Proceedings of the 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT 2018)
IEEE Xplore Compliant - Part Number: CFP18BAC-ART; ISBN:978-1-5386-1974-2

IoT based low cost smart irrigation system

Kiranmai Pernapati
Department of Electronics and Communications Engineering
National Institute of Technology Warangal,India
Email:kiranmai.pernapati@gmail.com

***Abstract*—One of the essential and basic services to survive on earth is Water. Recent time increasing the scarcity of water due to growing in population. So this is becoming as a universal obstacle. The old irrigation system which demands a lot of water, so it needs smart techniques for reducing the percentage of wasting available water for the irrigation. We have been seeing the increasing of huge demand for Internet of things in every domain from small and simple applications to large and complex applications. Practically implementation of a Smart Irrigation is very complex deal, but association with IoT using Smart wireless sensors it brings a great management system. The Humidity and Temperature Sensor sense the both water vapor content and temperature around the plant. The Soil Moisture Sensor sense the soil moisture of a plant, if water content is below minimum requirement then water will supply from water reservoir using relay and Ultrasonic sensor measures the water level of reservoir after that sends the data to ESP8266 NodeMCU. ESP8266 NodeMCU is a Microcontroller gets the data from smart wireless sensors, process the data and send to destination through A Message Queue Telemetry Transport (MQTT)protocol.**

***Index Terms*—Smart Irrigation , Internet of Things, water, Soil Moisture Sensor, Ultrasonic sensor, Humidity and Temperature Sensor**

I. INTRODUCTION

Only 0.01 % water is available on the earth surface, of overall exists of water. So water is a rare resource. And irrigation system also facing problem with water scarcity. Therefore it necessity to have a smart irrigation system where the water is precisely using.

The requirement of water in irrigation system is very crucial, so the new irrigation methods should implement in such a manner that requires less water consumption when compare to old technologies. Smart irrigation means not only consuming less water it also provide water supply depending on requirement. In this manner increases the efficiency of agriculture and possibility to reduce the risks. This system monitors the whether conditions, soil conditions of plant and water level in reservoir remotely using wireless sensors. The smart irrigation techniques can able to control the water waste up to 95% whereas the traditional methods results around 20% to 70%.

The main imperfection of normal irrigation system is wasting the water during filling in a reservoir and one more reason is over watering to plant. It is the main scenario where shortage of the water will arrives. The important factor in a smart irrigation system is monitoring soil moisture of plant. Depends on this one can assure that whether the plant is having sufficient water for its growth or not. Without sufficient water the growth of a plant is unattainable. Smartness in system means it should monitor the condition of plant continuously for excellent result. A wireless Soil Moisture Sensor helps out to measure the soil moisture content of a plan monotonously. And the system directs the irrigation system in such a way that it gets required quantity of water needs to be supply using relay. The water will release from reservoir whenever plant requires. The Ultrasonic sensor is useful to measure the level of water in a reservoir and also gives information about the quantity of water present in reservoir. The Humidity and Temperature Sensor senses both the humidity and under what temperature conditions the plant is growing. And these sensors are available in markets with very less prize, anyone can purchase to develop a smart irrigation.

The association of irrigation with IoT possible to get best results from the irrigation using innovative techniques. It has a potential to estimate the strong contents of smart irrigation like sensing water levels in reservoir, supplying water whenever required and finally analysis the amount of water consuming per day. In this proposed system MQTT protocol used for end to end communication.

II. SYSTEM OVERVIEW

This prototype designed for continuously monitoring the whether conditions,water level in reservoir, soil moisture and then supplying water depends on the requirement. So overal system act as a feedback system by taking input from the Soil Moisture Sensor and assert the water pump.The block diagram of a smart irrigation system depicted in the below diagram. The main central part is ESP8266 NodeMCU Microcontroller. In this system we can predefine the range of values for both soil moisture and for water level. During monitoring both will vary with respect to soil type and amount of water in reservoir.

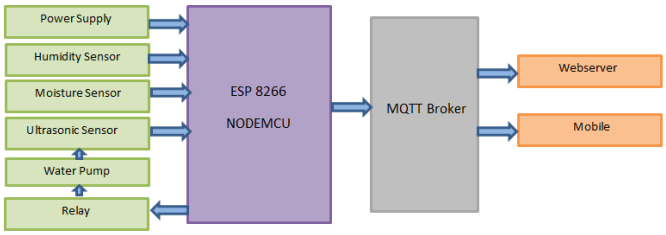

Fig. 1. PROPOSED SYSTEM ARCHITECTURE

The Humidity and Temperature Sensor measures the amount of water in the surroundings of a plant along with temperature. The Soil Moisture Sensor placed in the soil of a plant, it tracks plant continuously and the moment when it found insufficient water in soil with respect to a predefined value, water motor will ON to pump water from reservoir up to a time limit and also it can gives the notification to web servers and mobile through IoT protocol. Similarly the Ultrasonic sensor placed to the top of a reservoir. The Ultrasonic sensor measures the level of water from top side and gives the percentage of water in reservoir. If available water level in reservoir is below with respect to a predefined value then the notifications will send to web servers and mobile through IoT protocol. So that we can supply the water when plant needs and controlling the wasting of water from the reservoir. This kind of approach results a good outcome for irrigation system.

III. Proposed Methodology

The Soil Moisture Sensor, Humidity and Temperature Sensor and Ultrasonic sensor connected to ESP8266 NodeMCU Microcontroller, then sensors sends the data from their respective positions to ESP8266 NodeMCU. The received analog data can be processed by controller and then send to end users like web server, mobile via MQTT server.

The Soil Moisture Sensor, Humidity and Temperature Sensor and Ultrasonic sensor are connected as inputs to Microcontroller. The water pump connected via Relay. The measured temperature and humidity values send to end user. The moisture sensor sense the water quantity in soil and water pump will supply whenever quantity of water in soil reduced. For better understanding at end user the notifications can be sending like " Water deficiency in the soil ON water pump ", " Water efficiency in the soil OFF water pump ". The water level in a reservoir continuously survey by sensor and alert the customer with notifications like height of water level from the top view, current percentage of water present in the reservoir at that moment . Along with these numerical values it can also sends the notifications like " the water reservoir is almost empty " and " the water reservoir is almost full ". By these notifications wherever or whatever may be the end subscriber will alert and takes actions according to.

IV. HARDWARE COMPONENTS

1) ESP8266 NodeMCU
An ESP8266EX Wi-Fi module is a self-contained TCP/IP protocol that can able to access the any kind of Wi-Fi network. ESP8266 NodeMCU WiFi Module is an extremely cost effective, power management, requires minimal external circuitry, powerful enough in terms of storing capability and on-board processing. It allows integration of different sensors through GPIO pins with minimal run time. It is integrated with on chip self-calibrated RF allowing to work under any operating conditions.

A. Features :

a) It supports WLAN 802.11 b/g/n and antenna diversity.
b) It is integrated with a low power 32-bit Microcontroller unit.
c) It is integrated with a 10 bit Analog to Digital Converter.
d) It is integrated with network protocols named TCP/IP protocol stack.
e) It is Integrated LNA, TR switch, matching network and power amplifier.
f) It is Integrated PLL, regulators, and power management units.
g) To support WLAN here it use Wi-Fi technology (uses the 2.4 GHz spectrum) and also it supports WPA/WPA2.
h) Supports networking operation modes like STA/AP/STA+AP.
i) Support the Smart Link Function for Android as well as iOS devices.
j) Supports connectivity like SDIO 2.0, GPIO (H) SPI, UART, I2C , IR Remote Control, PWM and I2S.
k) Also supports two types of frame aggregation A-MPDU and A-MSDU, having guard interval as 0.4s.
l) Deep sleep power $<$ 10uA, Power down leakage current $<$ 5uA.
m) The Wake up and the transmit packets $<$ 2ms.
n) Standby power consumption is less than 1.0mW (DTIM3).
o) 802.11b mode the output power is +20 dBm.
p) To support working of this module the temperature is ranges from -40C to 125C.
q) Certified from FCC, CE, TELEC, WiFi Alliance and SRRC.

Fig. 2. ESP8266 NODEMCU WIFI Module

2) Soil Moisture Sensor
The soil moisture sensor is used to detect the quantity of water in a soil. The dielectric permittivity of water tells the ability of water to pass the electricity through it. Basically it is having two electrodes and generating the electromagnetic field line across this sensors and effected area by this waves is around 2cm. The sensor generates the voltage proportional to dielectric

permittivity. Means it is able to configure the dielectric permittivity of the soil. So overall it measures the resistance of soil. If higher the resistance lower will be the moisture content of that particular soil.

Fig. 3. Soil Moisture Sensor

3) Ultrasonic Sensor
An ultrasonic Sensor sends the ultrasonic waves into the air and whenever it find a object in its path of direction then the waves reflected back. Using the time difference between transmitted and reflected waves it calculates the distance of object from sensor. An ultrasonic sensor is a typical multiple vibrators and is fixed to the base. This is a composite of resonator and vibrator. The vibrator is again aggregate of piezoelectric ceramic sheet and metal sheet. The shape of resonator is in conical in order to send the waves conveniently from sensor to go out through the central part of the vibrator.

Fig. 4. Ultrasonic Sensor

4) Humidity and Temperature Sensor
The Humidity and Temperature Sensor measures the amount of water vapour and temperature in the surrounding air of plant.

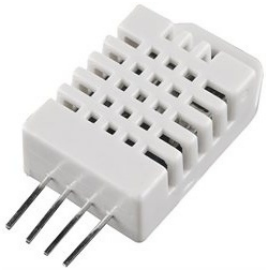

Fig. 5. Humidity and Temperature Sensor

5) Relay
The relay couples the microcontroller and water motor. It controls the water supply to plant. Depends on the condition of plant relay can ON and OFF the water supply.

Fig. 6. Relay

6) Water Pump
The water pump is controlled by relay and connected to the reservoir where water stores for irrigation purpose.

V. HARDWARE DESIGN

In this model the demonstration is about finding the water quantity in soil, supplying water whenever required for plant and measuring water level of a reservoir.

The Soil Moisture Sensor which interfaced with microcontroller gets the values from the soil where it placed. The Soil Moisture Sensor is a analog one so these values converted into digital from by inbuilt ADC of ESP8266 NodeMCU. The digital form range is 0-1023 and this digital form represents the resistance of soil. For dry soil resistance is high and wet soil has lower resistance respectively. The analog pin A0 of ESP8266 NodeMCU read the analog values form the sensors, so it connected to soil moisture sensor for reading the analog values of resistance. Similarly Ground and supply voltage pins of sensor connect to Ground and 3.3V supply of ESP8266 NodeMCU respectively.

Likewise the Humidity and Temperature Sensor have 4 pins. The 1st pin is connected to 3.3V supply, 2nd pin data pin connected to D2 and last pin connected to ground.

The Ultrasonic sensor placed on the top of reservoir and monitors the level of water. These modules have 4 pins. The Ground and Vcc pins connected to Ground and 3.3v of ESP8266 respectively. And remaining pins connected as trig pin to D3 and echo pin to D4 of ESP8266.

And the Relay have 3 pins. Relay -ve pin connect to GND of MCU, +ve pin connect to 3.3v of MCU and Input pin to MCU D6 pin.

VI. RESULT PART

Figure 3 and Figure 4 are shows the result part of the system. In these figures soil moisture value , Humidity and Temperature Sensor values and water pump status is shown.

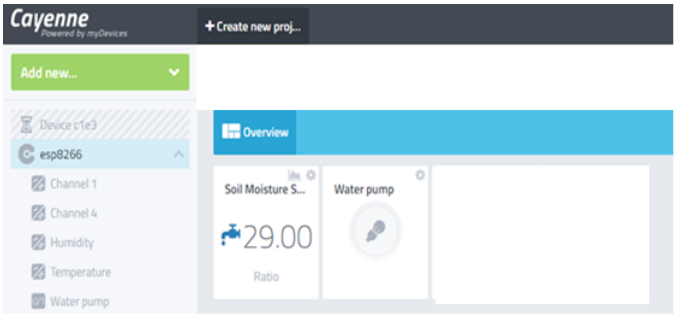

Fig. 7. Result part is display on Cayenne

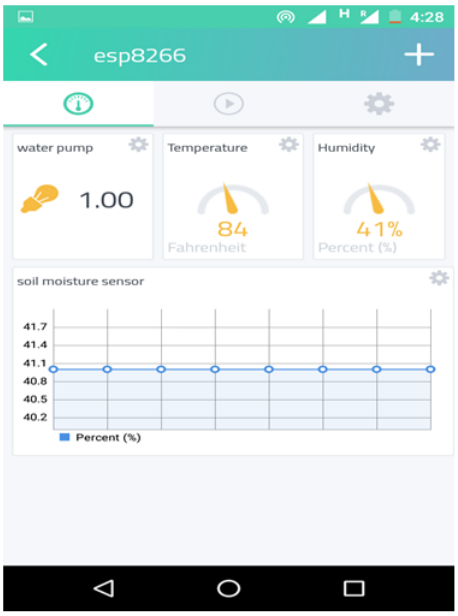

Fig. 8. Result part is display on Cayenne (mobile application)

VII. MQTT PROTOCOL

MQTT stands for Message Queue Telemetry Transport. And it is a publish/subscribe, designed for unreliable networks. In MQTT structure the sensors connected to a server called broker, information will forward from broker to all subscribed clients.

VIII. ADVANTAGES OF THIS SYSTEM

Day by day everywhere increasing the scarcity of water. The utilization of water must be in a proper manner, especially in the field of irrigation. Smart irrigation techniques cooperate to reducing water waste during filling in a reservoir by sending the alerts to user through smart wireless networks and controlling the water pumping to plants by continuously watching the conditions of plant, more over it acts as a feedback system. With these advantages this project can be implement so that it minimizing the manpower, saving the time and also reducing the cost as well as complexities.

IX. CONCLUSION

In normal irrigation systems the formers controlling the irrigating land manually. These techniques take longer duration and wasting the available water in higher rates so it leads to usage of water more than what required. For a plant to survive healthily it needs water continuously, the automatic system helps to get absolute results for this. For implementing this kind of irrigation system in agriculture gives more comfort to farmers in terms of time saving and accurate usage of water without wasting. And moreover the required power for operating the ESP8266 NodeMCU Microcontroller chip and wireless sensors is very less as well as all these feautres avilable at a very low cost.

REFERENCES

[1] Fan TongKe, "Smart Agriculture Based on Cloud Computing and IOT", Journal of Convergence Information Technology, vol. 8, no. 2, pp. 1, Jan 2013.

[2] W. A. Jury, H. J. Vaux, "The emerging global water crisis: Managing scarcity and conflict between water users", Adv. Agronomy, vol. 95, pp. 1-76, Sep. 2007.

[3] H.N. kamalaskar, P.H. zope, International journal of engineering sciences and research technology(UESRT) survey of smart irrigation system, pp. 2277-9655.

[4] Ravi Kishore Kodali,Vishal Jain,Susmit Karagwal, "IoT based smart greenhouse", 2016 IEEE Region 10 Humanitarian Technology Coference(R10-HTC), pp.1-6, April 2016.

[5] Joaqun Gutirrez, Juan Francisco Villa-Medina, Alejandra Nieto-Garibay, Miguel ngel Porta-Gndara, "Automated Irrigation System Using a Wireless Sensor Network and GPRS module", IEEE Transactions On Instrumentation And Measurement, vol. 63, no. 1, January 2014.

[6] Stefanos A. Nikolidakis, Dionisis Kandris, D. Dimitrios, Douligeris A Vergadoschristos, "Energy Efficient Automated Control Of Irrigation In Agriculture By Using Wireless Sensor Networks Computers And Electronics In Agriculture" in , Elsevier B.V, pp. 0168-1699, 2015.

[7] Venkata Naga, Rohit Gunturi, "Micro Controller Based Automatic Plant Irrigation System", International Journal of Advancements in Research and Technology, vol. 2, no. 4, April 2013.

[8] Muzammil Hussain; S. P. Gawate; P. S. Prasad; P. A. Kamble," Smart irrigation system with three level access mechanisms",2015 International Conference on Computation of Power, Energy, Information and Communication (ICCPEIC),Pages: 0269 - 0275,2015.

[9] P. Rajalakshmi; S. Devi Mahalakshmi,"IOT based crop-field monitoring and irrigation automation",2016 10th International Conference on Intelligent Systems and Control (ISCO),Pages: 1 - 6,2016.

[10] D. K. Sreekantha; Kavya A. M.,"Agricultural crop monitoring using IOT - a study",2017 11th International Conference on Intelligent Systems and Control (ISCO),Pages: 134 - 139,Feb.2017

[11] Ahmad Nizar Harun; Mohamed Rawidean Mohd Kassim; Ibrahim Mat; Siti Sarah Ramli,"Precision irrigation using Wireless Sensor Network",2015 International Conference on Smart Sensors and Application (ICSSA),Pages: 71 - 75, Nov.2015

[12] Nelson Sales; Orlando Remdios; Artur Arsenio,"Wireless sensor and actuator system for smart irrigation on the cloud",Pages: 693 - 698, Jan.2015