

# Irrigation Automation using IoT

[1]M.Chaitanya, [2]T,Thammi Reddy, [3]C.Rajeswari, [4] G.Haritha

[1] [3] Assistant Professor, Department of ECE, G.Pulla Reddy Engineering College(Autonomous), Kurnool, India,

[2] Associate Professor, Department of ECE, G.Pulla Reddy Engineering College(Autonomous), Kurnool, India,

[4] Assistant Professor, Department of EEE, G.Pulla Reddy Engineering College(Autonomous), Kurnool, India

[1]mulukutla.chaitanya@gmail.com,[2] thammireddy@gmail.com, [3] rajeswari.ch@gmail.com,

[4] gharitha804@gmail.com

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## Abstract

Cultivation is an integral part of millions of people's lives in an agrarian country like India. Employment in agriculture in India

was reported at 42.74 % in 2017 according to the World Bank estimate. Most of the irrigation is done using electric submersible pumps and traditional methods. The power cuts for irrigation is quite common in this land. Hence, farmers face many woes while working in their fields, especially during night hours, like electric shock, snake bites, extreme weather conditions. As many as 46,000 farmers die of snakebites in India alone every year, highest for any country in the world. Our current work finds cost-effective and an elegant prototype solution for smart irrigation anywhere, anytime basis, towards modernization of agriculture by using cloud computing based IoT scheme. A fully automated smart irrigation system is designed using Raspberry Pi platform and associated software and hardware from Xtrans Solutions. The remote unit is connected to moisture sensors, that uploads the sensed values to the cloud. Farmer can benefit from the unit through a smartphone with Android app. Irrigation happens in either of the two modes, viz. Manual mode and Remote Monitoring mode. In the former type, electric motor can be switched on/off via Android based RaspController App. In the latter case, the sensor determines the moisture level of the soil and turn motor on/off dynamically based on pre-set conditions. Python language is used for programming. In any of the cases, farmer is alerted through voice call, email and SMS about the status of the motor.

**Keywords:** Smart Irrigation, Raspberry Pi, Cloud, Moisture Sensor, Python.

## Article History

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## 1.INTRODUCTION

. Food items are the most essential needs of any human beings on the planet. Fortunately, India's strength for centuries is to harvest crops that are essential for human survival. The traditional farming knowledge is traditionally been transferred from generation to generation, mostly by illiterate farmers. Yet they did great job for feeding people. But, the population growth in the last 50 years made agriculture a really challenging. Farmers are facing tough times with the power cuts, odd timing, depreciating monsoon and underground water levels.

Handily, with the advent of suitable remote sensing and actuating coupled with IoT technologies, cloud services and popularization of smart phones, farmer gets some respite if not comfort. The level 3 IoT solution is proposed wherein the smartphone based monitoring and operating of remote pump-set as per the needs of the soil. The farmer will be relieved of laborious irrigation process with the automation of the same. The only requirement is that, there is a need of Internet at the farm and agriculture's mobile handset. The person is needed to know minimum hands-on working knowledge of modern mobile phone. The biggest advantage of the proposed system is, it works

on 24x7 basis. In the future, it shall be extended to level 4 or 5 where multiple things are incorporated those span the entire farm at suitable distances. It is also possible to take the weather forecasting into account as one of the decision making option, automatically, overriding the soil moisture levels. It can also be programmable to suggest irrigation intervals depending on the soil type, crop type, seasons etc. Machine to Machine(M2M) communication can be established to share the observations of each node with all other nodes in the soil. The proposed prototype transcends as low cost with low power consumption. The camera module can be added to view the crops remotely.

## II. BACK GROUND

R. Nageshwara Rao et.al, proposed a system for smart watering of crops. The farmers usually may not use the water optimally. Technologically, IoT based system that houses Raspberry Pi is utilized for smart water consumption. Two sensors were used and span of the sun light is measured on daily basis. The major advantage of the system is the precise calculation of amount of water needed for the crop. The cloud computing is utilized in precision farming[1]. Ge, Zhen Yang, et al, proposed a fuzzy control system to regulate the amount of water needed for a crop with the help of IoT things called moisture level sensors. The ATMELEL microcontroller was used for electromagnetic valve control. Simulink, MATLAB software were used for fuzzification algorithms. Its fully automated and closed loop control system[2]. Benyezza et al, have proposed a smart irrigation system. This system uses Arduino and ThinkSpeak platforms. Based on soil moisture sensor recommendations, the irrigation time is controlled. Its 24x7 basis and reduces the human effort[3]. Gupta et.al proposed smart irrigation system based on Wireless Sensor Network(WSN). The WAS used was squared one for prototype. NodeMCU was used for computations and controlling purpose. The humidity, temperature were the measured parameters. Wi-Fi network services were utilized for communication purpose[4]. Bhaktha et al, have reviewed the state of

the art precision agriculture papers published in the prominent journals. As per the results of the authors, many proposed solutions have revolutionized the agriculture done by the farmers after embracing the cutting edge technologies[5]. Dasgupta et al proposed a smart irrigation solution where dedicated microcontroller decided the needs of the irrigation based on sensing information from humidity, temperature, moisture level of the soil. The pollutants like PM2.5, PM10, CO, NOx are measured and standard recoded yield is compared against the actual one. The smart irrigation takes over based on the observations. This can be used for small as well as large estates. The plant growth is monitored for longitudinal and horizontal growths[6]. Pernapati et al proposed WSN based smart watering system wherein the amount of water used for the crop is saved considerably by electronic means. NodeMCU is employed as controller MQTT protocol was employed for telemetry purpose[7]. Nawandar et al, proposed a novel neural network based decision making system for irrigation purpose. The motto is to utilize the prime resources of water to the minimum. The parameters controlled are irrigation schedule, neural net decision making and remote data viewing. A prototype farm bed is laid. MQTT, HTTP protocols were employed for communication purpose[8]. Kamienski et al proposed a smart irrigation system based on integrating various IoT technologies. The pilot project was run in Brazil and Europe. The main purpose of the project, SWAMP, was three fold. To increase the yield of the crop, reduce the crop cost and finally efficient management of water resources. This project is a classic implementation of Precision Agriculture(PA)[9]. Lin et al propose a food safety traceability system based on IoT and blockchain technologies. This will ensure the safety of food right from seeding, breeding, cultivation, irrigation, harvesting, transporting to selling processes. Even it works in case the human beings in question are mistrusting among them, the technology ensures it.[10]

### III. WORKING PRINCIPLE

The motor can be controlled using an Android app called as Raspcntroller. The farmer can select the mode of irrigation. There are two modes :Manual mode & Remote monitoring mode. A button is added through GUI in Android app to select the mode of operation.

#### A. Manual Mode:

If manual mode is selected by the farmer through Android app button, then there would be another button directly interfaced to motor and the farmer can switch on and off the motor when ever required by pressing the button in Android app. This mode is especially beneficial to the farmers which save them from being physically present in the field during night hours or early in the mornings.

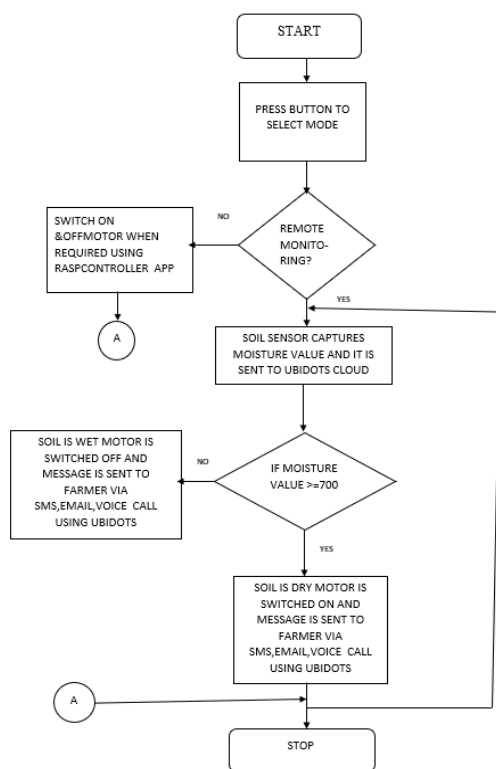


Figure1. Flowchart

#### B. Remote Monitoring Mode:

If Remote Monitoring mode is selected by the farmer through Android app button, then the soil moisture sensor captures the moisture value and the value is sent to the Ubidots cloud. An event is triggered in

Ubidots and if the value is greater than 700 mg/L the soil is dry and motor is switched ON. If the value is less than 700 mg/L the soil is wet and motor is switched OFF. Alert is sent to farmer via SMS, mail and voice call. The soil moisture senses the moisture value continuously and switches on or off the motor accordingly. The complete working style is shown in Fig1 in the form of flowhart.

### IV. HARDWARE DESCRIPTION

#### A. Raspberry Pi 3 - Model

The Raspberry Pi is a small single-board computer system developed in the UK by the Raspberry Pi Foundation. The Raspberry Pi 3 Model B+ is the latest series of Raspberry Pi 3 featuring a 64-bit quad middle processor running at 1.4 Ghz. It contains built-in WiFi and Bluetooth with improved dual-band 2.4 GHz and 5 GHz WiFi, Bluetooth 4.2/BLE and quicker Ethernet. The board is shown in Fig 2.

#### B. Soil moisture sensor

Soil moisture sensor includes two probes which can be inserted into the ground as shown in the Fig three. Soil moisture sensor is used to find the soil moisture content present in the ground. When current flows through the probes, if the ground has low moisture then the current won't pass throughout the ground which comes from the probes. When moisture content is higher than a level then the curent from the probes flows throughout the ground and this can be detected by the probes and this information will be sent to the ADC MCP3008. The output of ADC is used to control the stepper motor running according to the output of the ADC. Precision ground moisture sensor is chosen which is shown in figure 3 which consists of probes that are inserted in to ground. When the current flows through the probes, if the ground contains moisture then offers a less resistance and high current flows. That variable resistance is the parameter to detect the level of soil moisture.



Figure 2. Raspberry Pi three Microcontroller

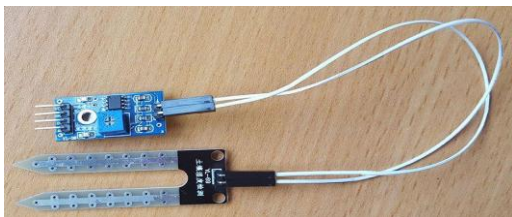


Figure 3. Soil Moisture Sensor

### C. Stepper Motor

A stepper motor is a synchronous electric motor which converts digital pulses into mechanical rotation of the shaft. Every revolution of the motor shaft is divided into a discrete range of steps, in most of the cases 200 steps, a separate pulse is sent to the motor for every step. The stepper motor takes one step at a time and each step is of the same size. As every pulse causes the motor to rotate a particular angle, typically  $1.8^\circ$ , position of the motor is controlled without any feedback mechanism. As the frequency of the digital pulses increases, the movement of the step appears as continuous rotation, with the velocity of rotation directly proportional to the frequency of the digital pulses. This motor has both commercial and business applications due to its less cost, excessive reliability, high torque at low speeds. It is a simple and robust product that can be operated in all most all types of environments.

### D. Software used

Python is the programming language that is used widely for Raspberry Pi computer system. The main

benefit is that programmer can write the code with less number of lines when compared to other programming languages. In spite of not being a web programming language, Python works like a PHP code and Fusion and Snug for server programming languages.



Figure 4. Stepper Motor

## V EXPERIMENTAL RESULTS

The proposed system is designed using 2-in-1 IoT Development Platform that includes both Raspberry Pi and Arduino. It is developed by M/S Xtrans Solutions. A sample of dry soil is taken and the soil moisture sensor is placed in the sample. The moisture sensor senses the value and sends the data to Ubidots cloud. Fig 5 shows the experimental setup.

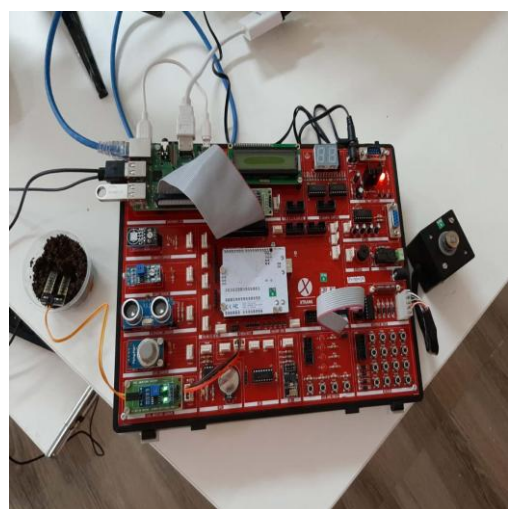


Figure 5. Experimental Setup

A device is created in Ubidots and two events are triggered. The first event checks if the moisture value

is greater than 700 mg/L sends an alert to the farmer via SMS, Email, Voice Call specifying that the soil is dry and motor is switched ON. Fig 6 and Fig 7 shows the event and the actions triggered if the soil is dry.

event and the actions triggered if the soil is dry. The screenshot of sample Email and SMS alerts sent to farmer are shown in Fig 10 and Fig 11 respectively.



Figure 6. Ubidots event for switching ON motor



Figure 8. Ubidots event for switching OFF motor



Figure 7. Ubidots actions done if event is triggered for switching ON motor

The second event checks if the moisture value is less than 700 mg/L sends an alert to the farmer via SMS, Email, Voice Call specifying that the soil is wet and motor is switched ON. Fig 8 and Fig 9 shows the



Figure 9. Ubidots actions done if event is triggered for switching OFF motor

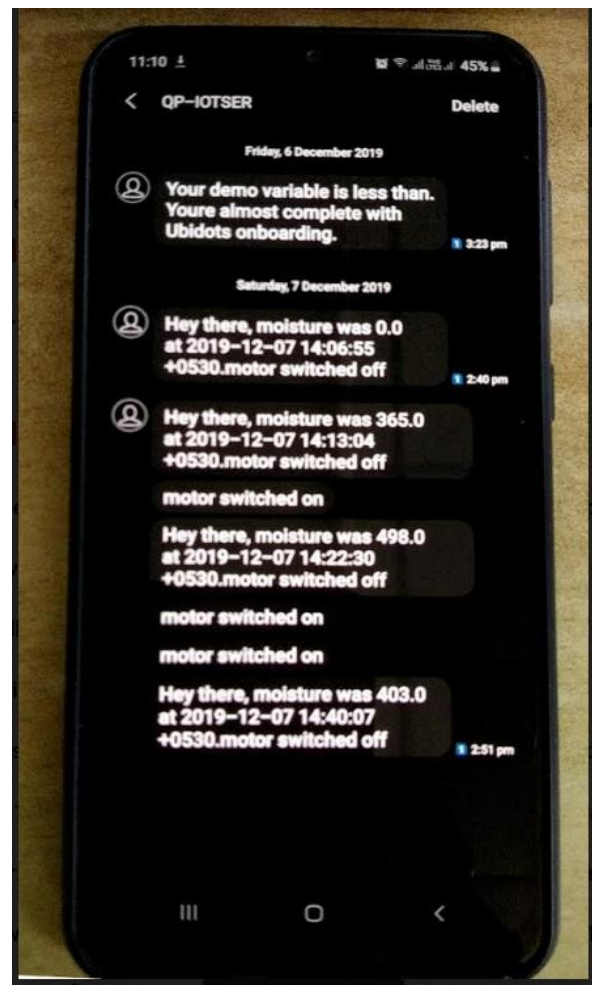


Figure 11 SMS notification from Ubidots

### Conclusion

Indian farmers have been feeding a whopping population of nearly 1.3 billion people every day with their traditional methods of irrigation. The current work provides a state-of-the-art, IoT-based, model solution for smart irrigation needs. Not only, it works out economical, but also suitable for 24x7 with a lot of convenience. Raspberry Pi platform coupled with sensor and actuator act as remote unit. And a smart phone with an Android App provides the flexibility with any of the cloud services. Python programming language provides the flexibility for pre-setting the desired moisture level. Cloud service is used to communicate the status with the end user.

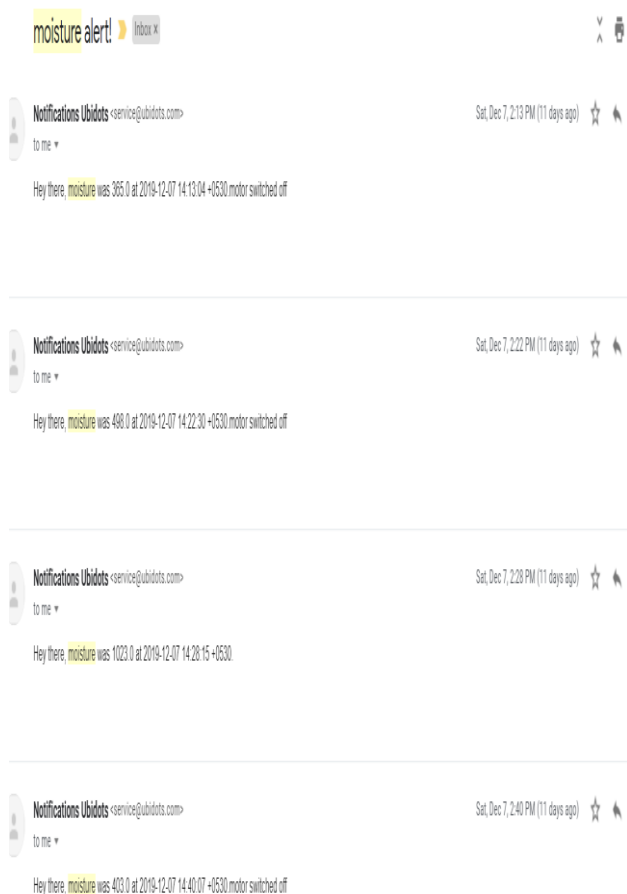


Figure 10 Email notification from Ubidots

**REFERENCES**

- [1].R. Nageswara Rao, B. Sridhar "IoT based smart crop-field monitoring and automation irrigation system" International conference on inventive systems and control,2018
- [2] Ge, Zhen Yang, et al. "An Automatic Plant Irrigation System Based on Fuzzy Control." Applied Mechanics and Materials, vol. 303–306, Trans Tech Publications, Ltd., Feb. 2013, pp. 1162–1166. Crossref, doi:10.4028/www.scientific.net/amm.303-306.1162
- [3] H. Benyezza, M. Bouhedda, K. Djellout and A. Saidi, "Smart Irrigation System Based ThingSpeak and Arduino," 2018 International Conference on Applied Smart Systems (ICASS), Medea, Algeria, 2018, pp. 1-4.doi: 10.1109/ICASS.2018.8651993
- [4] A. Gupta, H. P. Gupta, P. Kumari, R. Mishra, S. Saraswat and T. Dutta, "A Real-time Precision Agriculture Monitoring System using Mobile Sink in WSNs," 2018 IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS), Indore, India, 2018, pp. 1-5. doi: 10.1109/ANTS.2018.8710048
- [5] Bhakta, Ishita & Phadikar, Santanu & Majumder, Koushik. (2019). State of the Art Technologies in Precision Agriculture: A Systematic Review. Journal of the Science of Food and Agriculture. 99. 10.1002/jsfa.9693.
- [6] Dasgupta A., Daruka A., Pandey A., Bose A., Mukherjee S., Saha S. (2019) Smart Irrigation: IOT-Based Irrigation Monitoring System. In: Chakraborty M., Chakrabarti S., Balas V., Mandal J. (eds) Proceedings of International Ethical Hacking Conference 2018. Advances in Intelligent Systems and Computing, vol 811. Springer, Singapore
- [7] K. Pernapati, "IoT Based Low Cost Smart Irrigation System," 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT), Coimbatore, 2018, pp. 1312-1315.doi: 10.1109/ICICCT.2018.8473292
- [8] Nawandar, Neha K. and Vishal R. Satpute. "IoT based low cost and intelligent module for smart irrigation system." Computers and Electronics in Agriculture 162 (2019): 979-990.
- [9] Kamienski, C.; Soinenen, J.-P.; Taumberger, M.; Dantas, R.; Toscano, A.; Salmon Cinotti, T.; Filev Maia, R.; Torre Neto, A. Smart Water Management Platform: IoT-Based Precision Irrigation for Agriculture. Sensors 2019, 19, 276.
- [10] Lin, Jun & Shen, Zhiqi & Zhang, Anting & Chai, Yueting. (2018). Blockchain and IoT based Food Traceability for Smart Agriculture. 1-6. 10.1145/3265689.3265692

**AUTHORS PROFILE**

M.Chaitanya is Assistant Professor at G. Pulla Reddy Engineering College (Autonomous), Kurnool, AP, India. She has studied her M.Tech from GPREC, Kurnool in VLSI & Embedded Systems. She has worked as Software Engineer in Robert Bosch for 3 years. Her current research interests include Hardware Trojans, Wearable Devices and Embedded Systems.



T. Thammi Reddy is Associate Professor at G. Pulla Reddy Engineering College (Autonomous), Kurnool, AP, India. He is research scholar at JNTUH, Hyderabad, India. He has studied his M.Tech from IIT-BHU, Varanasi in Microelectronics. He has worked as VLSI Engineer for over 5 years. He is IEEE member since 2013. His current research interests include FPGA architectures, Low power VLSI and Embedded Systems.



C. Rajeswari graduated from Sri Venkateshwara University, Tirupati, AP, India, in June 2004. She received M.Tech degree in communications and signal processing from the Sri krishnadevaraya University, Anantapur, AP, India, in 2011. She is a faculty member with the rank of Assistant Professor in Electronics and communication Engineering Department at G.Pulla Reddy Engineering(Autonomous), AP, Kurnool. Her research interests include wireless communication systems and networks and Internet of things.



G. Haritha graduated from JNTUA, Anantapuramu in the year 2009. She received M.Tech degree from JNTUA, Anantapuramu in the year 2013. She is presently working as Assistant professor in the Electrical and Electronics Engineering Department at G. Pulla Reddy Engineering College, Kurnool, and Andhra Pradesh, India. Her interest area on research area includes power electronics and Electric drives, IoT.