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IoT based Smart Water Control System for Home Grown Plants

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Abstract*: Nowadays, most of the people are interested in cropping their own organic plants for health and safety. But, due to insufficient time they are unable to look after their own plants. Therefore, this paper introduces smart water control system for home grown plants, which is based on IoT technology. It makes use of various sensors, which include features like, detection of water level in the tank with ultrasonic sensor and with soil moisture sensor detection of water content in the soil based plants along with temperature sensor. The microcontroller used here is Node MCU, which shares sensoring data to Aadfruit io server and IoT mobile application. Adafruit io server is a cloud server, which stores real time data and IoT mobile application monitor these sensor values.

Keywords: IoT, Adafruit io server, IoT mobile application, Node MCU, water tank, soil based plant.

I. INTRODUCTION

Nowadays, Thailand government has introduced a policy of Thailand 4.0 to drive internet of thing (IoT) through smart devices, system development of sectors such as business and industry in everyday life, especially focusing on agriculture sector. Thai society should grow vegetables, fruits and medicinal plants for house hold consumption, advocated by His Majesty king Bhumibol Adulyadej promotes this philosophy of sufficiency in economy and sustainable development. Most of the people demand increasingly for cultivating own organic home grown plants for health and safety.

But, many of them don't have time to take care the plants. Hence, IoT Gardening system is used to monitor water content in soil based plant and automatically control water level in tank. If monitoring and controlling is not done properly, then it affects the growth rate of plant, its life span, and there will be lot of wastage of water. If we properly monitor our plants, then we can get fresh fruits and vegetables which are ripened naturally than compared to plants, which are ripened artificially. The main aim of this paper is to develop IoT Gardening tool, which measures level of water in tank and water content in soil based plant, along with temperature sensing. The model includes Node MCU, which is taken as microcontroller. Sensoring data is provided by ultrasonic sensor, soil moisture sensor and DHT11 temperature sensor. Adafruit io server is a cloud server to save real time data and IoT mobile application to monitor sensor values.

II. LITERATURE SURVEY

In [1] the paper explains "Microcontroller based Automatic Water level Control System", they proposed Automatic water pump control system which is based on different technologies in its design, development, and implementation. The system consist of microcontroller which displays overall status on LCD screen by detecting the level of water in a tank, switch on/off the pump, and has the ability to automate the process of water pumping in an over-head tank storage system. They have successfully provided an improvement in their research to indicate the water level by the use of calibrated circuit through existing water level controllers. The risk of electrocution is eliminated by the use of DC instead of AC power. In [2] the paper explains "A smart irrigation system for agriculture based on wireless sensors," To ensure proper use of water they proposed an automated irrigation system. In this system ZigBee radio modem and a GSM module is used with microcontroller which is based on PIC16F877A equipped with an RTC DS1307.

The data is received from sensors of YL-69 for soil-moisture and DS18B20 for temperature sensor via ZigBee and the data is displayed on LCD. In order to switch on and off water pump they used the temperature and soil-moisture thresholds. Android application is used to monitor the values of sensors. In [3] the paper explains "Automated precision farming using internet of things," To achieve automated precision farming system IoT is used based on Arduino UNO along with sensors of pH & YL-69 soil moisture. The server of IoT receives the data of these two sensors & sends it as a message to farmers. By this the farmers can setup the highest and lowest threshold values to water the plants as per their water requirement. The system will command the motor to start the irrigation system when the soil moisture reaches below the minimum threshold. In [4] the paper explain "Smart wireless water level monitoring & pump controlling system," Based on Arduino UNO equipped with ultrasonic HC-SR04, the proposed water monitoring & pump controlling system is developed. The ultrasonic HC-SR04 detects the water level and conveys command to Arduino UNO by ASK RF Transmitter which maintains start & stop of water pump.

III. PROPOSED DESIGN METHODOLOGY

The proposed method, IoT based smart water control system for home grown plants is illustrated in fig 1. Initially the system is powered with solar panel which converts sunlight energy into electrical energy using photovoltaic effect. Since, it is of 9v and our Node MCU controller runs at 5v, 7805 voltage regulator is used which converts 9v direct current into 5v DC. Node MCU is an open source firmware and development kit its hardware design can be edited and modified. Node MCU development kit consists of ESP8266 WIFI enabled chip, which provides flawless WIFI connectivity. Input to Node MCU will be ultrasonic sensor measures level of water present in tank, soil moisture sensor detect water content in soil based plant and temperature sensor for measuring temperature. The output side consists of submersible pump which is completely submerged into water. Therefore two pumps, pump1 act as water reservoir which provide water to the tank as an input and pump2 act as output from tank which provides water to the plant, depends on plant wet and dry condition. In order to interact with adafruit io server and IoT mobile application from Node MCU, WIFI is needed which can be provided by ESP8266 WIFI chip, which is inbuilt in Node MCU. Internet connectivity is provided by our mobile hotspot to Node MCU. Adafruit io server is a cloud server which stores real time data and IoT mobile application monitors sensor values.

A. Block Diagram

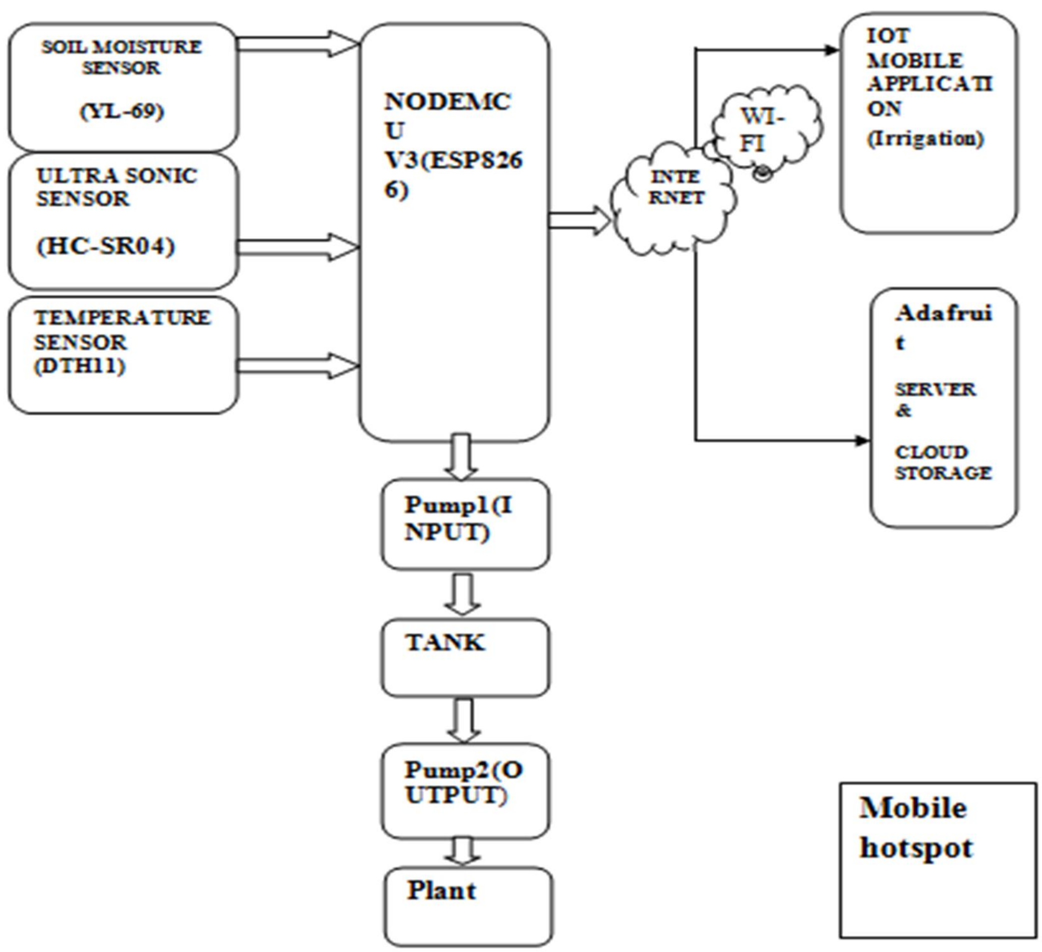


Fig. 1 Block diagram of proposed method

IV. HARDWARE IMPLEMENTATION

A. Components Required

1) *Power Supply:* The model requires both AC and DC power supply, AC requirement of 230v to submersible pump and DC of 5v to Node MCU. Solar panel is used to provide the power supply. Solar panel of 9v is used, two batteries of 4v connected in series, which stores the voltage generated by solar cells are then attached to 7805 voltage regulator to get constant 5v.
2) *Node MCU:* It is an open source firmware and development kit enabled with ESP8266 WI-FI chip which provides flawless WI-FI connectivity. Since it is an open source its hardware design can be edited or modified.
3) *HC-SR04 Ultrasonic Sensor:* Ultrasonic sensor measures the distance by using ultrasonic waves. Ultrasonic transmitter emits ultrasonic wave into the environment and return back to the receiver as a reflected wave after striking to the target. It measures the distance to the target, by measuring the time between emission and reception. Distance is calculated with the following simple formula: Distance=1/2×speed×time 330m/s will be the ultrasonic speed, time will be between emission and reception as because time is the go and return, distance value is multiplied by half (1/2).
4) *YL-69 Soil Moisture Sensor:* This sensor is great to use with automatic plant watering system. This is simple sensor which detects water content in the soil and Soil's wet or dry condition can be detected. Water is passed into the soil with two probes of sensor. Resistance provide the moisture level. More water in soil conducts more electricity with less resistance. Less water in the soil conducts poor electricity with more resistance.
5) *DHT11 Temperature and Humidity sensor:* This sensor measures both temperature and humidity which generates calibrated digital output. This sensor can be interfaced with any microcontroller and get instantaneous results. Since it is low cost, provides high reliability and long term stability. It can measure temperature between 0 – 50^0C and humidity between 20-90%.
6) *Relay:* It is an electro-mechanical switch which controls high power application through low power signal electronic circuits. The single pole double throw (SPDT) relay has one common terminal and two contacts they are normally closed and the other one is opened and, normally open the other one is closed. Basically SPDT relay switching between two circuits. When no voltage is applied to the coil one circuit receives current, the other one doesn't, and when the coil gets energized the opposite is happening. There are different types of relay like 3v, 5v, 6v and even 12v. We need to select them based upon the requirement of our project.
7) *Submersible Pump:* These pumps are completely submerged into the water and used by those machines which requires pump to function. It is compact in size, highly efficient tool made up of rust proof durable ceramic shaft with 18W of motor and an output pipe. They are mostly used in air coolers, aquariums and fountains. It is easy to install and handle, low electricity consumption, durable quality and water resistance. It can lift up to 1.85m of water and output water up to 1100L per hour.

V. EXPERIMENTAL SETUP AND RESULT

A. In IoT Gardening system, monitoring the values of soil moisture sensor, ultrasonic sensor and temperature sensor through IoT mobile application is shown. Initially soil moisture sensor check for wet condition where water need not to be poured and in dry condition water need to be poured. Then ultrasonic sensor, check for level of water by setting threshold value as 10cm. If water is above 10cm, then no need to pour water in tank. If less than 10cm water starts pouring into the tank automatically. Adafruit io server stores real time data along with the graphical representation of these sensors is shown.

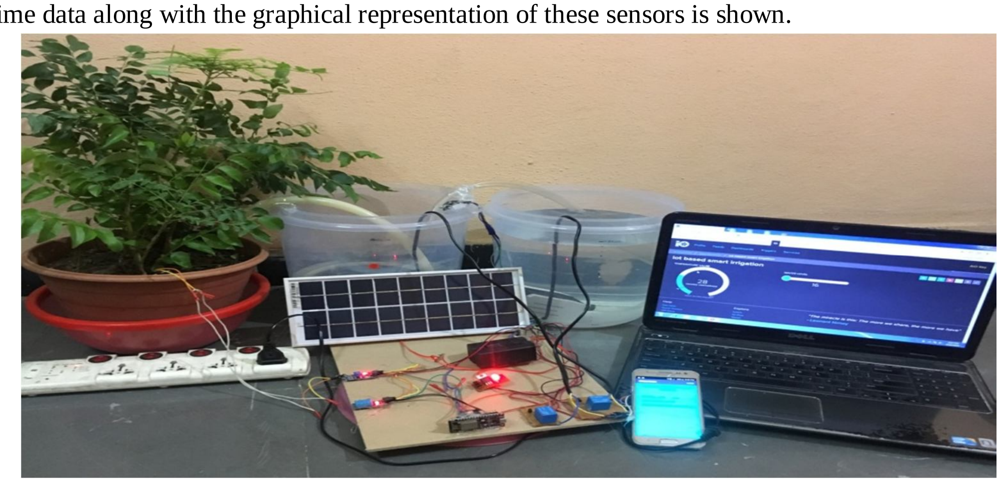


Fig. 2 Experimental setup of the project

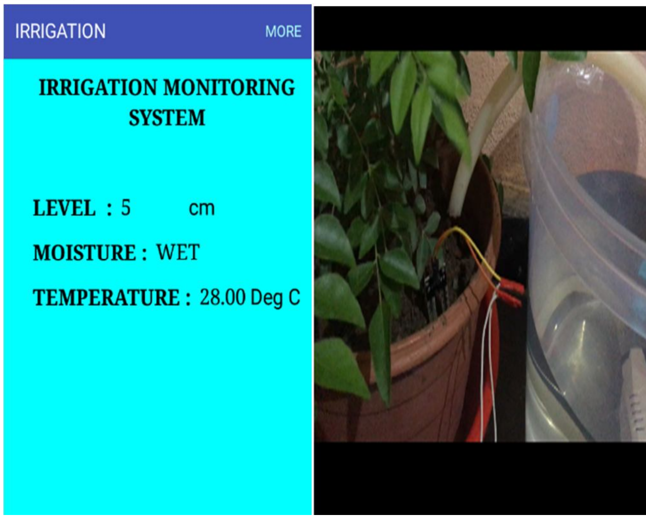


Fig. 3 Soil moisture sensor wet condition

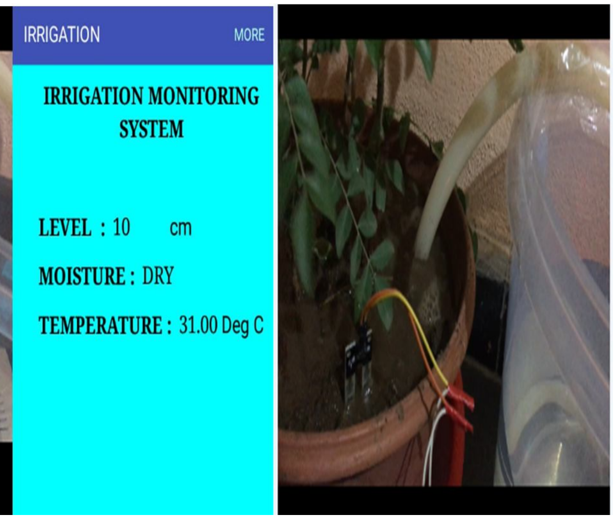


Fig. 4 Soil moisture sensor dry condition

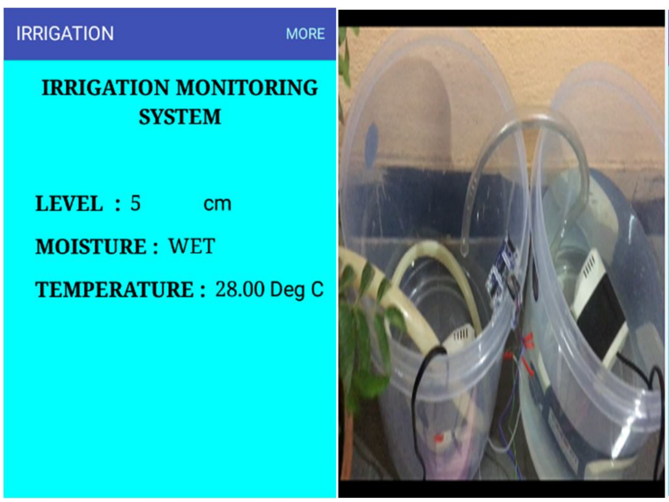


Fig. 5 No water present in tank

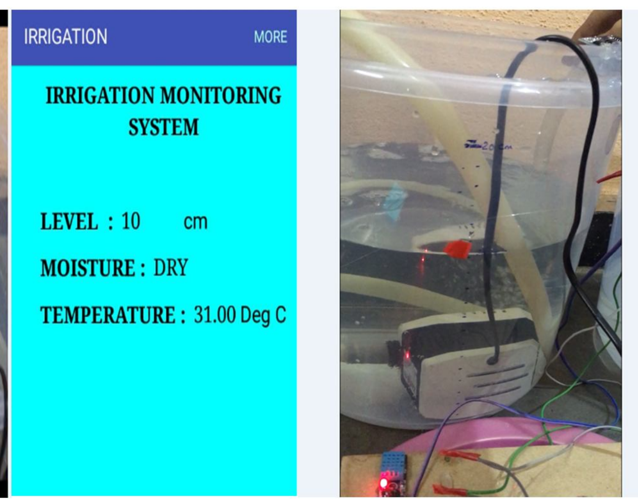


Fig. 6 Water present in tank

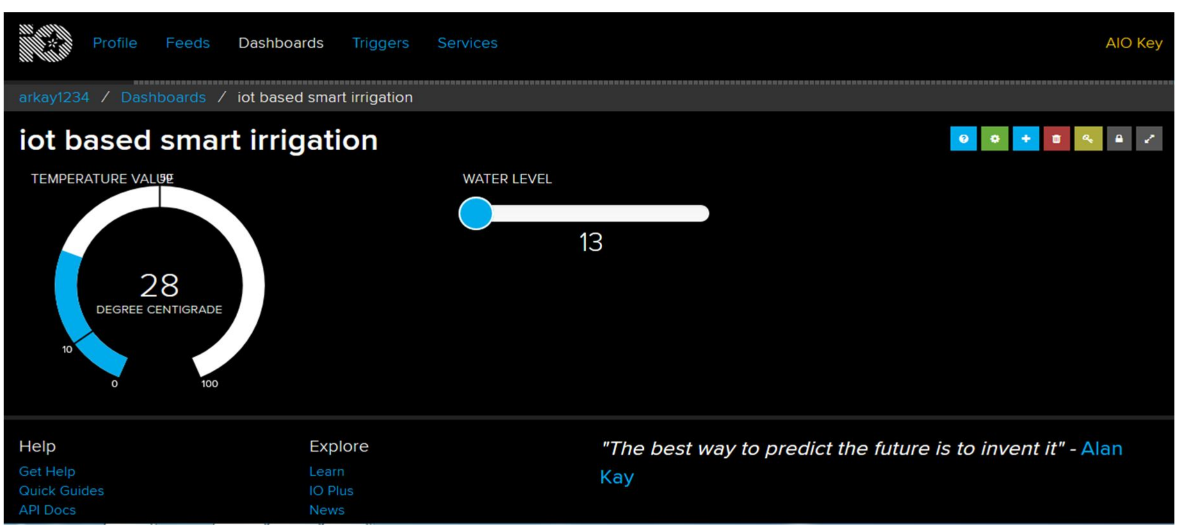


Fig. 7 Dashboard

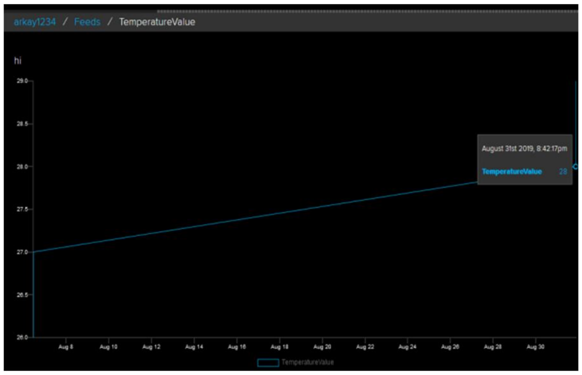


Fig. 8 Temperature value

Created at	Value	Location
2019/08/31 9:00:32pm	28.000000	0.0, 0.0, 0.0
2019/08/31 9:00:19pm	28.000000	0.0, 0.0, 0.0
2019/08/31 9:00:07pm	29.000000	0.0, 0.0, 0.0
2019/08/31 8:59:54pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:59:41pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:59:28pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:59:15pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:59:02pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:58:50pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:58:38pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:58:24pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:58:11pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:57:58pm	28.000000	0.0, 0.0, 0.0
2019/08/31 8:57:46pm	28.000000	0.0, 0.0, 0.0

Fig. 9 Stored values of temperature sensor

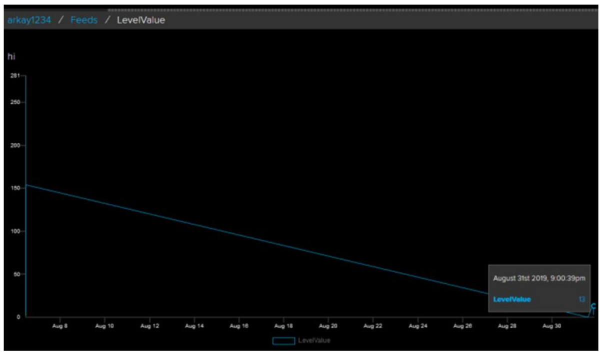
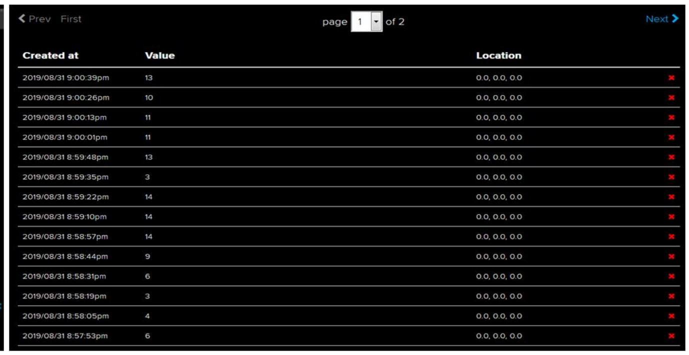


Fig. 10 Level Value



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Created at	Value	Location
2019/08/31 9:00:39pm	13	0.0, 0.0, 0.0
2019/08/31 9:00:26pm	10	0.0, 0.0, 0.0
2019/08/31 9:00:13pm	11	0.0, 0.0, 0.0
2019/08/31 9:00:01pm	11	0.0, 0.0, 0.0
2019/08/31 8:59:48pm	13	0.0, 0.0, 0.0
2019/08/31 8:59:35pm	3	0.0, 0.0, 0.0
2019/08/31 8:59:22pm	14	0.0, 0.0, 0.0
2019/08/31 8:59:10pm	14	0.0, 0.0, 0.0
2019/08/31 8:58:57pm	14	0.0, 0.0, 0.0
2019/08/31 8:58:44pm	9	0.0, 0.0, 0.0
2019/08/31 8:58:31pm	6	0.0, 0.0, 0.0
2019/08/31 8:58:19pm	3	0.0, 0.0, 0.0
2019/08/31 8:58:05pm	4	0.0, 0.0, 0.0
2019/08/31 8:57:53pm	6	0.0, 0.0, 0.0

Fig. 11 Stored values of level sensor

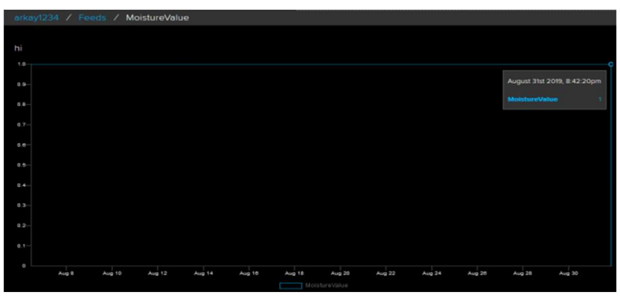

Fig. 12 Moisture value

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Created at	Value	Location
2019/08/31 8:48:10pm	0	0.0, 0.0, 0.0
2019/08/31 8:47:57pm	0	0.0, 0.0, 0.0
2019/08/31 8:47:45pm	0	0.0, 0.0, 0.0
2019/08/31 8:45:05pm	0	0.0, 0.0, 0.0
2019/08/31 8:44:52pm	0	0.0, 0.0, 0.0
2019/08/31 8:44:39pm	0	0.0, 0.0, 0.0
2019/08/31 8:44:27pm	0	0.0, 0.0, 0.0
2019/08/31 8:44:14pm	0	0.0, 0.0, 0.0
2019/08/31 8:44:01pm	1	0.0, 0.0, 0.0
2019/08/31 8:43:49pm	1	0.0, 0.0, 0.0
2019/08/31 8:43:36pm	1	0.0, 0.0, 0.0
2019/08/31 8:43:24pm	1	0.0, 0.0, 0.0
2019/08/31 8:43:12pm	1	0.0, 0.0, 0.0
2019/08/31 8:42:58pm	1	0.0, 0.0, 0.0

Fig. 13 Stored values of moisture sensor

VI. CONCLUSION

This paper is relied on soil moisture and ultrasonic sensor which precisely controls water in plant as well as water level in tank. IoT mobile application monitors sensor values and adfruit IoT server stores real time data. This project can be applied in agriculture, home grown plants to live healthier life style and can get healthy vegetables and ripened fruits. This technique is mostly beneficial for hobbyist's people and for them who don't have time to take care their own plants.

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