Effective Implementation of Low-Cost Smart Irrigation System

T. Anil Chowdary, D.V. Chakravarthy, R.V. Siva Rupesh, T. Sai Charan Ashish, V. Hemanth Sai Charan

ABSTRACT: ***Agricultural sector plays most significance role in Indian Economy.Farming land in India is about 60.7%. There are many models proposed on automated irrigation and the traditional method of smart irrigation has been the monitoring of dampness content in the soil and watering the field based on the threshold value. Using Internet of Things in irrigation field will reduce work of farmer in the field. The method with low cost and less power consumption will be more effective and it can be achieved with the use of NodeMCU as micro controller and Wi-Fi module. Predator detection in the field can be detected with the use of PIR sensor and email alert will be sent to the farmer through IFTTT, if anyone is detected in the field. The Dampness content can be found using soil moisture sensor. The type of crop to be grown in the field can be known with the help of ph value. The ph value can be measured using ph sensor. Based on the ph value we will suggest the farmer the type of crop that gives more productivity through the mobile application. The climatic parameters like temperature, humidity, clouds around the location of the crop can be taken from the open weather map api. This data is stored in the cloud for future reference and can be monitored through the mobile application provided to the farmer. This method provides automated irrigation system along with monitoring of weather parameters and providing security to the field.***

Keywords:Cloud, IFTTT, Mobile application, NodeMCU, Soil Moisture sensor.

I. INTRODUCTION

Internet of Things is connecting huge number of devices over a network by using internet, where each device will have its own unique address. These devices are known as things. Internet of Things is combination of wireless sensor network, cloud and mobile application, where wireless sensor network consists of sensors integrated to the micro controller in a network. The sensors measure the physical and environmental parameters around it and transfer the data between the other nodes in a network. The microcontroller then acts as a gateway and sends the sensor data to the cloud which will be used for future purpose. The user from anywhere around the world can access the data in the cloud through the mobile application provided to the user. In the agricultural sector using of Internet of Things can be useful for farmers. Farmers grow crops based on the price and availability of water in that season, these factors do not provide efficient production of the crop.

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T. Anil Chowdary, Associate Professor, Department of ECE, KoneruLakshmaiah Educational Foundation, Vaddeswaram, A.P

D.V. Chakravarthy, Student, Department of ECE, KoneruLakshmaiah Educational Foundation, Vaddeswaram, A.P

R.V. Siva Rupesh, Student, Department of ECE, KoneruLakshmaiah Educational Foundation, Vaddeswaram, A.P

T. Sai Charan Ashish, Student, Department of ECE, KoneruLakshmaiah Educational Foundation, Vaddeswaram, A.P

V. Hemanth Sai Charan , Student, Department of ECE, KoneruLakshmaiah Educational Foundation, Vaddeswaram, A.p

So, the main factor responsible for growth of crop is Ph value of the soil and it can be found using Ph sensor which is useful to suggest the
farmer about the type of crop to be used and to irrigate the field soil moisture sensor is used which is used to measure the dampness content in the field and irrigate the field based on the threshold dampness content given to the controller. In the crop area to find the presence of predators in the field Pir sensor is used and an email alert will be sent to the farmer about the presence of someone in the field.

The usage of most important parameter for irrigation is water and using water carefully is also very important during irrigation, when there is chance of rain and at the same time if the crop is irrigated then the water will overflow in the field and gets wasted so, if chance of rain is predicted then we can stop irrigating the crop. This can be done using open weather map api. Weather parameters like temperature, humidity, clouds and wind speed can be retrieved from open weather map api which will be useful for the weather prediction. These parameters can be monitored through the mobile application provided to the farmer and this data can be sent to the cloud for future analysis.

Water is the main concern for irrigation where electric pump is used to detect the water level to save water using CoAP communication protocol which is operated over UDP and it is based on REST architecture [1]. To perform the traditional irrigation method both raspberry pi and Arduino can also be used but, the cost of the system will be more [2]. To find the Temperature of the crop temperature sensor can be used in the field and GPRS module can be used to communicate with the other nodes [3]. To detect the level of water in the field without being wasted water flow sensor can be usedand the data is sent through gateway and is displayed in a website [4]. The cloud platform Thinger.io is an open source and which can be used as IoT platform for agricultural applications [5]. To communicate among the nodes and the control centre zigbee can be used as communication device between sensor to the web [6].

There are algorithms to get the performance or usage of orphaned nodes back into the network like branch and bound method and random-bit-climbing method [7]. To communicate with sensors in the field GSM module can also be used where the data is collected from the sensors and is sent to the cloud [9].Apart from the traditional method of sensing the dampness content we can also use camera module and know the difference between the wet and dry soil by capturing the images and processing them [10]. Animals in the field can be detected and can be diverted without entering the field by sending sounds in the opposite direction of the field [11].

Apart from the famous controllers CC3200 MCU can also be used in the agricultural field which is interfaced with camera module and sensors [12].

II. METHODOLOGY

The proposed method uses NodeMCU as micro controller which is integrated with Ph sensor, PIR Sensor, Soil Moisture Sensor, Relay and DC Motor. Ph sensor will be in activated state until it suggests the farmer about the type of crop to be grown. Soil Moisture Sensor will be monitored continuously and if the dampness content is less than the threshold value the motor will starts watering the plant. PIR Sensor will also be monitoring continuously and if anyone is detected email alert will be sent to the farmer through IFTTT. NodeMCU has an in-built Wi-Fi module which pushes the data to the cloud. NodeMCU also extracts the data from open weather map API which will be in json format and convert it into the readable format and sends the data to the cloud.

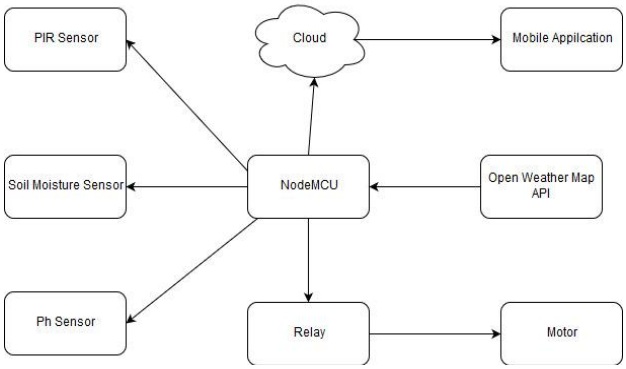

Figure1. Block Diagram

A. NodeMCU

The microcontroller used in this method is NodeMCU which also acts as Wi-Fi module that sends sensor data to the cloud by acting as a gateway. The main purpose of using NodeMCU is it consumes less power of 3.3v and it is less cost than other micro controllers / processors like Arduino and Raspberry bi.

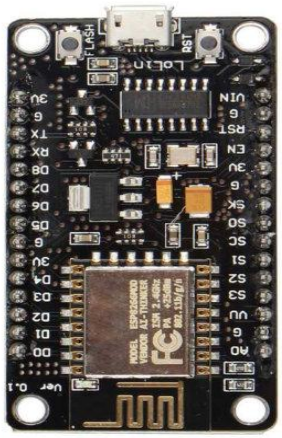

Figure2.NodeMCU

The limitation with NodeMCU is it has only one analog pin, but for our application that is not a problem. So, usage of NodeMCU is suitable for this application. NodeMCU is connected to PIR sensor, Ph sensor, Soil Moisture sensor and it will receive weather parameters from open weather map api and sends the data to the cloud platform.

The features like establishing a Wi-Fi connection with just few lines of code, Plug and play mode, Programmable Wi-Fi module and Arduino like software and hardware IO made NodeMCU an IoT Tool and best suitable for various applications based on Internet of Things. It has a deep sleep mode which consumes less power and is useful for low power consumption of an application.

B. Soil Moisture Sensor

The soil moisture sensor in irrigation field is used to measure the dampness content in the soil and if the dampness content is less than the threshold value then NodeMCU will send the control signal to the Relay and will switch on the motor that starts watering the plants.

The crop field will be monitored continuously by the NodeMCU and if the dampness content receives above the threshold value then the motor goes to off state and stops watering the plants. The data is sent to the cloud and can be monitored through mobile application, this is helpful in automated irrigation.

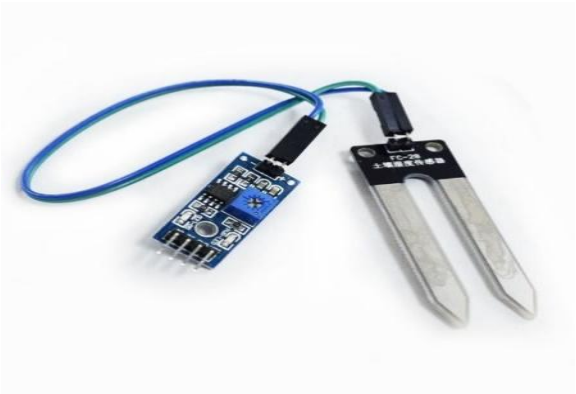

Figure3. Soil Moisture Sensor

C. PIR Sensor

PIR (Passive Infrared Sensor) is used to sense the infrared light radiating from the objects (Humans orAnimals) in its sensing area. This sensor in the field is used find the predator's in the field. This sensor senses the heat energy emitted in the form of infrared rays from the moving objects(Animals or Humans) around its measuring range. When Someone is detected then the farmer will get an email alert stating someone is in the field area.

Figure4. PIR Sensor

D. Ph Sensor

Ph of soil is used to know the type of soil whether it is acidic type of soil or basic type of soil. This can be known by the ph value of the soil. The ph value of soil varies from 0 to 14. If the ph value of soil is in between 0 to 7 it is of acidic type. If the ph value of soil is 7 then it is neutral type and if it is in between 7 to 14 then it is basic type of soil. Based on the ph value we can suggest the farmer the type of crop to be used.

Figure5. PH Sensor

E. DC Motor

It is an electrical component which converts current into mechanical power. When current is supplied to the coordinate, mechanical power follows it due to the electromagnetic impact on it.We will be using relay to control the flow between NodeMCU and the motor because, NodeMCU needs only 3.3v.

Figure6. DC Motor

F. Relay

It is an electronic device that protects the system from damage by closing and opening the contacts to cause the operation of the other electrical control. Here, it is connected to the motor and NodeMCU board to avoid any damage to the system from the current driving the motor operation.

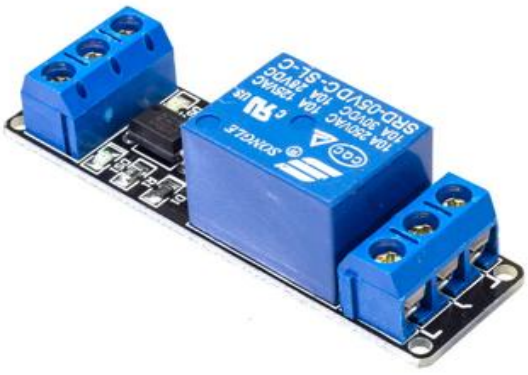

Figure7. Relay

G. Cloud Platform

Cloud is used for storage and analysis of data. There are many cloud platforms available as open source. Here Thingspeak cloud platform is used where the sensor data is saved in the cloud. We can retrieve the data in the form of excel sheet for future reference. The user interface of this cloud platform is very simple and user friendly. Thingspeak will provide us the API keys which are helpful in writing the data to the cloud and reading the data from the cloud to the mobile application. By integrating the Cloud platform with the IFTTT farmer will be the email alerts if some is in the field

Figure8.Thingspeak Home page

H. Mobile Application

The Mobile Application was developed in MIT App inventor. It provides drag and drop mechanism for the user increating of the mobile application. In the designer interface we will provide the interface which is visiblewhen user opens the mobile application from the mobile phone. In the Blocks phase logic will be provided which will act accordingly from the cloud and displays in the application.

Figure9. MIT APP Symbol

I. IFTTT

IFTTT (If This Then That) is an open source web-based service. This is used to provide alerts by linking cloud with the various web services like Gmail. Facebook, Telegram, Instagram, Pin interest etc., In our application we have connected IFTTT with the Gmail when PIR sensor detects someone moving around the field then the farmer will get the notification about predators' presence in the field.

Figure10.IFTTT

Results and Discussion

This image describes the storage of environmental parameters temperature, humidity, clouds and moisture percentage in the cloud where x-axis consists of time and date and the y-axis consists of the parameter that is sensed by the sensor. This data can be retrieved in the form of excel sheet for future analysis.

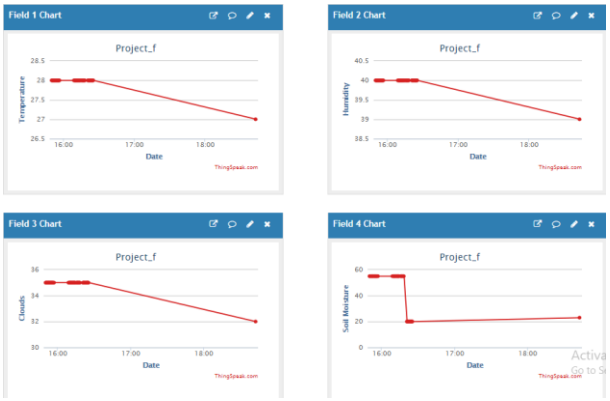

Figure11. Cloud Image

This image shows the home screen and when get data button is pressed another screen with moisture and weather information will be displayed.

Figure12. APP Screen 1

This screen displays the moisture content of the soil and the status of the motor. Environmental parameters temperature, humidity, clouds of the location of the crop field retrieved from open weather map API will be displayed in this screen and when pressed on Ph and predator button it will be redirected to screen-3.

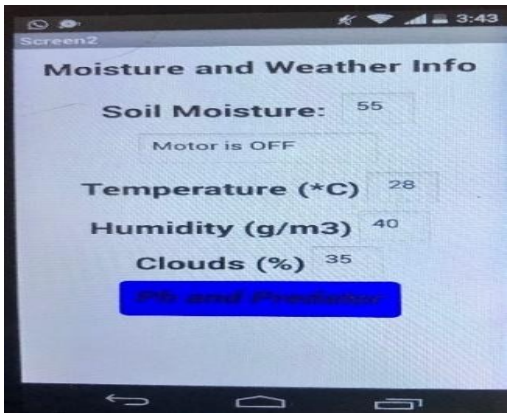

Figure13. APP Screen 2

In this screen Ph value of soil is displayed along with-it suitable crops along with the ph value is displayed as a suggestion to the farmer and presence of predator in the field is also shown in this screen and when pressed on exit button the app will exit.

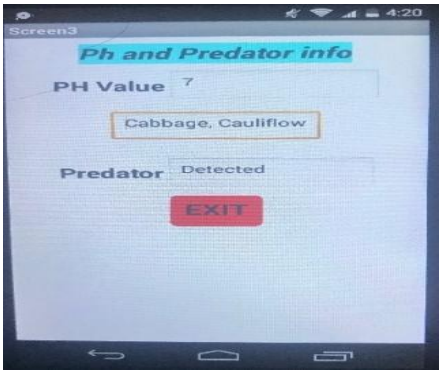

Figure14. App Screen 3

Table-1. Suggested Crops according to Ph range

Ph Range	Suggested Crops
Greater than or equal to 5 and Less than or equal to 5.5	Blue Berries, Irish potatoes, Sweet potatoes.
Greater than or equal to 5.5 and Less than or equal to 6.5	Blue grass, Corn, Cotton, Peanuts, Rice, Soya beans, Watermelon, Wheat
Greater than or equal to 6.5	Cabbage, Cauliflower, Mustard, Sun flower, Spinach, Onion, Pea

The table above Based on the Ph value of the soil the crop is suggested to the farmer through the mobile application. Any of the Crop in that Season will provide best production results. If predator exists in the field, then pir sensor recognizes their presence and send the data to the cloud and if their presence is confirmed then email will be sent through IFTTT to the farmer stating predator detected which will similarly be shown in the mobile application.

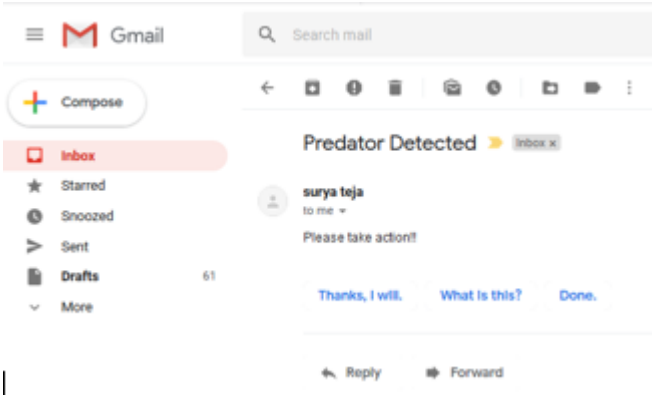

Figure15. IFTTT Image

The above shown prototype is the system that was developed where Ph sensor tells through the ph value of the soil what type of crop will be more productive in that season. Soil moisture sensor measures the dampness content of the soil and pushes the data to the cloud and if the dampness content is less than 30% the sprinklers turn on and water the field until it reaches the maximum value. PIR sensor used for the predator detection in the field and sends email if predator is detected and its status can be monitored through the mobile application provided to the farmer.

Figure16. Prototype

III. Conclusion and Future Scope

This proposed system is very effective in the field for irrigation, Environmental parameters monitoring and predator detection. The prediction of the crop in the field is also very accurate due to the use of ph sensor. Due, to the prediction of the crop to be grown the productivity of the crop will be more. This is very useful for the farmers for monitoring the situation of the field without going to the field. This system is very much helpful for the rice crops as it requires much water than the other crops. This system also will be useful for any type of crop. The developed system is of low cost and consumes less power due to the usage of NodeMCU as micro controller. The use of pir sensor in the field does not show the difference whether predator in the field is human or animal So, it is limitation of this system.

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AUTHORS PROFILE

Mr.T.Anil Chowdary, currently working as an associate professor in the department of ECE in KLEF. Completed B.Tech in the stream AMIETE in ECE at New Delhi. M.Tech in VLSI Design , ECE at SRM University , Chennai. Pursuing PH.D on SOC testing in VLSI atKoneruLakshmaiah Educational Foundation, Guntur.

Mr. D.V.Chakravarthy, currently pursuing B.Tech4thYear in ECE branch at KoneruLakshmaiah Educational Foundation , Guntur. Area of Interest is VLSI Design.

Mr. R. Venkata Siva Rupesh, currently pursuing B.Tech 4th Year in ECE branch at KoneruLakshmaiah Educational Foundation, Guntur. Area of Interest is VLSI Design.

T. Sai Charan Ashish, currently pursuing B.Tech 4th Year in ECE branch at KoneruLakshmaiah Educational Foundation, Guntur. Area of Interest **is** VLSI Design.

Mr.V.Hemanth Sai Charan, currently pursuing B.Tech in ECE branch at Koneru Lakshmaiah Educational Foundation , Guntur. Area of Interest is VLSI Design.