# IoT based Soil Moisture and Sun Light Monitoring for Smart Planting

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# IoT based Soil Moisture and Sun Light Monitoring for Smart Planting

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**Abstract.** Plant enthusiasts, entrepreneurs, and farmers usually have more than one plant that needs to be looked after every day. Lack of water and unproportioned sun light can be a serious problem if they have to leave the plant for a long period of time. An Internet of Things (IoT) based automatic remote plant sprinkler with sun light cover was designed to solve this problem. This system eases the users for monitoring the condition of plants without having to be in the field. The system model uses an ESP32 microcontroller, Light Dependant Resistor (LDR), relay, and L298N DC motor driver. In dry soil conditions, the water pump and sprinkler will turn on and water the soil. When the soil conditions are moist or wet the pump and sprinkler will not turn on. When there is intense sun light, the DC motor will pull the curtains to cover the plant. All the data can be monitored remotely via Wi-Fi connection. The results of this work shows that the system works well with 100% monitoring success rate.

## 1. Introduction

Plant enthusiasts, entrepreneurs, and farmers must have more than one plant that needs to be cared every day. One of the most important treatments is to provide water with sprinklers. Lack of watering can cause serious problem for plant if the owner have to leave the plant for a long time [1]. The other factor to provide a good environment for plant to grow is the sun light intensity [2]. Sufficient water and adequate sun light are important factors in carrying out photosynthetic activities. If this is not well considered, the plants will quickly wither and die. An IoT based automatic plant sprinkler and cover system that can be monitored and controlled remotely makes it easier for users to monitor the condition of these plants anywhere and anytime [3]-[7].

Gunawan (2018) has designed automatic sprinkler using soil moisture sensor [8]. This system will automatically water the plant whenever the plant need watering based on the soil condition. Prasojo et al. (2020) has also designed automatic sprinkler using Arduino Uno microcontroller [9]. Other references about IoT based automatic plant sprinkler can be seen in [10]-[12]. In this work, Android based smartphone receives and displays the soil condition data, whether it is dry, moist, or wet according to the sensor readings.

Based on the aforementioned problems, the development of automatic sprinkler combined with sun light plant cover was proposed in this work. Soil condition and sun light intensity will be sensed to drive the system whether it will water and cover the plant or not.

The remainder of this paper is organized as follows. Section 2 provides the description of system model used in this work. Section 3 presents results and discussion. It will describe the system performance based on the system success rate. Section 4 provides the conclusion of the work.

## 2. System Model

The system is using a remote control via the Blynk application as an IoT platform embedded in smartphone. This tool uses a soil moisture sensor to determine the moisture content in the soil and an LDR sensor to determine the intensity of sun light. DC motor is used as actuator to open and close of the curtains as plant cover from the intense sun light. DC water pump is used for watering the plants. The data that has been obtained from each sensor will be sent to the Blynk application. This system uses ESP32 microcontroller to control all actuators.

Figure 1 show the system model of this work. Soil moisture sensor will detect three condition; dry, humid and wet. If the soil is dry, when it gets an output with a range > 3500, the relay will turn on then the DC water pump will water the plants. If the soil is in a humid condition with a range > 1600 and < 3500 or wet with a range < 1600, the relay will not turn on and the DC water pump will not flush. The LDR sensor will work if the sunlight intensity is too hot and it results an output with a range < 1500 and the DC motor will close the plant curtains. Likewise, when the sunlight intensity is not too hot and an output has range > 1500, the DC motor will open the plant curtains.

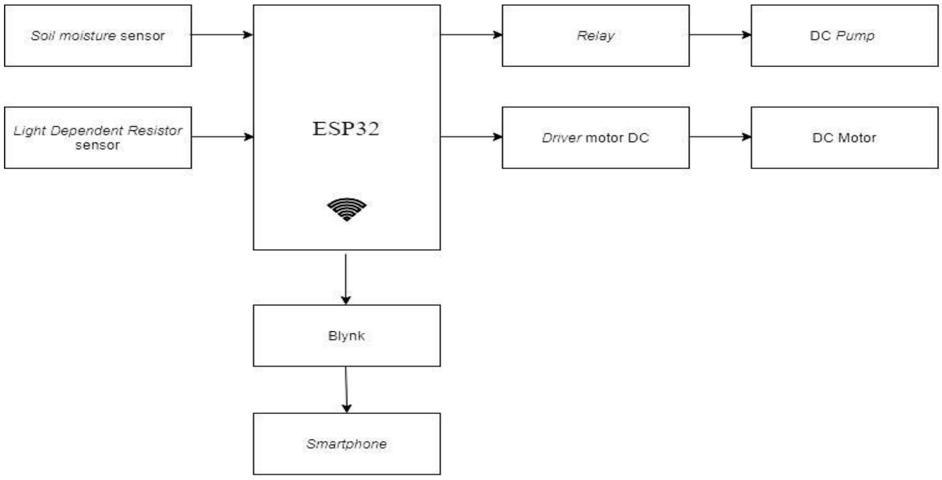



**Figure 1.** System Model

### 2.1. Activity Diagram

Figure 2 show the flowchart of the overall system work process. At the beginning of the process, the system will search for a Wi-Fi connection. If it is connected, then it will proceed to process each sensor reading. The soil moisture sensor then will initialize the input port of microcontroller and it will read the analogue data value of the sensor.

The soil is classified as dry soil when it gets an output sensor value with a range above 3500, humid soil when the value range below 3500 and above 1600, and wet soil when the value range below 1600. When the value of soil moisture sensor above 3500, then the relay and DC water pump will turn on. When the value of soil moisture sensor is below 3500, then the relay and DC water pump will not turn on. Data from sensor measurement results are then sent to Android smartphone via Blynk application.

The sensing and monitoring is done in the same process for LDR sensor. The LDR sensor will initialize the input of microcontroller and it will read the analogue data value of the sensor. When the analogue value of the LDR is below 1500, the plant curtains will open. When the LDR sensor value is above 1500, it will close the curtains and cover the plants. Data from sensor measurement results are then sent to Android smartphone via Blynk application.

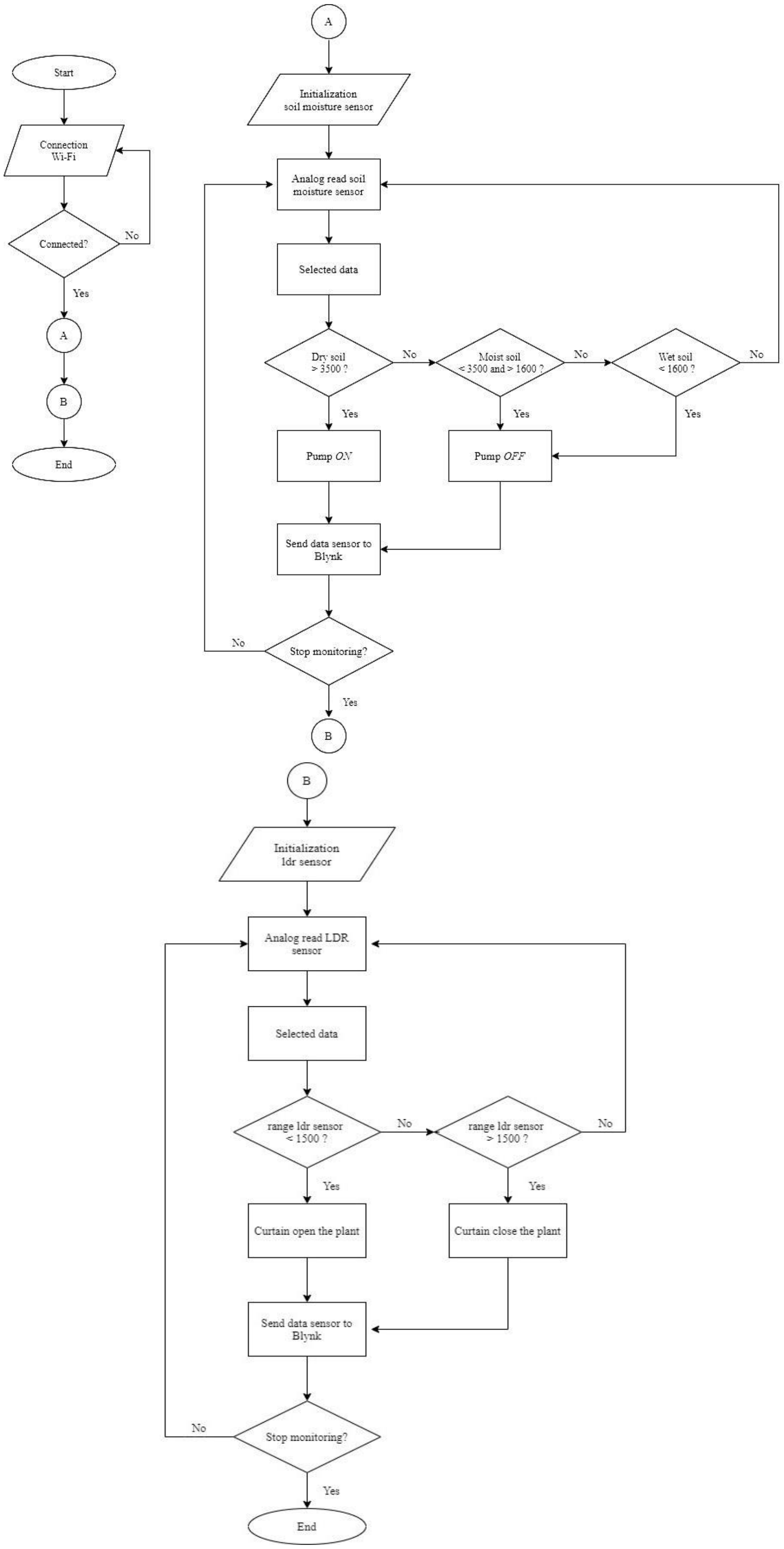
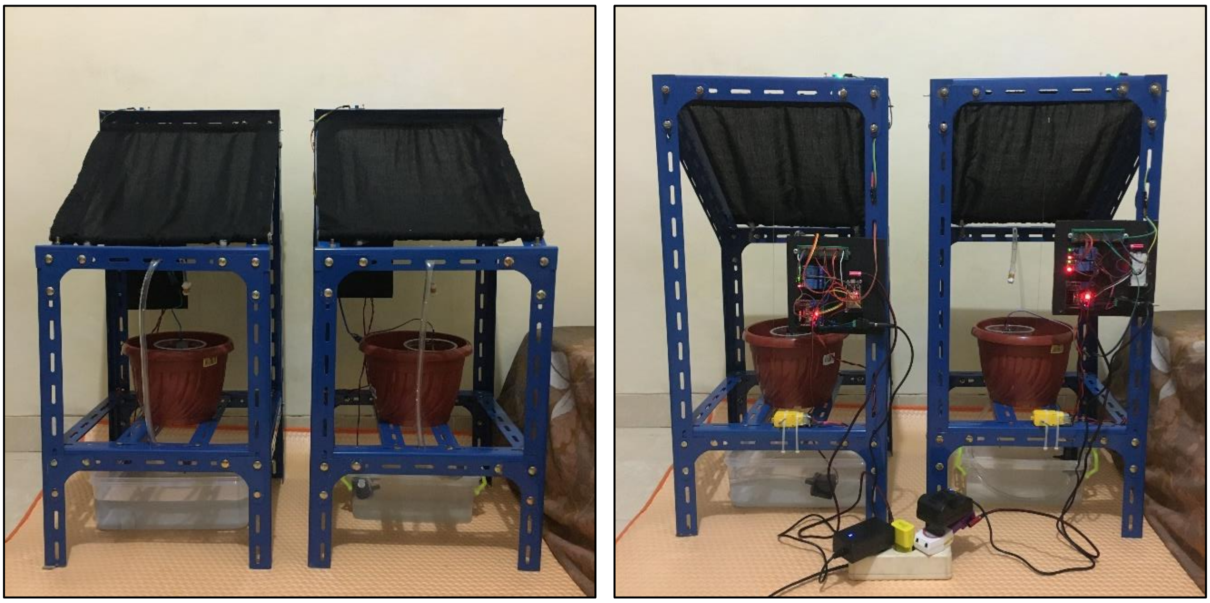



**Figure 2.** System Flowchart

The frame of this system is made using a metal hole angled and shown in Figure 3. The system consists of two identical sub systems. Each sub systems have different IP addresses. Moreover, it have two sensors, that are soil moisture and LDR sensor, and two actuators, that are water pump and DC motor to water the plan and push-pull the black curtain plant cover. The use of two identical sub systems is to test the performance of IoT platform based on the two different IP addresses.



(a). Front view (b). Back view

**Figure 3.** Design of the Hardware Model

## 3. Result and Discussion

Table 1 show the results of the data from the system testing used to measure the success rate. System testing is carried out in several parts, namely the sensor which is *soil moisture* able to detect soil, dry, moist and wet conditions. The LDR sensor is able to detect light intensity. The actuator DC motor is able to open and close plant curtains and a water pump can water plants. All of the data obtained is sent to Blynk successfully.

**Table 1**. Overall System Test Result

| No | Light Condition | DC Motor | Plant Curtain | Soil Condition | Water Pump | Send Data to Blynk | Note |
|---|---|---|---|---|---|---|---|
| 1 | Dark | OFF | CLOSE | DRY | ON | YES | Success |
| 2 | Lamp 5 Watt | OFF | CLOSE | | | YES | Success |
| 3 | Lamp 15 Watt | OFF | CLOSE | | | YES | Success |
| 4 | Lamp 25 Watt | OFF | CLOSE | MOIST | OFF | YES | Success |
| 5 | Lamp 40 Watt | OFF | CLOSE | | | YES | Success |
| 6 | Lamp 60 Watt | ON | OPEN | WET | OFF | YES | Success |
| 7 | Lamp 100 Watt | ON | OPEN | | | YES | Success |

**Table 2**. Test Result of Plant Watering Sub System 1

| No | Test # | Soil Moisture Sensor Value | ADC | Soil Condition | Analog reading | Digital reading | Pump ON (Second) | Note |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 4095 | 3.3V | DRY | DRY | DRY+ | 16.17 | Success |
| | 2 | 4095 | 3.3V | DRY | DRY | DRY+ | 16.92 | Success |
| | 3 | 4095 | 3.3V | DRY | DRY | DRY+ | 20.58 | Success |
| | 4 | 4095 | 3.3V | DRY | DRY | DRY+ | 22.04 | Success |
| | 5 | 4095 | 3.3V | DRY | DRY | DRY+ | 31.16 | Success |
| 2 | 1 | 1641 | 1.33V | MOIST | MOIST | NOR | 0 | Success |
| | 2 | 1759 | 1.42V | MOIST | MOIST | NOR | 0 | Success |
| | 3 | 1821 | 1.47V | MOIST | MOIST | NOR | 0 | Success |
| | 4 | 2055 | 1.65V | MOIST | MOIST | NOR | 0 | Success |
| | 5 | 2352 | 1.9V | MOIST | MOIST | NOR | 0 | Success |
| 3 | 1 | 1008 | 0.82V | WET | WET | WET+ | 0 | Success |
| | 2 | 1052 | 0.89V | WET | WET | WET+ | 0 | Success |
| | 3 | 1103 | 0.92V | WET | WET | WET+ | 0 | Success |
| | 4 | 1133 | 0.92V | WET | WET | WET+ | 0 | Success |
| | 5 | 1112 | 0.9V | WET | WET | WET+ | 0 | Success |

**Table 3**. Test Result of Plant Watering Sub System 1

| No | Test # | Soil Moisture Sensor Value | ADC | Soil Condition | Analog reading | Digital reading | Pump ON (Second) | Note |
|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 4095 | 3.3V | DRY | DRY | DRY+ | 16.32 | Success |
| | 2 | 4095 | 3.3V | DRY | DRY | DRY+ | 16.85 | Success |
| | 3 | 4095 | 3.3V | DRY | DRY | DRY+ | 20.16 | Success |
| | 4 | 4095 | 3.3V | DRY | DRY | DRY+ | 21.7 | Success |
| | 5 | 4095 | 3.3V | DRY | DRY | DRY+ | 30.29 | Success |
| 2 | 1 | 1708 | 1.38V | MOIST | MOIST | NOR | 0 | Success |
| | 2 | 1762 | 1.42V | MOIST | MOIST | NOR | 0 | Success |
| | 3 | 1835 | 1.48V | MOIST | MOIST | NOR | 0 | Success |
| | 4 | 2032 | 1.64V | MOIST | MOIST | NOR | 0 | Success |
| | 5 | 2384 | 1.92V | MOIST | MOIST | NOR | 0 | Success |
| 3 | 1 | 1023 | 0.84V | WET | WET | WET+ | 0 | Success |
| | 2 | 1072 | 0.88V | WET | WET | WET+ | 0 | Success |
| | 3 | 1141 | 0.92V | WET | WET | WET+ | 0 | Success |
| | 4 | 1210 | 0.98V | WET | WET | WET+ | 0 | Success |
| | 5 | 1125 | 0.94V | WET | WET | WET+ | 0 | Success |

Table 2 and Table 3 shows that analogue reading from sensors and digital value from ADC can detect soil conditions when it is dry, moist or wet. The tests for each condition were done 5 times. When the soil condition is dry, the analogue value is 4095 and ADC value is 3.3V. The water pump will turn on. When the condition is moist or wet, the water pump will turn off. The soil moisture sensor and the DC pump work well according to the design with 100 % success rate.

Table 4 and Table 5 show the test result of plant cover of sub system 1 and 2. When the lights are dark, 5 Watt, 15 Watt, 25 Watt and 40 Watt, the DC motor is OFF. When use the lamp of 60 Watt and 100 Watt, the DC motor is ON. The digital light meter shows the measurement of the lux value of each lamp condition. When the analogue sensor value increase, the lux value will decrease and vice versa. The LDR sensor and DC motor work well with a 100 % success rate.

**Table 4**. Test Result of Plant Cover Sub System 1

| No | Lamp Condition | LDR Value | ADC | Digital Light Meter AS803 | DC Motor | Note |
|---|---|---|---|---|---|---|
| 1 | Dark | 4095 | 3.3V | 0 lux | OFF | Success |
| 2 | 5 W | 2538 | 2.05V | 3 lux | OFF | Success |
| 3 | 15 W | 2384 | 1.92V | 5 lux | OFF | Success |
| 4 | 25 W | 2128 | 1.74V | 10 lux | OFF | Success |
| 5 | 40 W | 1606 | 1.3V | 22 lux | OFF | Success |
| 6 | 60 W | 1358 | 1.09V | 36 lux | ON | Success |
| 7 | 100 W | 974 | 0.78V | 78 lux | ON | Success |

**Table 5**. Test Result of Plant Cover Sub System 2

| No | Lamp Condition | LDR Value | ADC | Digital Light Meter AS803 | DC Motor | Note |
|---|---|---|---|---|---|---|
| 1 | Dark | 4095 | 3.3V | 0 lux | OFF | Success |
| 2 | 5 W | 2445 | 1.97V | 3 lux | OFF | Success |
| 3 | 15 W | 2346 | 1.88V | 5 lux | OFF | Success |
| 4 | 25 W | 2110 | 1.7V | 10 lux | OFF | Success |
| 5 | 40 W | 1685 | 1.36V | 22 lux | OFF | Success |
| 6 | 60 W | 1454 | 1.33V | 36 lux | ON | Success |
| 7 | 100 W | 1125 | 0.91V | 78 lux | ON | Success |

## 4. Conclusion

The system works well as it was designed. Both of sub systems can send data to the Blynk correctly. Sprinkler work well with 100% success rate. Soil moisture sensor and LDR can detect soil and sun light condition as it specification range. Water pump will water the soil when the condition is dry.

## Acknowledgments

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## References

[1] Purnawarman R 2004 *AT89C51 Microcontroller Based Automatic Plant Watering Tool* Final Project, Sanata Dharma University, Yogyakarta.

[2] Pardede F O I and Simamora B A 2020 Designing Automatic Sprinklers and Web-Based Plant Monitoring Using a Microcontroller *Jurnal Mantik* **4** (3) 2232-2236

[3] Kumar J, Gupta N, Kumari A and Kumari S 2019 Automatic plant watering and monitoring system using NodeMCU *2019 9th International Conference on Cloud Computing, Data Science & Engineering* 545-550

[4] Bhardwaj S, Dhir S and Hooda M 2018 Automatic plant watering system using IoT *2018 Second International Conference on Green Computing and Internet of Things* 659-663

[5] Monica M, Yeshika B, Abhishek G S, Sanjay H A and Dasiga S 2017 IoT based control and automation of smart irrigation system: An automated irrigation system using sensors, GSM, Bluetooth and cloud technology *2017 International Conference on recent innovations in signal processing and embedded systems* 601-607

[6] Johar R, Bensenouci A and Bensenouci M A 2018 IoT based smart sprinkling system. In *2018 15th Learning and Technology Conference* 147-152

[7] Kuncoro A H, Mellyanawaty M, Sambas A, Maulana D S, Subiyanto and Mamat M 2020 Air Quality Monitoring System in the City of Tasikmalaya based on the Internet of Things (IoT) *Jour of Adv Research in Dynamical & Control Systems* **12** (2) 2473-2479

[8] Gunawan M S 2018 Automatic Water Sprinkler using Soil Moisture Sensor *Journal of Electrical Technology* **3** (1) 1-15

[9] Prasojo I, Maseleno A and Shahu N 2020 Design of automatic watering system based on Arduino *Journal of Robotics and Control* **1** (2) 59-63

[10] Noerhayati E, Dwisulo B and Rahmawati A 2020 Sprinkler irrigation design with microcontroller based on IoT *IOP Conference Series: Earth and Environmental Science* **456** (1) 012063

[11] Chowdhury B S and Raghukiran N 2017 Autonomous sprinkler system with Internet of Things *International Journal of Applied Engineering Research* **12** (16) 5430-5432

[12] Athawale S V, Solanki M, Sapkal A, Gawande A and Chaudhari S 2020 An IoT-Based Smart Plant Monitoring System *Smart Computing Paradigms: New Progresses and Challenges* 303-310