Solar System Powered Iot Solution for Smart Irrigation

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Abstract—: **In this paper, the challenges in remote access to smart irrigation have been addressed. With the development of technology, in the last two decades, various smart irrigation systems (SIS) are developed that work with no or minimum human intervention. Through SIS is very promising, it does not get popularity due to given two challenges: - (1) As the smart irrigation system works in a remote location, providing power to it is very difficult. (2) Due to remote Installation of SIS, the farmer can't track its operation and remain ignorant of the condition of the farm. This paper addresses the listed challenges. The contributions of the paper are listed: (1) for remote power supply, solar panel based system is proposed. (2)For remote information transformation, an Internet of things (IoT) based solution is proposed. A prototype has been prepared to validate the proposed model.**

Keywords— Smart irrigation systems (SIS), Internet of things (IoT), Solar panel, Arduino mega 2560, Soil Moisture Sensor, GSM module, Solenoid Valve

I. INTRODUCTION

Though agriculture is an ancient profession, still it is the backbone of the economy of many developed and developing countries. With increasing population growth, the pressure on the agriculture sector is tremendous. An appropriate amount of water in right time is the key for the success of any crop. As the occurrence and amount of rain are random, artificial watering termed irrigation is essential. From ancient age, irrigation is done manually that demands the physical presence of a farmer with significant expertise. With the development of technology, in the last two decades, various smart irrigation systems (SIS) are developed that work with no or minimum human intervention. An SIS is driven by a central processor may be a microcontroller that collects real-time physical data using sensor and according to that instructs the course of action to the actuators. The concept of smart precision based agriculture using sensors was proposed by Lakshmi Sudha *et. al.* that focuses on developing devices and tools to manage, display and alert the users by leveraging wireless sensor network system [1]. Ramu *et. al.* had proposed a cost-effective solution for agricultural atomization using 8051 microcontrollers as a central processing unit [2]. A water saving technique is being proposed by Venkata *et. al.* that uses an 8051 microcontroller that drives the sprinkler with interrupt signal [3]. Nandurkar *et. al.* had proposed wireless sensor network technique to collect the real-time values of soil moisture and temperature from various location of farm [4]. Gayatri *et. al.* had introduced the IoT technique by using cloud computing and GPS location tracker in SIS [5]. Application of various sensors for collecting real-time information is discussed in [6-7]. In [8], a volumetric analysis of soil moisture is included in the decision-making process. GPS based remote controlled robot has been proposed in [9] for SIS. Through SIS is very promising, it does not get popularity due to given two challenges :-(1)As the smart irrigation system works in a remote location, providing power as it is very difficult. (2)Due to remote Installation of SIS, the farmer can't track its operation and remain ignorant of the condition of the farm. This paper address the listed challenges. The contributions of the paper are listed: (1) for remote power supply, solar panel based system is proposed. (2)For remote information transformation, an IoT based solution is proposed. A prototype has been prepared to validate the proposed model. The organization of the rest is as given: The conventional SIS system is described in section II, the proposed model is given in section III, the prototype of the proposed model is given in section IV and section V concludes the paper.

II. SMART IRRIGATION SYSTEM MODEL

The basic block diagram of a conventional SIS is shown in figure 1. It has mainly three subsystems: (1) Sensor subsystem, (2) Central processing subsystem, (3) Actuator subsystem. Sensor subsystem has soil moisture sensors that read the real-time data of water content in the soil. The data is in the form of analog voltage. The equivalent digital information is produced using an analog to digital converter which is sent to the central processing subsystem. The central processing subsystem is the heart of total system consists of a microcontroller which is a small computer on a single integrated chip. The processor checks the input condition provided by the sensor and generates an essential command for the actuator subsystem. Power is used to give the voltage supply to the microcontroller and clock is used to carry all the function that the microcontroller provides. The actuator subsystem has a device switching unit may be a relay that drives the solenoid valve and sprinkler.

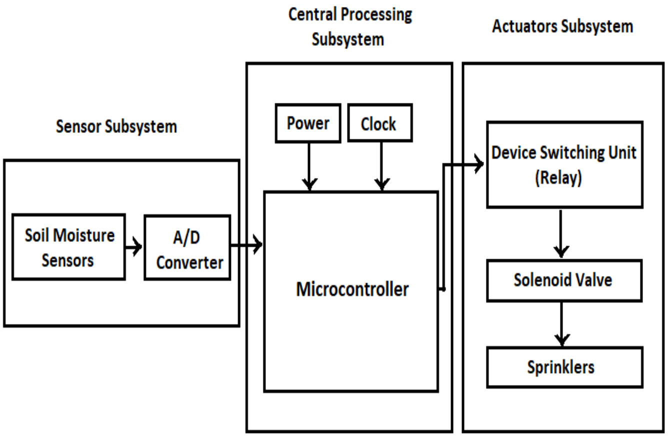

Figure:-1 Block diagram of an SIS system

III. PROPOESED MODEL

IV.

In the proposed model, two additional subsystems have been included with the existing subsystem: (A) Remote power supply subsystem, (B) IoT subsystem. Block diagram of a proposed model is given in figure 2. The central processing Subsystem in the proposed model is based on Arduino mega2560 board.

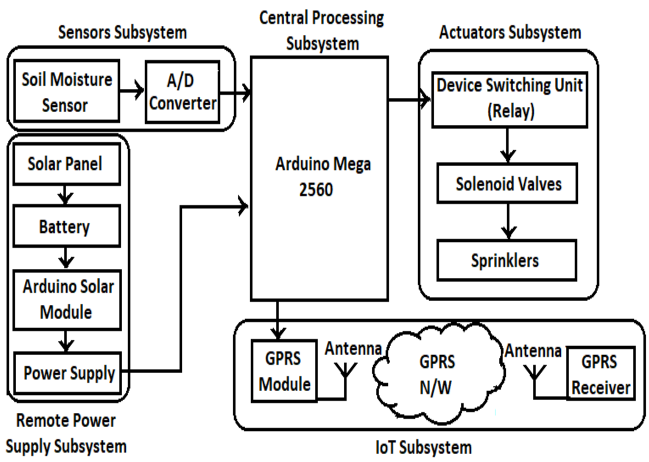

Figure:-2 Block diagram of a proposed model

(i) Remote power supply subsystem: For accessing power supply in a remote location, an array of solar cells to provide 3W power has been used that is connected to the input of the lithium battery charger (model number TP4056) and produced an output which is connected to the lithium battery (model number 18560). These solar cells produced only 3.7V dc voltage but in order to provide a 5V dc supply to the Arduino we use 5V step-up voltage booster to the battery which is also called Arduino-compatible solar module and the output of the Arduino solar module is connected to the power supply port of the Arduino.

(ii) IoT subsystem: In this subsystem, a GPRS module has been installed which is connected to the Arduino to deliver information regarding actuator operation to the farmer with GPRS receiver at distance location. The GPRS network acts as an interface between the GPRS module and GPRS receiver. Whenever the Arduino detects the value of water content in soil is less than the threshold value, GPRS module will transmit a message "motor ON" to the user end via GPRS network and the relay will switch the solenoid valves ON in order to provide the water to the sprinkler. As soon as the plant get enough of water, value of water content in soil will become equal to or greater than the threshold value, and GPRS module will transmit a message "motor OFF" to the user end via GPRS network and the relay will switch the solenoid valves OFF in order to stop the supply of water to the sprinkler. GPRS module is a combination of transmitting (Tx) and receive (Rx) subsystem, the Rx pin of Arduino is connected to the Tx pin of GPRS module and the Tx pin of Arduino is connected to the Rx pin of GSM module in order to transmit and receive the data or signal over GPRS network. GPRS module allows packet data transmission at the rates between 56 kbps to 114 kbps and it promises the continuous connection to GPRS network for GPRS module and GPRS receiver.

IV. PROTOTYPE OF PROPOSED MODEL

(A) Description of components: In the proposed model, various components are shown in figure 3 and listed below:

(i) The Arduino Mega 2560 (fig: 3.a) is a microcontroller board based on the ATmega2560 having 16 analog input pins and 54 digital input/output pins [10].

(ii) Soil moisture sensor YL-69 (fig: 3.b) is a capacitive sensor that measures the volumetric water content in the soil. Its operating voltage is 3.3V-5V that gives the analog value output which is converted to digital using analog to digital converter [11].

(iii) Solenoid valves (fig: 3.c) is an actuation valve to control the flow of liquids by an electric current through a solenoid.

(iv) Electromagnetic relay (fig: 3.d) that operates on the principle of electromagnetic attraction. This switch is basically generating a magnetic field for opening and closing the switch and for performing the mechanical operation.it operates on 5V.

(v) Sprinkler (fig: 3.e) is used to irrigate the farm similar to natural rainfall.

(vi) Solar panel (fig: 3.f) these panels are designed with solar cells composed of materials. The main function of Solar panels is to convert solar energy into DC electrical energy generally of 12V, but using DC-DC converter we can minimize it to 5V, the main function of this panel is to charge lithium batteries. A 3W solar panel supplying a voltage of 5 V to charge a 2,300 mAh Lithium battery [12].

(vii) GSM/ GPRS module (fig: 3.g) GSM module has been used to operate the whole system using the mobile phone by sending and receiving the message over the phone. SIM800 is a complete quad-band GPRS solution, quad-band

850/900/1800/1900MHz can be used to transmit SMS with low power consumption [13].

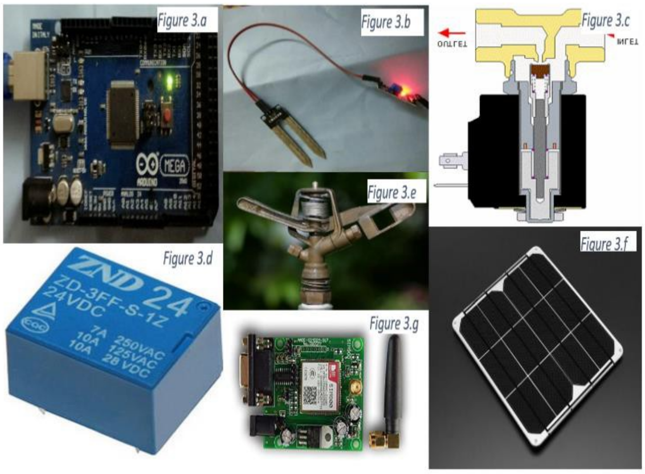

Figure 3: Various components used in prototyping (3.a: Arduino mega 2560; Figure 3.b: Soil moisture sensor; Figure 3.c: Solenoid valves; Figure 3.d: Electromagnetic relay; Figure 3.e: Sprinkler; Figure 3.f: Solar panel; Figure 3.g: GSM module)

Hardware and Software Description: The hardware connection is shown in figure 4. This Figure shows how the different sensors interface with Arduino mega 2560 board to make an entirely new system which solves the real-life problem. As these equipment need to be installed in the very moist environment, an IP68 box is being used as an external case which is a moisture and dust resistance box and also offer 30-meter deep protection .

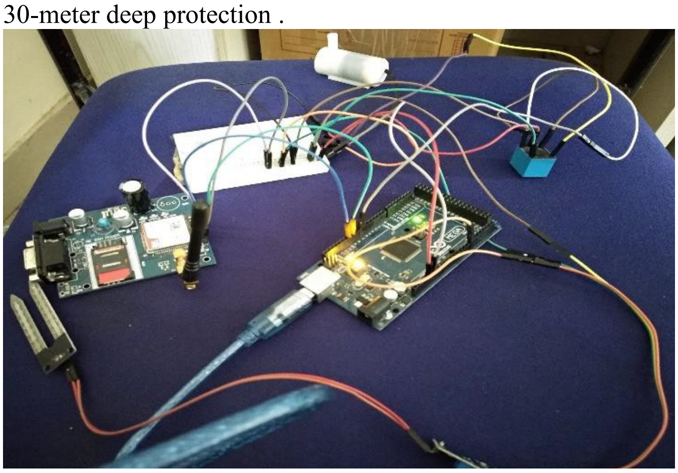

Figure-4: Circuit connection of proposed Model

The flowchart of the algorithm is given in figure-5. Soil moisture sensors located in various locations of the farm collects the real-time measurement of water content in soil and sends into the Arduino analog input pins. The onboard ATmega2560 microcontroller receives the digital version of the data. The ATmega2560 compares the data with a threshold that is a predefined set point depending on the crop condition and soil type. If the analog read is equal to or greater than the threshold value then the motor will OFF otherwise it will be ON. And if the analog read is less than the threshold value then the motor will ON otherwise it will be OFF. And in each case, the corresponding message will be sent to the user end via GPRS module continuously.

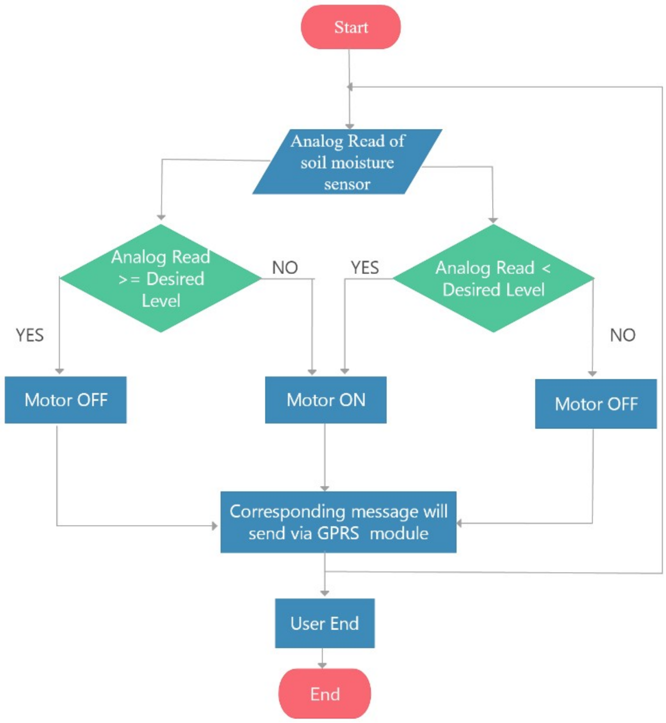

Figure 5. Algorithm of proposed model

V CALCULATION OF WATER SAVING

Using conventional method: - Water requirement for one kg of rice production in different states (in liters)

West Bengal	2605
Karnataka	2797
Assam	2783
Andhra Pradesh	3145
Bihar	3178
Uttar Pradesh	4564
Haryana	4232
Punjab	5337

2500 kg of paddy can be grown in 1 acre of land. Now, 1acre=4046.86m^2
For 400m^2 of area, total 250 kg of paddy can be produced Approximately, 70% of rice can be extract from produced paddy That means, total 175 kg of rice can be produced in 400 m^2 area.
And for Uttar Pradesh total water requirement for producing rice in 400m^2 area is = 798,700 liters.

And using smart irrigation system: Total water requirement is approximately 550,000 liters. So, the water saving is percentage is approximately 30%.

VI CONCLUSIONS

In this paper, the challenges in remote access of smart irrigation has been addressed by proposing a solar system powered IoT solution. In the proposed model, two additional subsystems are being added to the conventional SIS. The remote power supply subsystem is based on a solar panel that generates the required power of operation in the remote station. The IoT subsystem provides the elegance to the farmer to operate the remote station. The proposed model reduces human intervention by ensuring proper irrigation and minimization of water wastage.

REFERENCES

[1] K. Lakshmisudha, S. Hegde, N. Kale, S. Iyer, “Smart Precision Based Agriculture Using Sensors”, *International Journal of Computer Applications* (0975- 8887), Volume 146, No.11, pp.36-38, 2011.

[2] M. Ramu, CH. R. Prasad, "Cost effective atomization of Indian agricultural system using 8051 microcontroller", *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 2, no. 7, pp. 2563-2566, 2013.

[3] Naga RohitGunturi, “Micro Controller Based Automatic Plant Irrigation System”, *International Journal of Advancements in Research & Technology,* Volume 2, pp.1436-1439, Issue4, 2013.

[4] S. R. Nandurkar, V. R. Thool, R. C. Thool, “Design and Development of Precision Agriculture System Using Wireless Sensor Network”, *IEEE International Conference on Automation, Control, Energy and Systems* (ACES), 2014.

[5] M.K.Gayatri, J.Jayasakthi, G.S.Anandhamala, “Providing Smart Agriculture Solutions to Farmers for Better Yielding Using IoT”, *IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development*, 2015

[6] M. Dwarkani, R. Ram, S. Jagannathan, R. Priyatharshini, “Smart Farming System Using Sensors for Agricultural Task Automation”, *IEEE International Conference on Technological Innovations in ICT for Agriculture and Rural Development*, 2015.

[7] D. Chaware, A. Raut, M. Panse, A. Koparkar, "Sensor Based Automated Irrigation System", *International Journal of Engineering Research & Technology (IJERT),* vol. 4, no. 05, pp. 33-37, 2015.

[8] R. Jain, S. Kulkarni, A. Shaikh, A. Sood, "Automatic Irrigation System for Agriculture Field Using Wireless Sensor Network (WSN)", *International Research Journal of Engineering and Technology (IRJET)*, vol. 3, no. 04, pp. 1602-1605, 2016.

[9] N. Gondchawar, R.S.Kawitkar, “IoT Based Smart Agriculture”, *International Journal of Advanced Research in Computer and Communication Engineering*, Vol.5, Issue 6, pp.838-842, June 2016.

[10] https://www.robotshop.com/media/files/pdf/arduinomega2560datasheet.pdf

[11] https://randomnerdtutorials.com/guide-for-soil-moisture-sensor-yl-69-or-hl-69-with-the-arduino/

[12] https://www.hackster.io/igorF2/solar-charged-battery-powered-arduino-uno-645d89

[13] http://www.mtsystem.ru/sites/default/files/documents/sim800_hardware_design_v1.09.pdf