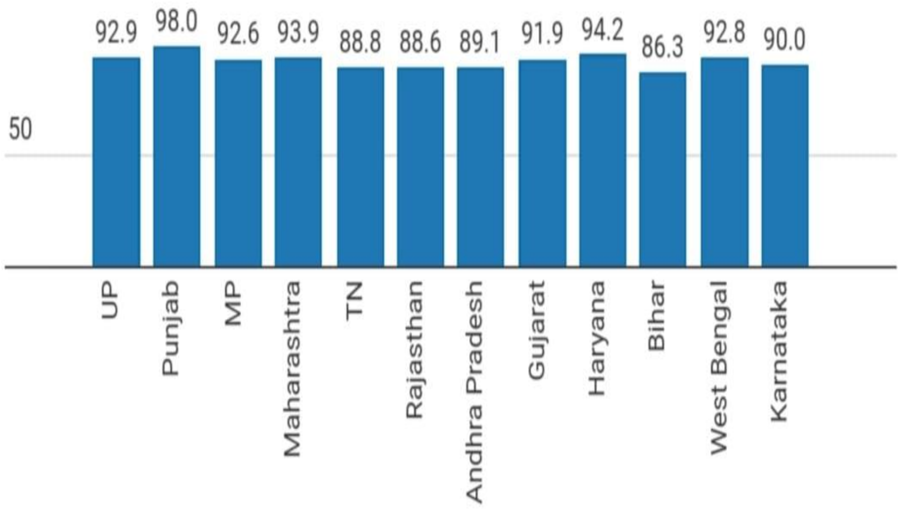

Fig. 2: Water used in irrigation in past years[Image from livemint.com]

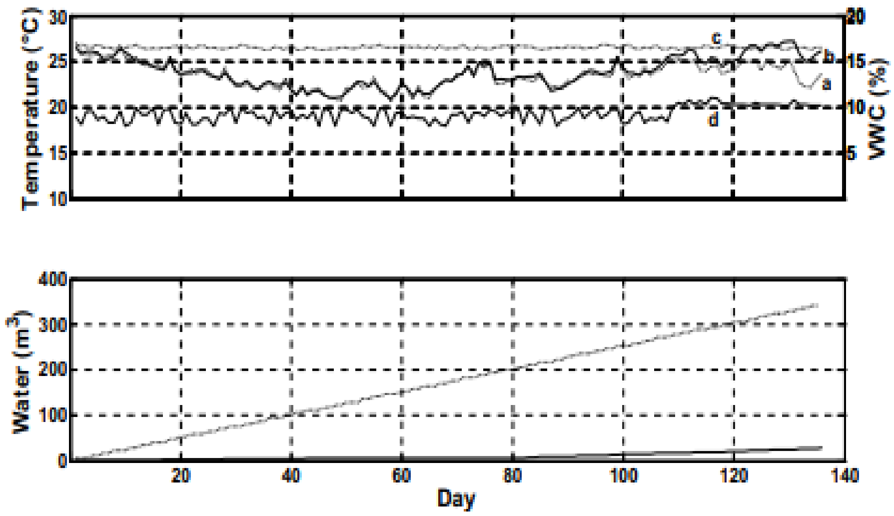

Fig. 3: Daily mean soil temperature (a: traditional; b: automated), daily mean soil moisture (c: traditional; d: automated), and accumulated water irrigation volumes (dotted line: traditional; solid line: automated) over the entire sage cropping season.[13]

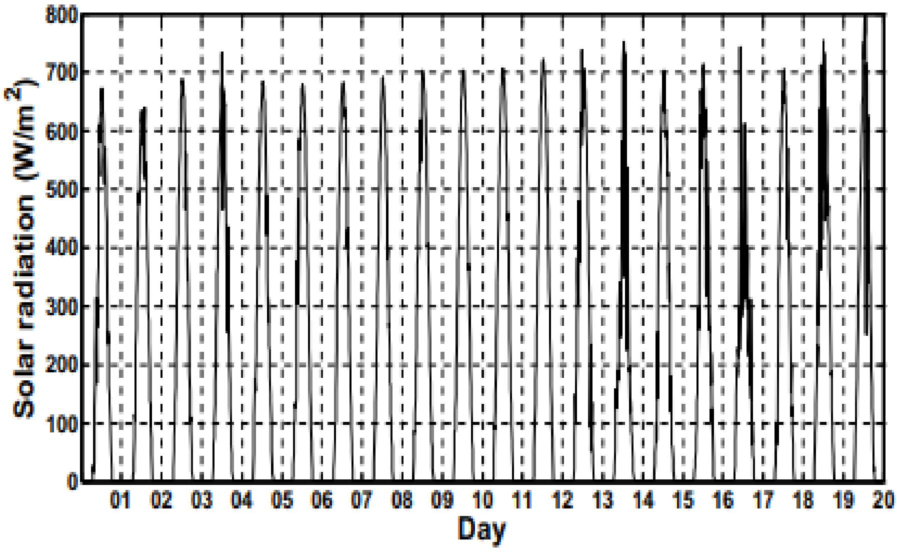

Fig. 4: Solar radiation along the experiment of the charge-discharge cycle of a wireless sensor unit (WSU).[13]

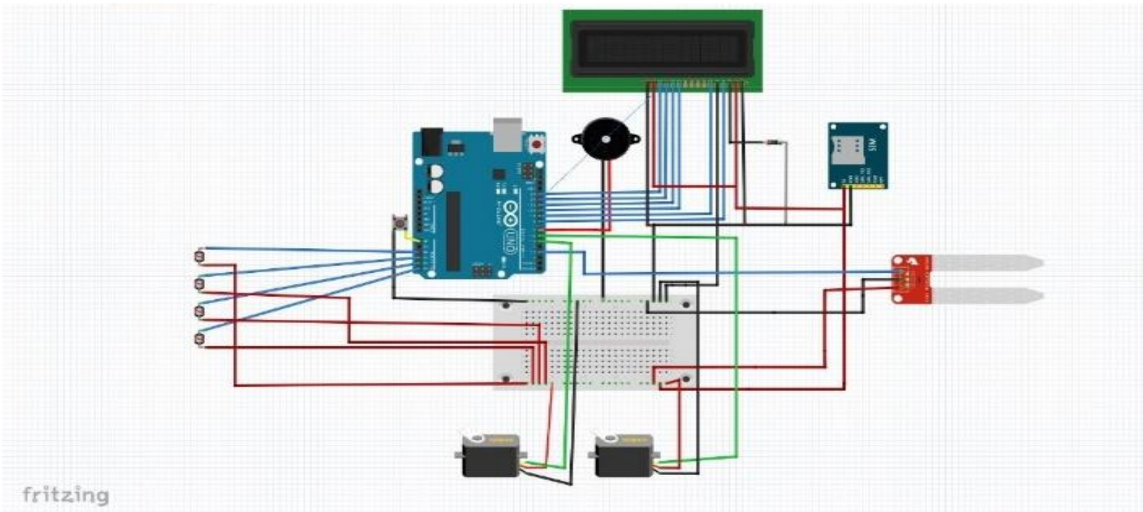

Fig. 5: Circuit Diagram of Complete System

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III. THE PROPOSED SOLUTION

In this proposed system we make use of solar strength from solar panels to routinely pump water from the bore nicely at once into a floor-degree ground tanker lying on the intensity of sunlight. This solar panel is a dual-axis solar tracking system which is the upgraded version of basic previous solar tracking systems. While conventional methods include pumping water from a bore well into a well and from this well onto the field using another pump, our system uses only a single-stage strength consumption in which the water is pumped into a ground-level tank from which an easy valve mechanism controls the waft of water into the field. This saves a substantial amount of energy and makes efficient use of renewable energy. A valve is controlled using an intelligent algorithm that regulates the flow of water into the field depending on the moisture requirement of the land. In this gadget, we use a soil moisture sensor that detects the amount of moisture gift in the soil and relying upon the requirement of level of moisture content required for the crop the water flow is regulated thus, conserving the water by avoiding the over-flooding of crops.

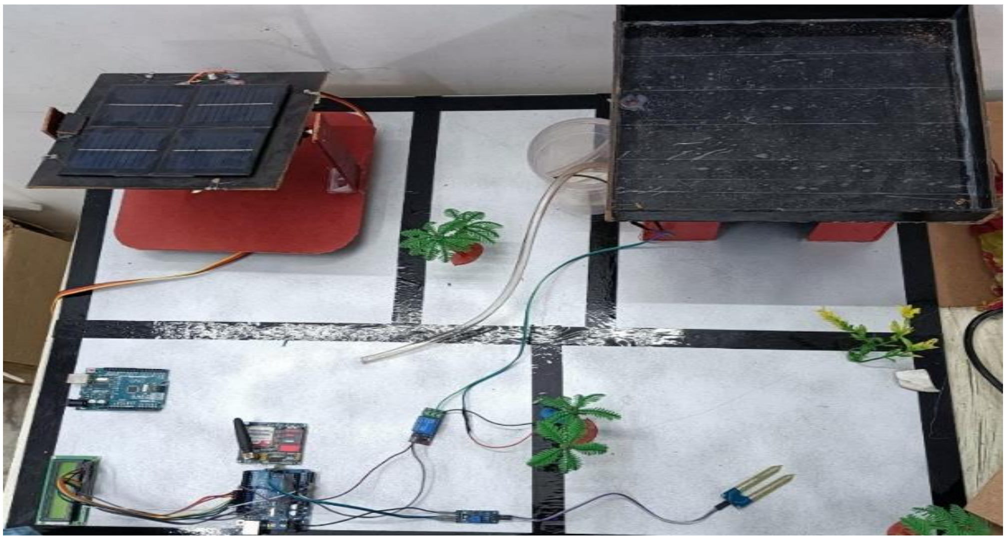

Fig. 6: Constructed Prototype

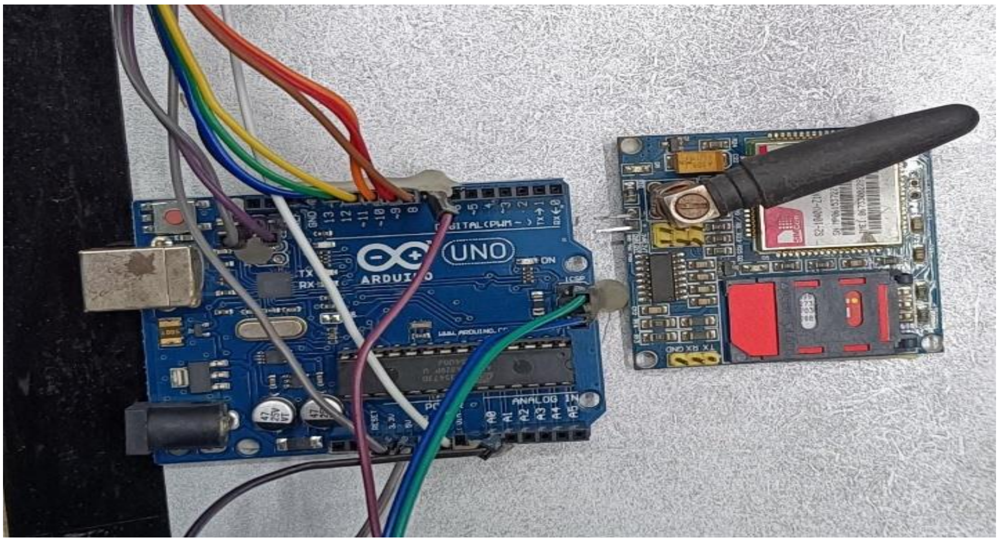

Fig. 7: Arduino Module and GSM 900 Module

- Here Arduino module helps in connecting all the pieces of equipment of the system with each other.
- GSM 900 module helps in communication for alerting the farmer about the moisture level, whether water pump is ON/OFF and also about the theft if happen to the water pump.

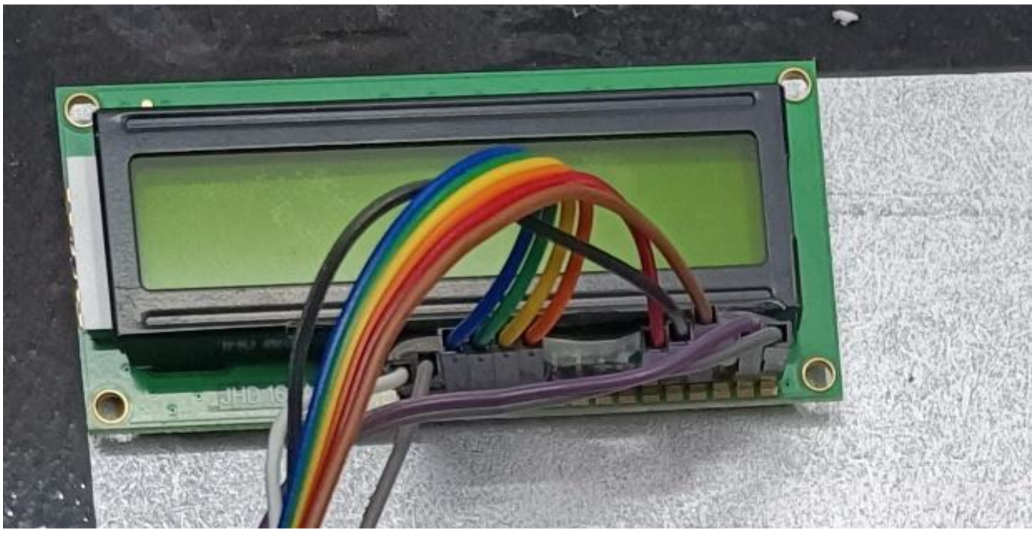

Fig. 8: LCD

- The LCD helps in displaying the details.

Fig. 9: Double-Axis Solar Tracking Panel

- This solar panel helps in receiving maximum sunlight from the sun as compared to the previous solar panels.This helps in increasing the production of solar energy.

Fig. 10: Micro Submersible water pump

- The water pump helps in providing the water requirement in the field.

Fig. 11: Soil Moisture Sensor

- The moisture sensor provides the moisture level of soil to the farmer.

Fig. 12: Piezo Electric Buzzer Alarm

- This 5v electric buzzer helps in alerting the farmer about the theft of a water pump from the field.

A. System description

The proposed irrigation device particularly includes module solar panel modules and an automated irrigation module. within the solar panel module, a solar panel of the desired specification is hooked up near the pump set.

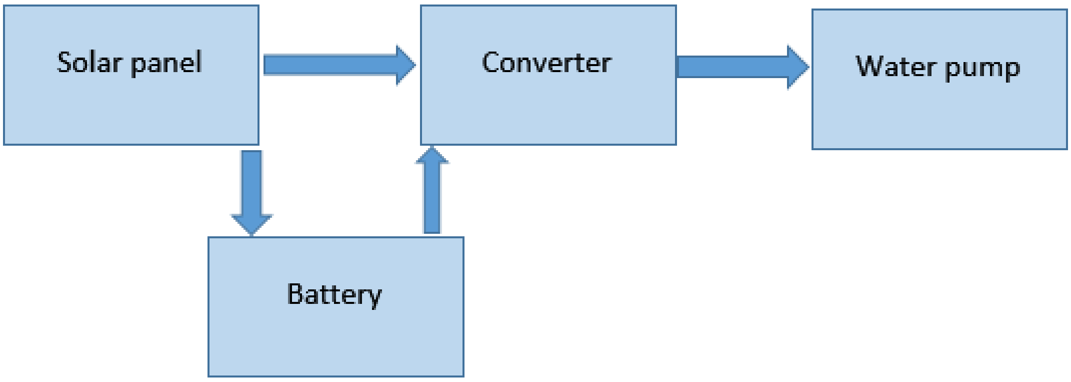

Fig. 13: Block diagram of solar pumping module.

B. Solar-Powered Smart Irrigation System

In this, the control circuit is used to charge a battery. The battery uses a converter circuit, it gives power to the water pump which is submerged inside the well. Then the water is pumped into an overhead tank for storing water quickly earlier than liberating the water into the sector. within the automated irrigation module, the water outlet valve of the tank is electronically managed with the aid of a soil moisture sensing circuit. The sensor is placed in the field where the crop is being cultivated. The sensor converts the moisture content in the soil into equivalent voltage. This is given to a sensing circuit that has a reference voltage that can be adjusted by the farmer for setting different moisture levels for different crops. The amount of water needed for soil is proportional to the difference between these two voltages. A control signal was given to a stepper motor whose rotational angle is proportional to the difference in voltage. The stepper motor in turn controls the cross-sectional area of the valve to be opened controlling the flow of water. Therefore the amount of water flow is proportional to the moisture difference.

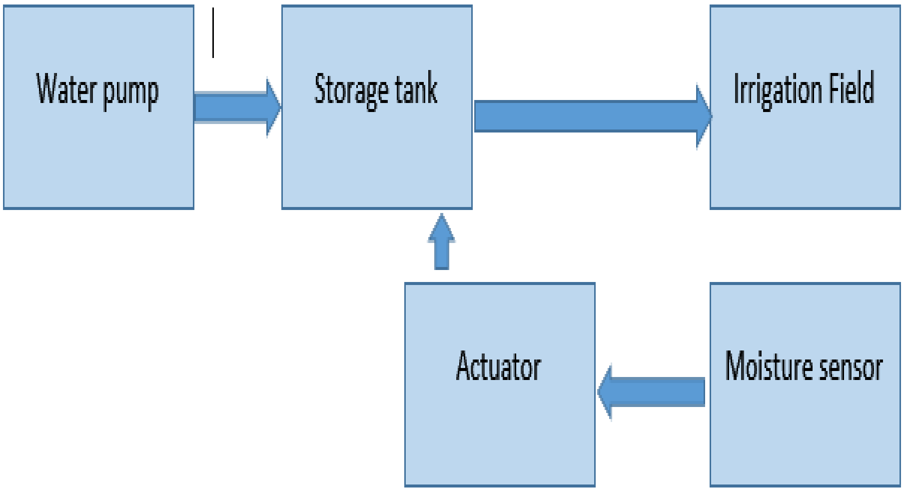

Fig. 14: Block diagram of automatic irrigation module

IV. METHODOLOGY

The proposed system is to setup a smart network over the entire field including the source of water and the pumping. The device will make sure of two conditions, while the moisture content of the sector is below a threshold it's going to command the motor pump to turn on the pump to water to that unique part of the sector. Second, when the desired moisture is reached, every other command could be sent to show off the pump and consequently slice the water source to the sector. The system will also be able to do this because of the following functionalities:

- In the beginning the water level values will be sent to the farmer with the help of the GSM module and after that, the irrigation process is started if the water level is below a threshold value.
- While the water is being supplied, the sensor node ofthat particular part of the area waits for a certain period of time, then maintains to test the moisture of the identical element again as a move-check earlier than shifting directly to the next.
- Whilst the desired level of moisture is finished by way of the field, every other message is sent to the sink node to prevent water delivery.
- In this manner, the entire field is swept once and thegoes to Sleep Mode, hence by doing this,power savingisalso achieved.
- There is a rainwater harvesting mechanism also there to preserve rainwater so that preserved water will be used later for irrigation purposes.
- There is also an anti-theft alarm for the protection of water pumps as in rural areas there are cases of theft of water pumps of farmers from their fields.

A. Components Used

Table 1: Components Used

COMPONENT	SPECIFICATIONS
Water Pump	9 V / 130 ~ 220mA
Arduino Uno Rev3	5 V / 16 MHz
Solar Panel	12 V / 1W
Servo MotorMG90S	5 V
Ultrasonic Sensor	5 V / 5.3 mA
Moisture Sensor	5 V
GSM 900	5 V / 890 - 915 MHz (UP) /935 - 960 MHz (Down)
Track Ball	5 V
Piezo Electric Buzzer	5 V /95 dB /3900±500Hz
LDR Sensor	5 V

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B. Software Used

- *Arduino IDE 2.0.4*

Fig. 15: Arduino code of moisture sensor, water pump, and electric buzzer

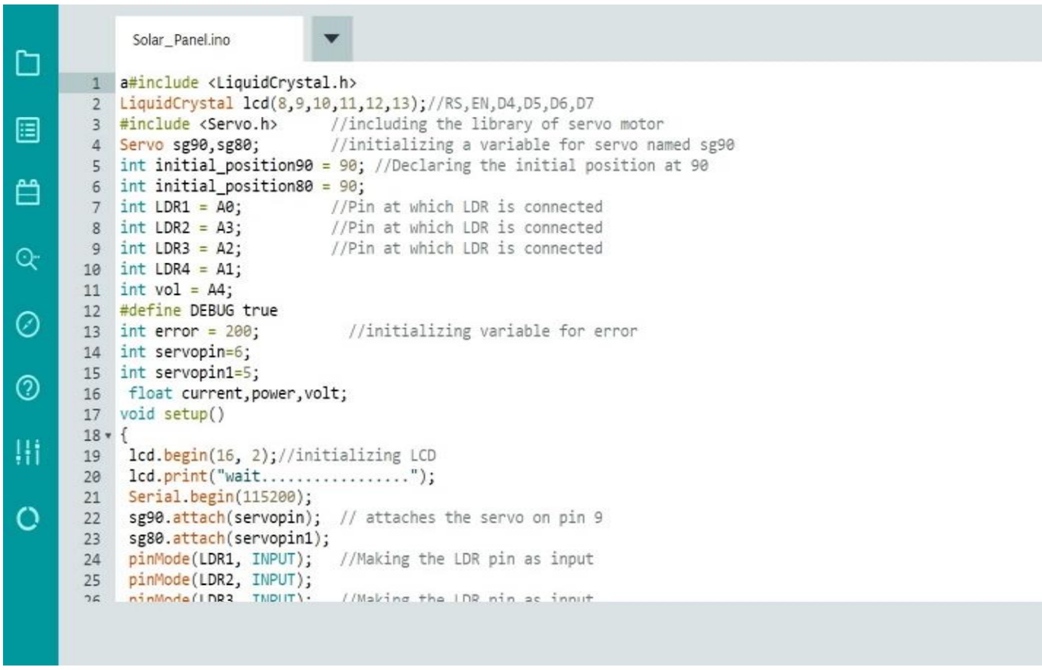

Fig. 16: Arduino Code of Solar panel using LDR sensor

V. RESULT

In this, we can see that the prototype of the irrigation management system function automatically without requiring much human intervention. The fact that the system starts functioning as soon as power is supplied, and each moisture sensor can measure the moisture level and sequentially send it to the GSM module is a positive development. It is also encouraging to note that the system can skip watering certain parts of the field if the moisture level is above the threshold. This means that water is being conserved, and wastage is minimized. The fact that the GSM module can switch to Deep-sleep mode after circuiting the entire field once, thereby conserving power, is also commendable. Overall, this is a promising development in the field of agriculture and could help improve crop yield and reduce water wastage. Optimizing water use minimizes stress on water sources, reduces the risk of water scarcity and promotes ecological balance. Additionally, the use of precise irrigation methods minimizes the runoff and release of fertilizers and chemicals into the environment, promoting sustainable and environmentally friendly agricultural practices.

VI. FUTURE WORK

In the future, the Automated Irrigation System Using Linear Programming with CCTV camera surveillance that will give real-time feedback control and protection to the cultivating field. This control system monitors the cultivation of the entire irrigation system and efficient water management at same timeproviding greater profit at a lower cost. Manpower and water may be saved by using this approach, and productivity and, eventually, profit can be increased. By adding further sensors and valves, this system can eventually feed agricultural chemicals such as sodium, ammonium, zinc, and calcium to the field in addition to fertilizers.

VII. CONCLUSION

In addition to the benefits mentioned, the application of automatic irrigation systems can also help to conserve water resources. This can prevent over-irrigation, which is a common problem in traditional irrigation methods, and ultimately conserve water resources. With reduced labor and time spent on irrigation, farmers can focus on other important aspects of farming, such as crop management, harvesting, and marketing. Previously on other projects the risk of theft of the water pump was very high and the amount of electricity produced by the solar panel is very low but in this project, both the problems are resolved as there is an anti-theft alarm on the water pump that will alert the farmer if any wrong happens and now come to the solar panel part in this project we used a double axis solar panel which rotates in that direction in which it gets maximum sunlight which increases the electricity production.

Overall, the application of automatic irrigation systems can significantly impact agriculture's sustainability and growth. It can reduce the reliance on manual labor, conserve water resources, cost-effective electricity usage, and improve the efficiency and productivity of farming operations.

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