# Smart Irrigation System using IoT

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**บทคัดย่อ**—บทความนี้กล่าวเกี่ยวกับการควบคุมความชื้นของน้ำในดินและความต้องการน้ำของพืชพร้อมทั้งการเฝ้าติดตามความชื้นในดินด้วยอุปกรณ์ที่ถูกเชื่อมโยงทุกสิ่งทุกอย่างสู่โลกอินเตอร์เน็ต เช่น ราสเบอร์รี่พาย (Raspberry Pi) และเซนเซอร์วัดความชื้นในดิน เป็นต้น ซึ่งในการทำการเกษตรมีความจำเป็นที่จะต้องตรวจวิเคราะห์ความชื้นในดินด้วยเซนเซอร์ และควบคุมระบบการชลประทานน้ำอัตโนมัติ เพื่อให้เหมาะสมกับความต้องการน้ำของพืชตามแต่ละชนิด

***คำสำคัญ: อินเทอร์เน็ตสำหรับสรรพสิ่ง, ราสเบอร์รี่พาย, การทดน้ำ***

Abstract— this paper focuses on controlling of soil moisture content and water requirements for plants, as well as the monitoring of soil moisture content with Internet of Thing, such as Raspberry Pi and soil moisture sensors. Agriculture, it is necessary to analyze the soil moisture with a sensor. And control the pump for automatic irrigation. The smart irrigation system controls the pump automatically which creates the suitable moisture effectively. To suitable the water requirements of each plant.

**Keywords—IoT, Raspberry Pi, Irrigation**

## I. INTRODUCTION

Agriculture is a very important factor for developing country because it produces food for people and other materials. The rainfall of in Thailand depends on each season. Rainfall can affect irrigation for agriculture, so the agriculture seems as the gambling against the nature. In order to gain productivity of crops, irrigation is used effectively for agriculture in Thailand. There are different types of method for irrigating in Thailand for different types of a crop field. Generally, Thai farmer uses these three methods of irrigation system such as a channel, sprinkler and drip system. A Channel system is a traditional method of irrigation and it is unofficial way to use water for crops. Therefore, we propose smart irrigation system is a new technology to irrigating crop field automatically and effectively.

Today, IoT is more popular because it is cheap therefore it is applied to many innovative applications including irrigation for crop field. We can see smarter devices based on IoT, which is around us. The smart irrigation system using IoT can save energy and resources. Farmers are able to adjust the amount of water at any time. It can reduce water loss in order improve irrigation system performance. This paper proposes a smart irrigation system using IoT, which is useful in monitoring and gathering the data, such as moisture and amount of planting water as well as controlling pump for the moisture soil. Our irrigation system, which is cheap and can control water pump effectively.

## II. LITERATURE REVIEW

R.Hemalatha et al [1] proposed an automatic irrigation system thereby saving time, cash and power of the farmer. The standard farm-land irrigation techniques need manual intervention. With the machine-controlled technology of irrigation the human intervention will be reduced. Whenever there's a modification in temperature, humidity, wetness And pH level of the environment these sensors senses the changes and offers an interrupt signal to the ARDUINO CONTROLLER. Then it will be transferred to the IOT (Internet Of Things) technology so farmer will monitor and management the irrigation from anyplace.

S. Rawal [2] proposed an automated irrigation system which monitors and maintains the desired soil moisture content via automatic watering. Microcontroller ATMEGA328P on Arduino Uno platform is used to implement the control unit. The setup uses soil moisture sensors which measure the exact moisture level in soil. This value enables the system to use appropriate quantity of water which avoids over/under irrigation. IOT is used to keep the farmers updated about the status of sprinklers. Information from the sensors is regularly updated on a webpage using GSM-GPRS SIM900A modem through which a farmer can check whether the water sprinklers are ON/OFF at any given time. Also, the sensor readings are transmitted to a Thing speak channel to generate graphs for analysis.

N.Suma [3] proposed the project includes various features like GPS based remote controlled monitoring, moisture & temperature sensing, intruders scaring, security, leaf wetness and proper irrigation facilities. It makes use of wireless sensor networks for noting the soil properties and environmental factors continuously. Various sensor nodes are deployed at different locations in the farm. Controlling these parameters are through any remote device or internet services and the operations are performed by interfacing sensors, Wi-Fi, camera with microcontroller. This concept is created as a product and given to the farmer's welfare.

A. J. Rau et al [4] identified a few fundamental issues that are faced by the paddy farmers today. It includes the problem of over or under watering and the need for regular manual irrigation. Furthermore, when it comes to rice, which is the staple crop of Kerala, there does not exist a system for

automatically monitoring the diseases associated with the rice species, and checking whether the crop is supplied with ample amount of nutrients. In this paper, we have devised a means for cost-effective automated irrigation and fertigation along with MATLAB based image processing for identifying the rice diseases and nutrient deficiencies. Here, we are focusing on two important nutrients, namely magnesium and nitrogen. The hardware consists of a Raspberry Pi, DHT11 temperature and humidity sensor and solenoid valves. Furthermore, the proposed model enables the farmer to monitor weather conditions using an Android Application, with which he also has a choice to override the system if required.

R. Ramkumar [5] proposed system, Humidity and Temperature sensor is used to find out the environmental condition. Where microcontroller read the value and programmed with controller to control the system based on the environmental condition. Here we use Internet of Things technology by which particular plant variety is selected based on the plant's unique ID to select which plant are using in the farm land and day by day processes information will update to the web server . Here camera is used to surveying the farm land and growth of the particular plant. If the plant is affect by any disease then immediately alert message is sent to the farmer.

S.Reshma et al [6] proposed an automated irrigation system provides a web interface to the user so that the user can monitor and control the system remotely i.e., can make the irrigation system ON and OFF remotely.

Next section presents our irrigation system using IoT technology which is widely used and IoT devices are connected more than 20 billion devices in 2017. [7]

## III. METHODS OF IRRIGATION

Generally, Thai farmer use these three methods such as channel, sprinkler and drip system. These method are not effective way to use water for crop field because a lot of water can loss before crop can absorb for growing. Therefore, our proposed Smart irrigation system is a new technology to irrigating crop field automatically and effectively.

### *A. Drip Irrigation System*

Drip Irrigation System uses waterfall drop by drop at the position on the roots of crop. It is the best technology for watering fruit plants, gardens and trees. Water flow through a main pipe and divided into sub pipes. Special prepared nozzles are attached to these sub pipes. In this system waste of water is very less than another system and no need worker for irrigating. When the farmer knows the status of the farm field then start the motor and chose the direction from nozzles. Then automatically watering the plants and after some time the farmer check the status of the field and while the whole crop are irrigating then OFF the motor.

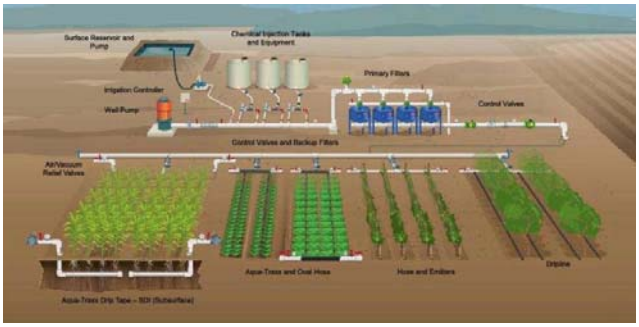

Figure 1. Drip Irrigation System

### *B. Corn Water Using And Irrigation Timimg*

An understanding of corn water using and the factors that affect it can help guide irrigation decisions to maximize yield potential and improve water efficiency on your farm. The terms crop water use and evapotranspiration (ET) are used synonymously to describe the movement of water through evaporation (E) from the soil and plant surfaces and transpiration (T) through the plant. Transpiration is the movement of water from the soil into plant roots, through plant stems and leaves, and back out into the atmosphere. Transpiration is an important concept because yield is related to the amount of water a plant transpires. The factors that affect ET include crop developmental stage, climate, and soil characteristics.

Table I. Corn Water Using.

| Growth Stage | Average water use rate (mm/day) | Total water use during Stage (mm/day) | Day growth Stage (Day) |
|---|---|---|---|
| **Emergence (VE)** | **2.03** | **20.32** | **10** |
| 4-leaf (V4) | 2.54 | 45.72 | 18 |
| **8-leaf (V8)** | **4.57** | **73.66** | **16** |
| 12-leaf (V12) | 6.60 | 45.72 | 7 |
| **Early tassel (R1)** | **8.13** | **96.52** | **12** |
| Silking (R2) | 8.13 | 96.52 | 12 |
| **Blister Kernal (R3)** | **8.13** | **48.26** | **6** |
| Beginningdent (R4.7) | 6.10 | 96.52 | 16 |
| **Full dent (R5.5)** | **5.08** | **96.52** | **19** |
| Maturity (R6) | 2.54 | 35.56 | 14 |

a. Sample data for understanding of corn water using.

*Corn Irrigation Timing*

- *first time* after planting.
- *Second and third times* away from the first irrigation, each time 15 days.
- *Fourth, fifth, sixth times* away from third irrigation, each time 7 days.
- *Seventh, eighth and ninth times* away from sixth irrigation, each time 5 days.
- *Tenth, eleventh, twelfth times* away from ninth irrigation, each time 7 days.

## IV. THE PROPOSED SYSTEM

During the past 1-2 years, the Ministry of Agriculture and Cooperatives has dreamed of raising Thai farmers to be smart farmers. The focus of agriculture is on water and soil, so this research will focuses on controlling the water content in soil and water needed for plants and monitoring moisture using it. Our Irrigation system is based on the soil moisture. Sensors are placed on the crop field. Distance between the two sensors is based on the type of soil on the farm. Raspberry Pi and moisture sensors are used for detecting the moisture content in soil.

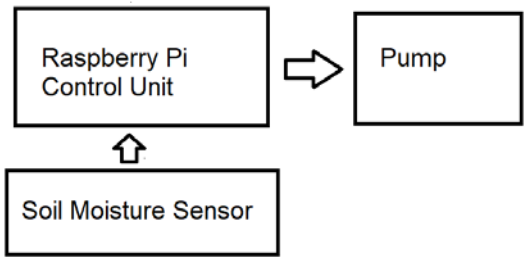


Figure 2. Smart Irrigation System using IoT.

The Fig.2 shows our system is controlling pump and monitoring the data from soil moisture sensors. Our system consist of Raspberry PI, Soil moisture sensor and water pump.

### *A. Raspberry Pi3*

The Raspberry Pi is a microcontroller or single-board PCs created in the United Kingdom by the Raspberry Pi Foundation to advance the instructing of fundamental software engineering in schools and in creating nations. It gathers all information from sensors and control water pump by sending electrical signal to motor. Raspberry Pi has SD card slot on board. All data is recorded in SD card. CPU on Raspberry processes all command from Python programming.

Figure 3. Raspberry Pi 3

*Raspberry Pi 3 Specifications:*

- SoC: Broadcom BCM2837
- CPU: 4× ARM Cortex-A53, 1.2GHz
- GPU: Broadcom VideoCore IV
- RAM: 1GB LPDDR2 (900 MHz)
- Networking: 10/100 Ethernet, 2.4GHz 802.11n wireless
- Bluetooth: Bluetooth 4.1 Classic, Bluetooth Low Energy
- Storage: microSD
- GPIO: 40-pin header, populated
- Ports: HDMI, 3.5mm analogue audio-video jack, 4× USB 2.0, Ethernet, Camera Serial Interface (CSI), Display Serial Interface (DSI)

### *B. Soil Moisture Sensor*

Soil moisture sensors measure the water in soil. The information from soil moisture sensor indicates the condition of the soil. The signal from Soil Moisture Sensor is sensitive more than different one hundred levels which compare human can indicate only normal, dry or wet. The sensor board has both analogue and digital outputs. The Analogue output provides a variable voltage that indicates the moisture content of the soil. The digital output provides a digit number that is ON or OFF when the soil moisture content is over a certain value. The value is adjustable by calibrating on board potentiometer.

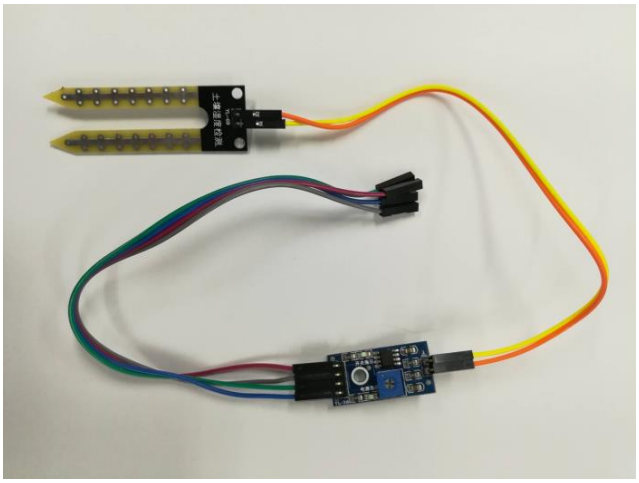

Figure 4. Soil moisture sensor

*Soil Moisture Sensor Specifications:*

- Sensor blade is constructed of a multi-layer fiberglass stick
- No electrical contact with soil
- Has a built-in temperature sensor used while calibrating the soil moisture readings

- Can only be connected to Baseline controllers
- Requires 3M™ DBR/Y-6 or equivalent wire connections on the two-wire side
- Comes with 50 feet of 18-gauge (UL) direct burial, dual conductor irrigation cable to connect to the two-wire (voltage rating: 300V, temp rating: 167 ºF (75 ºC))
- Freeze/heat resistant -4 ºF to 140 ºF (-20 º C to 60 ºC)
- Sensor logic module measures 2" x 3" x 1"

*C. Water Pump*

A water pump is a device that move water from the source to where we need. The pump needs sufficient current that a suitable power supply is required. The pump might needs suitable motor drive board is connected between Raspberry Pi and pump in order to avoid overload current. If the switching current is too high for the relay, transistor is added in this circuit.

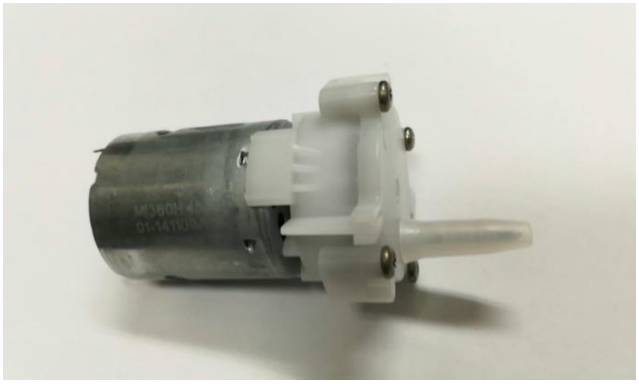

Figure 5. Water Pump

*Water Pump Specifications:*

- Power supply: DC 12V Working environment: temperature 0-40 ℃, relative humidity <80%
- Medium flow: the flow of the peristaltic pump connection depends on the power level of positive and negative, positive and negative terminals can be arbitrarily chosen level
- Flow range: 0-100 ml / min
- Speed range: 0.1-100 rpm
- Motor RPM: 5000RPM
- Drive Size (Φx H): Diameter 27.6 x height 37.9 (mm)
- Head size (Φx H): Diameter 31.7 x height 20.1 (mm)
- Equipped with pump tube (IDxOD): 2.5 x outer diameter of the inner diameter of 4.7 (mm)

*D. Algorithm of the Smart Irrigation System*

- Step 1: Start the process.
- Step 2: Check the moisture level form Table. 1
- Step 3: If the moisture level is lower than a fixed value, the pump is turned on.
- Step 4: If the level will be more than a fixed value, the pump turns off.
- Step 5: It moves to beginning
- Step 6: Stop the process.

Table II. The relationship between type of soil and water using by plants.

| Soil | Soil moisture content | Water used by plants |
|---|---|---|
| rough | 5.5 | 3.5 |
| Roughly | 22.2 | 10.2 |
| moderate | 34.6 | 14.3 |
| Quite detailed | 33.8 | 12.5 |
| Detailed | 33.5 | 13.3 |

a. Sample data for type of soil affecting the water using of plants.

## V. EXPERIMENTAL RESULTS

After Raspberry Pi, soil moisture sensor, and water pump are installed. The sensor is able to detect moisture in soil. System compare with relationship between soil moisture content and soil, then pump is turn on when the moisture is lower that a curtain point on others hand. The pump is turn on when the moisture is upper another curtain point. The water flows during the pump is turn on. The Raspberry Pi display to LCD two chart which are soil moisture content and water volume per minute.

Figure 6. Soil Moisture Sensor installed

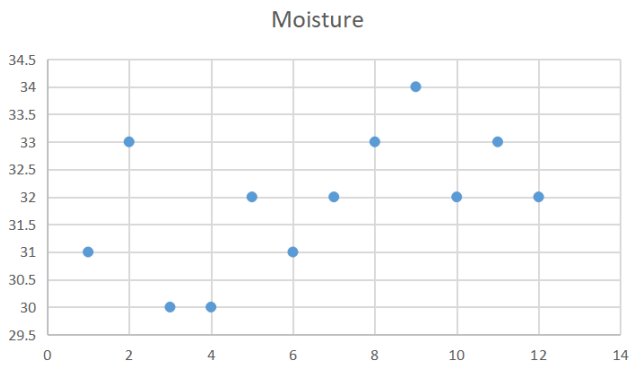


Figure 7. Moisture chart

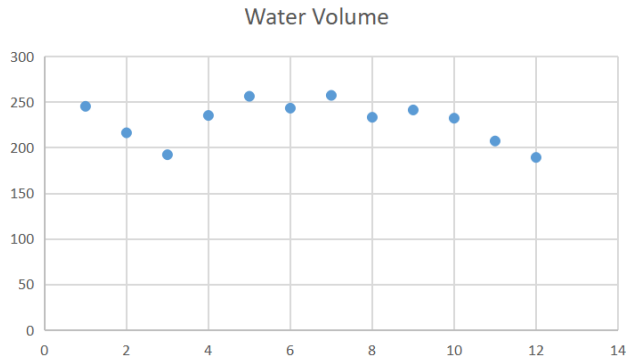


Figure 8. Water Volume chart

The figure 7 presents Soil moisture content in soil was measured by percentage of soil moisture content. The figure 7 presents water volume per minute.

The irrigation generates a chart in real time. Therefore, we can monitor the status of moisture in soil. When the soil moisture content level drops below the set point. The algorithm will instruct the water pump system to work. The relationship between soil moisture content and plant water use was compared. This will allow us to accurately determine the amount of water required for the plant. And can be adjusted according to the needs of the plant cycle.

## CONCLUSIONS

Our irrigation system can perform effectively and can work as data logger by gathering information soil moisture in Figure 7 shows the status of the moisture level. Moreover water volume was monitored by our system in Figure 8. When the pump operates, the water flow to the soil until the set point, it will turn off. The prototype of the proposed smart irrigation systems using IoT still under development and it aim to be more efficient to control the flow of water. Using Raspberry Pi, it is IoT technology and cheap we can monitor the moisture of soil. It can be added other sensors for more accuracy performance. Finally, our irrigation system is a very effective tool and can change farmer life to be better.

## SUGGESTION

From our irrigation system. We have found some ideas that can bring our irrigation system to the development of modern agriculture. Especially in the age where technology plays a major role in agriculture. Our system will next offer intelligent watering solutions adapted to the needs of water of the crop cycle. Since the beginning of sowing. Until grown up. The farmers can cultivate effective. The higher the yield. Create a source of income for farmers to continue.

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