International Journal of Electronics Engineering (ISSN: 0973-7383
Volume 11 • Issue 2 pp. 378-385 June 2019-Dec 2019 www.csjournals.com

IOT Based Automatic Irrigation and Data Logging System Using Solar Energy

C. Ramcharan Reddy[1], D. Kiran kumar[2]
[1]Student,Dept. of Electronics and Communication Engineering
[2]Asst. Professor, Dept. of Electrical and Electronics Engineering
Jawaharlal Nehru Technological University, College of Engineering, Hyderabad.

Abstract: ***IoT (Internet of things) is a system of interconnected devices which have the ability to transfer data over a network without any need of human to human and human to machine interaction. It makes lives and processes efficient and more comfortable. IoT along with renewable energy are the future hope for sustainable development. Agriculture is the major source of food, the most important necessity of life, by making use of IoT technology we can make agricultural processes more efficient and productive. Health of and produce by a crop depends on various variables like water availability, temperature, humidity, sunlight, nutrients in the soil etc. By using various sensors and microcontrollers we can record and scrutinize these variables and based upon the recorded data we can act further to increase productivity. In the proposed system the watering of field can be automated based on the soil moisture sensor data collected and a message, EMAIL is sent to the farmer to inform on/off status of motor. The data from soil moisture, temperature and humidity sensors is logged and visualized using an IoT platform so that variables can be monitored remotely and also a LED light which mimics the sunlight in case of greenhouse farming is controlled based on the light intensity measured using photo resistor.***

Keywords:*Automatic Irrigation, Data analytics, Cloud computing, IoT,Wireless sensor networks.*

I.INTRODUCTION

India has 18% of world population but only 4% of worlds fresh water out of which 80% is used for agriculture.40% of agricultural water is from ground water and expected to become 50% in the near future[1]. Also there is increase in population and decrease in arable land and fresh water resources. These statistics reveal that there is a dire need to make agriculture more productive to meet the increasing demand with available water and land resources.

Traditional irrigation processes alone which uses rivers, canals and monsoon rains can’t be enough to feed the world. The monsoons have become less predictable and have been staying for lesser duration. Also dams have been constructed exhaustively across all major rivers and further constructions may damage the ecological balance worsening the situation, even using highly mechanized systems can only take us so far.Thus it is very important to use land and water resources smartly.

In this precarious situation we may have a solution in the form of IoT.By using IoT system various variables which effect the healthy crop production is monitored, the resources are used effectively using sensors and automating watering ofplants and few other actions.So, the plan is to design a system that has mechanism to monitor all the variables, record, process data and take action to control those variables based on the data.

Besides world is looking more and more towards renewable energy sources to combat climate change. Solar energy occupies the major share of renewable energy production. It can be contributing significantly to meet energy demands in especially tropical countries like India and many countries in Africa which receive high insolation[2]. Importantly individuals can produce solar energy off grid with limited setup and technical knowledge. Also we can use greenhouse farming to grow crops year-long despite unfavorable environmental conditions for a particular crop.

By using combination of IoT, solar energy and greenhouses we can

- Increase farm productivity
- reduce land and water requirements
- solve power problems in remote areas.

II. SYSTEM DESIGN

The system uses resistive soil moisture sensor, temperature & humidity sensor, photo sensor. The sensors monitor the respective variables continuously and these sensors are interfaced using wires with a microcontroller. The microcontroller after acquiring the data sends it toIoT platform using GPRS module which is interfaced to microcontroller. The sensor data is logged in the cloud databases and visualized suitably. Based

International Journal of Electronics Engineering (ISSN: 0973-7383
Volume 11 • Issue 2 pp. 378-385 June 2019-Dec 2019 www.csjournals.com

on the sensor data obtained the motor is turned on or off if soil moisture content is below or above the threshold respectively. Also led light intensity is varied based on the sensor values.

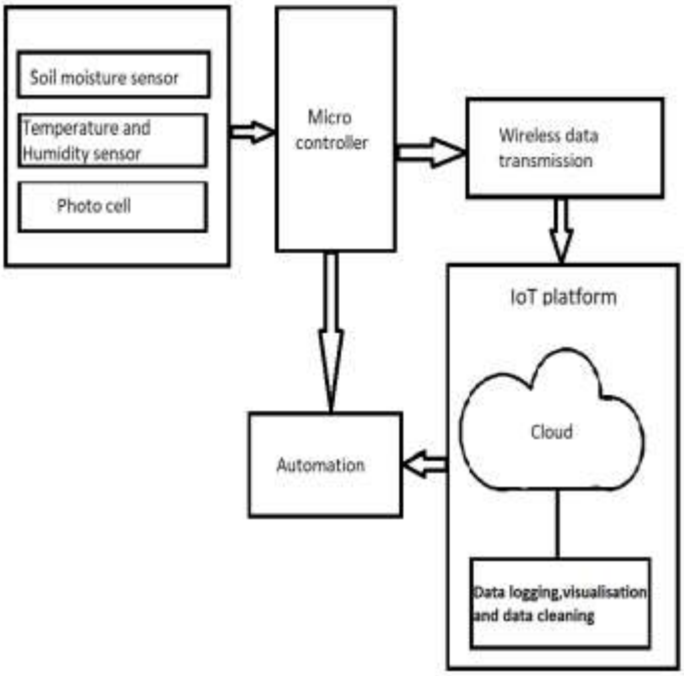

Figure 1. System design

A. Sensor data acquisition

Soil moisture:
A resistive soil moisture sensor is used in the system. It contains two probes inserted into the soil. How strongly soil resists the flow of electricity (soil resistivity) is used to determine soil moisture content. The probes are connected to LM393 comparator chip. It is interfaced to either Arduino digital or Analog pins based on the input we want from the sensor.

Figure 2. Soil moisture Sensor

Temperature and humidity:
A single sensor module DHT11 is used to measure both temperature and humidity. It also is interfaced to microcontroller. It too can output either analog or digital values. These values become important in case of greenhouse farming.

Figure 3. DHT11 Temperature and humidity Sensor

Light dependent resistor(LDR):
A light dependent resistor is used to detect the light intensity. The resistance changes based on the magnitude of intensity of light falling. It is connected to micro controller using wires.

Figure 4. Light Dependent Resistor

Photovoltaic system:
Solar energy is harnessed using solar panels to produce enough energy to meet the demands of all the components in the system. Lead-Acid battery is used to store the energy produced by solar panels and battery powers various components. Initially a standard voltage solar panel is taken and is regulated to supply power to the battery. From the battery, various components draw current from the battery. As various component need different voltages and currents we need to regulate the voltage using voltage regulators and capacitors appropriately. A switch is used to switch the battery from charging state to power draining state.

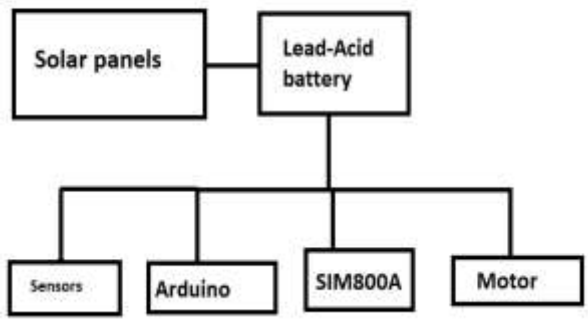

Figure 5.Solar power supply

Microcontroller:
Arduino development board is used which has an onboard ATmega microcontroller IC and varied number of analog and digital pins depending upon the variant. Arduino Uno is used in the system. Arduino IDE is used for programing and dumping the code into the microcontroller, it uses simplified version of C++ for programming. It has an onboard voltage regulator to provide constant 5volts supply to the board.
Code can be dumped into the microcontroller by connecting it to the computer using USB. Uno doesn't have the Ethernet capability but some other variants can connect to Ethernet. It can be connected to other modules to connect to the internet.

B. Wireless data transmission:

All the sensors are interfaced to the microcontroller using wires. The sensor data is initially stored in the variables defined in the microcontroller code and then sent to the database(cloud) provided by IoT platform thingspeak. Here GSM/GPRS (*Global System for Mobile Communications/*General Packet Radio Services) module SIM 800A is used for wireless data transmission. It is interfaced and interacts with Arduino using serial communication. It has IMEI (*International Mobile Equipment Identity*) number for its identification [3]. The modem uses AT commands for interfacing with microcontroller, which are communicated through serial communication. Different AT commands can be sent by microcontroller to interact with GSM and GPRS cellular network and connect to internet. In India SIM 800A supports quad band 900 MHz, it can transmit voice, SMS and data information with low power consumption. It has inbuilt TCP/IP protocol stack. It can use HTTP to send or access data from web. It provides idealized data rates at 56-114 KB/S. The sensor data is sent to cloud as HTTP client using SIM 800A connected to internet using cellular network.

Figure 6.SIM800A

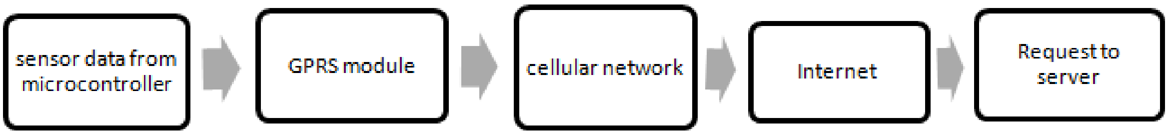

Figure 7. Wireless Data Transmission using GSM/GPRS modem

C. Data processing and decision making

The data after receiving is compared with threshold values, the threshold values fixed by considering environmental conditions and quantity of water utilized by the crop and conditions favorable for the growth of crop. The motor is turned on if the value provided by soil moisture sensor falls below threshold and turns off after soil moisture value exceeds the threshold, the intensity of light which simulates sun in case of greenhouses is varied periodically based on the light intensity [5].

The motor is connected to the microcontroller through a relay. The relay is controlled using control signals sent by microcontroller which again are based upon the sensor values. The motor is connected or disconnected from power supply based on control signals. The relay may also be used to connect the LED to power supply and also to the microcontroller. Automation is done at the microcontroller level and also by the IoT platform **i.e.** actuator control and sending notifications. Turning ON/OFF of motor and LED based on sensor values and sending the status of actuator.

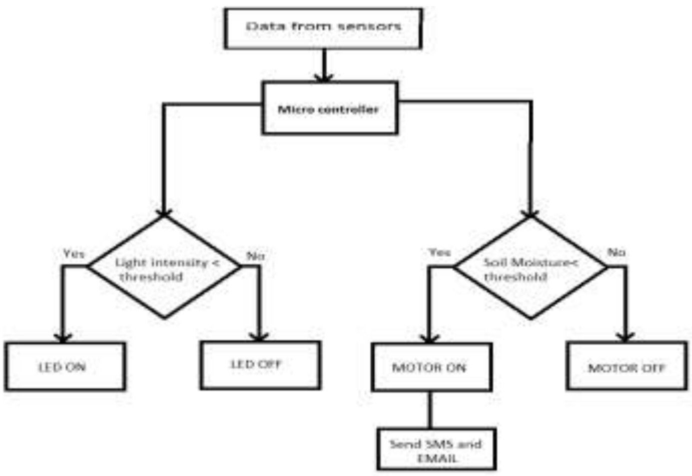

Figure 8. Flow diagram of automation

An NPN transistor is used in saturation region to switch motor on and off. The base of the motor is connected to digital control pin of Arduino and the collector to voltage supply and motor through a diode and collector connected to ground.

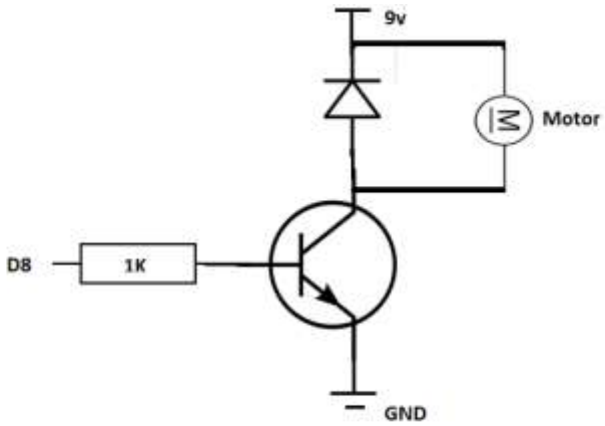

Fig.9. Motor switching circuit

by using MATLAB analysis tool we can trigger an IFTTT service whenever a value exceeds threshold or just to view the status of a variable and send an email or a mobile notification. The system sends an email every time soil moisture sensor values falls below threshold.

III.DATA LOGGING AND VISUALISATION

IoT platform Thingspeak is used for data logging and visualization. Thingspeak is an open IoT platform with MATLAB analytics. It is used to collect data and stored in cloud and data is visualized with MATLAB. It provides applications to trigger a reaction based on the data to send and visualize data we need to create what is called a channel and it has 8 fields to graph 8 different variables. It provides a write API key and read API key to send and receive data from the channel.

The data sent to various fields is represented in the form of graphs with time stamps on x-axis and the variable on y-axis. In addition to visualizing, data is stored in the form of CSV files. The sensor values are inputted into this files in the form of key value pairs and can be imported or exported and accessed from any other web applications or mobile applications. The data in the form of graphs can also be viewed on thingview mobile app.

Figure 10. Snapshot showing sensor values mapped against time. (higher value --> low soil moisture).

Figure 11.SMSand EMAIL sent usingGPRS module and IoTserver

IV. DATA CLEANING

From Fig10 we can see that the temperature and humidity sensor tend to send values that are not feasible practically in natural conditions which may be due to glitches in the sensor or connection problems.Also, data logged in the cloud can be too much for our analysis i.e. we may not need high precision. We should remove the outliers to make sure that the final conclusions aren't influenced by incorrect data. Data cleaning can be done by Matlab analysis application provided within the IoT platform or we can import the data from cloud in the form of CSV files and it can be analyzed and filtered using data analytics tools provided by programming languages like python,R etc. By using python tool 'Pandas' we can effectively filter the data[6], we can also plot the data using python tool MatplotLib[7].

Figure12. Cleaned data visualized using Thingspeak

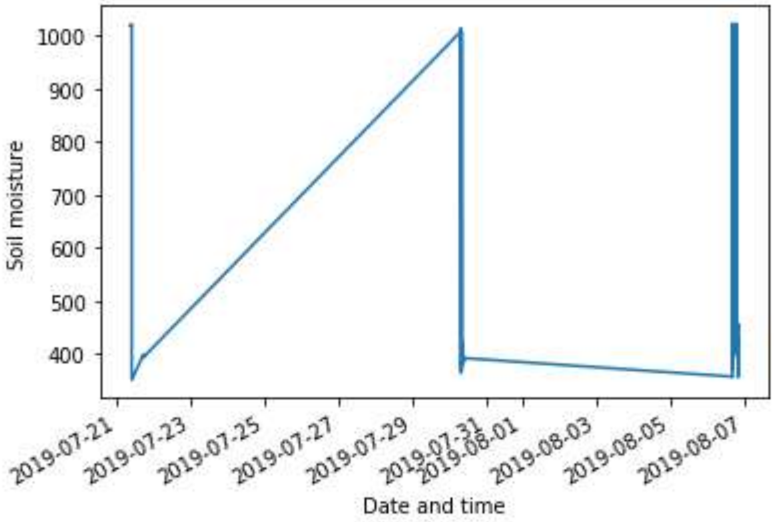

Figure 13.Cleaned soil moisture sensor data plotted using MatplotLib

V. RESULTS AND DISCUSSION

Under various condition like different temperature, pressure, soil-moisture and light conditions the system is tested, data is sent to cloud database and automation is done successfully.

Table I: Soil moisture sensor readings

Soil condition	sensor values	
	Minimum	Maximum
Dry	0	380
Humid	380	760
Water	760	1008

Table II: Photo cell readings

Light conditions	Photocell reading
Dark	0-12
Dim	129-246
Light	130-429
Bright	429-601
Very Bright	> 601

A. Power requirement

The Arduino uses 5 volts, around 40 mA current and consumes much less when in sleep mode. The GPRS module consumes peek current of 2 amperes and power requirements are very less and nominal. The motor runs on a voltage of 9 volts and when it is being run and it draws an average current of 200 mi amps the propose system can be run with a capacity of below 10 ampere-hour a day.

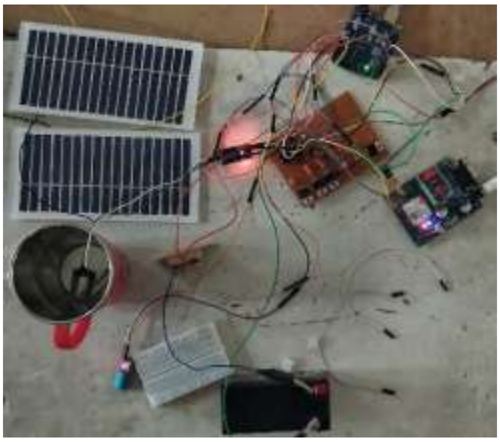

Figure 14. Practical setup

VI. CONCLUSION

The system is designed and implemented. It is effective, smart and beneficial in many ways. It uses renewable energy and can reduce the hassle of powering sensors in remote areas. The data is logged, cleaned and acted up on according to preferences. After data logging and cleaning is done the next step is to employ prediction algorithms to predict future water and power requirements[8]. We can also sense various other soil parameters like nitrite, phosphate content and use suitable fertilizes can use to make the system more efficient.

VII. REFERENCES:

[1].http://eands.dacnet.nic.in/PDF/Agricultural_Statistics_At_Glance-2015.pdf, Government of India Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare Directorate of Economics and Statistics.

[2].Kabir, Ehsanul& Kumar, Pawan& Kumar, Sandeep &Adelodun, Adedeji& Kim, Ki-Hyun. (2017). Solar energy: Potential and future prospects. Renewable and Sustainable Energy Reviews. 82. 10.1016/j.rser.2017.09.094.

[3].Joaquin Gutiérrez, Juan Francisco Villa-Medina,Alejandra Nieto-Garibay, and Miguel Ángel Porta-Gándara"Automated Irrigation System Using a WirelessSensor Network and GPRS module" , Ieee Transactions OnInstrumentation And Measurement, Vol. 63, No. 1, January,2014.

[4]. D. K. Fisher and H. A. Kebede, "A low-cost microcontroller-based system to monitor crop temperature and water status," *Comput. Electron. Agriculture.*, vol. 74, no. 1, pp.168–173, Oct. 2010.

[5].P.Rajalakshmi,Mrs.S.DeviMahalakshmi "IOT Based Crop-Field Monitoring And Irrigation Automation" 2016 10th International Conference on Intelligent Systems and Control (ISCO) 7-8 Jan. 2016.

[6]. https://realpython.com/python-data-cleaning-numpy-pandas/

[7]. https://heartbeat.fritz.ai/introduction-to-matplotlib-data-visualization-in-python-d9143287ae39

[8].Subhashree Ghosh ; SumaiyaSayyed ; KanchanWani ; MrunalMhatre ; Hyder Ali Hingoliwala"Smart irrigation: A smart drip irrigation system using cloud, android and data mining"2016 IEEE International Conference on Advances in Electronics, Communication and Computer Technology (ICAECCT).

[9]. The State of Food Insecurity in the World Meeting the 2015 international hunger targets: taking stock of unevenprogress food and agriculture organization of the united nations Rome, 2015.

[10].S. Harishankar1, R. Sathish Kumar2,SudharsanK. P, U. Vignesh and T.Viveknath,"Solar Powered Smart Irrigation System"Advance in Electronic and Electric Engineering. ISSN 2231-1297, Volume 4, Number 4 (2014), pp. 341-346.

[11]. B V Praveen Kumar, Y K Sundara Krishna, G K Mohan Devarakonda,"A Survey on Architectures of Internet of Things",International journal of electronics engineering,International Journal of Electronics Engineering (ISSN:0973-7383Volume 11 Issue 2 pp. 281-285 June 2019-Dec 2019.

[12].Karambir1, Kalyan Singh2, Sandeep kumar3,"Role of Solar Power Technology for Generation Electricity",Volume-9, Number-1 Jan -June 2017 pp. 225-230.