

# Performance of Solar Energy Watering Cassava Crop Systems with Systems Control by Smartphone

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**Abstract:** In this paper, design and development solar energy watering cassava crop systems with systems control by smartphone is presented. The objective is study the performance of the watering system by smartphones. The hardware component was Arduino Uno, Wi-Fi module, water pump, relay, solar panels, battery, smart phone and blynk applications, respectively. The design and development of the prototype watering cassava crop system with controlled by smartphones and write program command code for systems control by using blynk applications. This research was studied working distance incase with or without obstruction and studied working of water pump and solenoid valve, respectively. From the experiment results of the solar energy watering cassava crop systems that smartphone can ON-OFF solenoid valve to open or close water flow of 0-50 meters (diameter =100 m) in case without obstruction, 0-30 meters (diameter = 60 m) in case with obstruction, working distance of moisture sensor of 0-90 meters, water pump and solenoid valve can work precisely, respectively. Moreover, the experimental results of monitoring of watering cassava crop system by smartphone as follows: the average temperature of 36C°, average ambient humidity of 50%, and average soil moisture of 60%, respectively. Therefore, the watering cassava crop systems with systems control using smartphone can use for the communities to reduce time, increase efficiency and increase the productivity of the community sustainably.

**Keywords:** Microcontroller; arduino; cassava; watering systems; solar cell

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## 1. INTRODUCTION

Nowadays, water is very important for the cassava crop plant in Thailand. The volume cropping of cassava in 2020 in Thailand of 1.95 million acres. Various factors contribute to the yield of cassava crops such as proper soil preparation, different varieties of crops and respective techniques for production. The chemical fertilizer is volume added to the soil, various natural hazards occurring in the cultivated place, number of seeds added in the related area, proportion of moisture in the fields, plant disease detection and adoption of modern technologies, respectively. The water is a mainly factor to helping in the growth of cassava crop plant. In the summer season, the cassava crop plant need water for help watering of the plant. Since water in Thailand have the water limited. Therefore, if have the watering systems for management of the water. Currently, technology internet of thing (IoT) is technology for support management of the water. The mainly benefits that farmers get from IoT application in agriculture such as, increase in the yielding,

benefit is the cost of production, reduces the wastage coming from the production and automates the most of the processes, respectively.

Therefore, several researchers are design and development systems for agriculture plant. In 2013, the researcher designed a system that can be controlled its performances using short text message (SMS) from the cell phone [1-3]. This research has been implemented the monitoring systems by using GSM with a digital mobile telephone system. According to Louis D. Albright, Robert W. Langhans (2015), the author used sensor devices coupled with wireless technologies to monitor the temperature, humidity and moisture [4]. The details of their ideas are having a wireless sensor that connects through a Wi-Fi to a Central Monitoring Station through General Packet Radio Station. In addition, it also connects with Global Positioning System (GPS) to send message to the central monitoring station. The other researcher is studied online control of remote agricultural robots operated using fuzzy controllers and virtual instrumentation. The system in the robot consisted of a microcontroller, a DC motor, and a Fuzzy

logic controller algorithm [5]. Polpitiya and et. al. are design wireless agricultural sensor networks consisting of a temperature sensor, a humidity sensor, a pH level sensor, a light sensor, a microcontroller, and a WSN [6]. The monitored and controlled the aeroponic growth system for potato production by Idris and Muhammad Ikhsan Sani. This system consisted of a microcontroller, a temperature sensor and pH, humidity, and fogging sensors [7]. Mahamai, P. et al. [8] have proposed automatic watering using solar PV tracking to the longan. This application is suitable for areas without electricity system. The research in [9] proposed an automatic watering system by wireless network based on Arduino Uno R3 microcontroller and Xbee wireless module. In addition, the satisfaction of wireless communication is also considered. Some researchers have proposed microcontrollers based irrigation systems for solving a serious problem of food in India [10]-[11]. Nevertheless, we consider that those of the systems may also improve and deployment the growing up of vegetables and provide more agricultural outputs. A watering system should be modifying for increase performance and more control by using smartphone and use solar energy for support systems in the area without electricity. Therefore, it should be improving system for support solar energy watering cassava crop systems with systems control by smartphone.

In this paper presents design and development of watering cassava crop systems with systems control through smartphone by using solar energy. The objective is study the performance of the watering system by smartphones. The prototype of watering systems use hardware component are Arduino Uno, Wi-Fi module, water pump, relay, solar panels, battery, smart phone and blynk applications, respectively. This research is studied working distance incase with or without obstruction and studied working of water pump and solenoid valve, respectively. Improve the watering cassava crop systems with systems control using smartphone can use for the communities to reduce time, increase efficiency and increase the productivity of the community sustainably. Detail the experiment results and discussion show in next section.

## 2. THE MATERIAL AND METHODS

### 2.1 Hardware component

All this system some hardware components use for sensing the inputs signal and operate accurately to get the exact outputs. Arduino Uno are control the components by programming the software code.

#### 2.1.1 Arduino Uno

Arduino Uno is Arduino boards used interfaced between various expansion boards and other circuits used for digital electronics. The Arduino UNO has 14 digital in/out pins and 6 Analog in/out pins. This analog in/out pins are best useful for analog sensor. In this system Arduino UNO board use as the brain that read input signal from the sensors and then process and generate output signal to the motor driver relay. Perform the necessary functions by connected the various components.

#### 2.1.2 Soil Moisture Sensor

Soil Moisture Sensor has two conducting plates to sense the moisture level in the soil. The sensor measures the moisture level of the soil by passing electric current through the two plates. The soil conducts more electricity, lower resistance when there is more water. The soil conducts less electricity, higher resistance when there is dry, less water. The moisture sensor placed in the soil to measure the moisture level of soil.

#### 2.1.3 Relay

Relay is devices that used low power signal to control another high power circuit while they are completely separate. It is electromagnetic device, which is use to connect two circuits magnetically and isolate them electrically. A relay switch can be divide into input and output. The input section has a coil, which generates magnetic field when a small voltage from an electronic circuit is apply to it. This voltage is call the operating voltage. Commonly used relays are available in different configuration of operating voltages. This research uses the relay modules that are powered using 3.3V, which is ESP8266.

#### 2.1.4 Water power pump

Water power pump is a device that transfer water, fluids or liquids from lower place to higher place or far place by mechanical action. It can classify into three major groups according to the method they use to move the fluid direct lift, displacement, and gravity pumps. Pumps operate by some mechanism and it consume energy to perform mechanical work by moving the fluid. Pumps operate by many energy including manual operation electricity, engines, or wind power come in many sizes, from microscopic for use in medical applications to large industrial pumps. This research uses solar powered water pump DC 12V.

#### 2.1.5 Solar cell

Solar cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is a physical and chemical phenomenon. It is a photoelectric cell defined as a device whose electrical characteristics, such as, current, voltage, or resistance, vary when exposed to light. Individual solar cell devices are often the electrical building blocks of photovoltaic modules, known colloquially as solar panels. This research uses solar panels of DC 12V, 150 W.

#### 2.1.6 Battery

Battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry. During a discharge cycle, lithium atoms in the anode are ionized and separated from their electrons. This research use battery of DC 12V, 20 Ah.

#### 2.1.7 Solenoid valve

Solenoid valve is a valve system by using electrical energy to control the valve opening and closing. By sending electrical energy to the magnetic coil and control valve for ON-OFF water systems.

#### 2.1.8 Smartphone

Smartphone is a mobile or cellular phone that runs off a mobile operating system and functions like a mini computer. Smartphones also function as portable media players, digital cameras, video cameras and GPS navigational devices. The operating system equips the device with advanced computing capabilities, runs applications and enables the device to perform the following basic features.

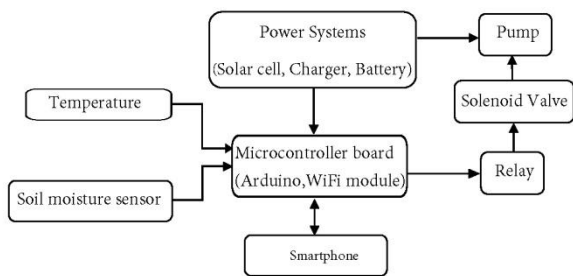
#### 2.1.9 Blynk

Blynk is a platform with iOS and Android apps to control, ESP8266, Rasperry Pi and the likes over the Internet. It has can easily build graphic interfaces for all your projects by simply dragging and dropping widgets.

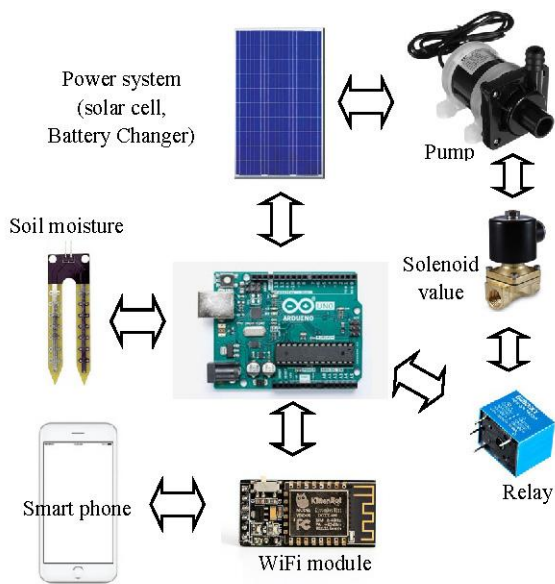
### 3. DESIGN of WATERING CASSAVA CROP SYSTEMS THROUGH SMART PHONE

#### 3.1 Structure of watering cassava crop systems through smart phone

The design and development of solar energy watering cassava crop systems with systems control by smartphone. The structure of the proposed systems composes the prototype of a watering system and programming to control the operation of the watering system for cassava that is controlled by mobile phone. The block diagram of watering cassava crop systems through smart phone as shown in figure 1(a) and picture of watering cassava crop systems through smart phone, as shown in finger 1(b).



(a) Block diagram of watering cassava crop systems through smart phone



(b) Picture of watering cassava crop systems through smart phone

Figure 1. Watering Cassava Crop systems through Smart Phone

The design and development of watering cassava crop systems by control through smartphone as following:

1. Create the systems by connecting between device are the solar panel, the controller charger, battery, Arduino UNO control board, relay, water power pump to soil moisture sensor for control solenoid value ON-OFF system.

2. Microcontroller [12] board that is compatible with Arduino Uno and has ESP8266EX as an integrated Wi-Fi module. In this prototype for controls other electronic components such as soil moisture sensor, relay, solenoid valve and watering pipe. The ESP8266EX as the Wi-Fi module built-in the board, serve to connect the watering device.

3. Soil Moisture sensor [13] is to detect soil moisture or can be used to determine whether Moisture in the soil around the sensor. The soil moisture sensor is the sensor used to the soil to detect moisture.

4. When soil moisture has reached the specified value, it sends a command to the relay. The relay is device will act connected to the solenoid valve to open or close water flow.

5. Smartphone is device for control ON-OFF the water flow by Wi-Fi module with design command code for systems control by Blynk Apps [14].

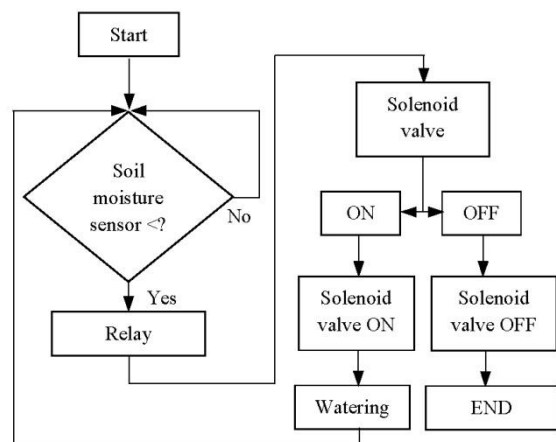
The prototype of watering cassava crop systems through smart Phone, as shown in figure 2.



Figure 2. Prototype of watering cassava crop systems through smart Phone

#### 3.2 Controllable of the watering cassava crop systems through smartphone

The watering cassava crop systems through smartphone is presented. One part of systems is program command code for systems control by using Blynk apps installed on smartphone to control ON-OFF the watering systems, as show in figure 3.



(a) Block diagram



(b) Smartphone display

Figure 3. Smartphone display and block diagram of watering cassava crop systems through smart phone

From figure 3, show the smartphone display and block diagram of watering cassava crop systems through smart phone. This systems using Arduino Uno R3 will process to enter the process of sending on-off data to relay to turn ON-OFF electromagnetic valve through smartphone.

#### 4. RESULTS OF WATERING CASSAVA CROP SYSTEMS

This researcher, we studied performance of solar energy watering cassava crop systems with systems control by smartphone as following:

##### 4.1 The experiment working distance between cassava crop watering system and smartphone

First, the experiment working distance of watering systems for find distance between cassava watering system and smartphone in case without obstruction. In this case, we studied the performance of watering systems 5 trials and study distance of 10-100 meters. The experiment results are shown in table 1.

Table 1. Experiment results of distance between cassava crop watering system and smartphone in case without obstruction

Order	Experiment	Distance (m)									
		10	20	30	40	50	60	70	80	90	100
1	Working distance between cassava crop watering system and smartphone No. 1	✓	✓	✓	✓	✓	×	×	×	×	×
2	Working distance between cassava crop watering system and smartphone No. 2	✓	✓	✓	✓	✓	×	×	×	×	×

3	Working distance between cassava crop watering system and smartphone No. 3	✓	✓	✓	✓	✓	×	×	×	×	×
4	Working distance between cassava crop watering system and smartphone No. 4	✓	✓	✓	✓	✓	×	×	×	×	×
5	Working distance between cassava crop watering system and smartphone No. 5	✓	✓	✓	✓	✓	×	×	×	×	×

From the experiment results of the performance working watering systems for find distance between cassava crop watering system and smartphone in case without obstruction in table 1. The experiment results of systems can ON-OFF solenoid valve to open or close water flow from smartphone of 10-50 meters (diameter =100 m).

Second, the experiment working of watering systems for find distance between cassava watering system and smartphone in case with obstruction. In this case, we studied the performance of watering systems 5 trials and study distance of 10-100 meters. The experiment results as shown in table 2.

Table 2. Experiment results of distance between cassava crop watering system and smartphone in case with obstruction

Order	Experiment	Distance (m)									
		10	20	30	40	50	60	70	80	90	100
1	Working distance between cassava crop watering system and smartphone No. 1	✓	✓	✓	×	×	×	×	×	×	×
2	Working distance between cassava crop watering system and smartphone No. 2	✓	✓	✓	×	×	×	×	×	×	×
3	Working distance between cassava crop watering system and smartphone No. 3	✓	✓	✓	×	×	×	×	×	×	×
4	Working distance between cassava crop watering system and smartphone No. 4	✓	✓	✓	×	×	×	×	×	×	×
5	Working distance between cassava crop watering system and smartphone No. 5	✓	✓	✓	×	×	×	×	×	×	×

From the experiment results of the performance working watering systems for find distance between cassava crop watering system and smartphone in case with obstruction in

table 2. The experiment results of systems can ON-OFF solenoid valve to open or close water flow from smartphone of 0-30 meters (diameter = 60 m). The experiment, it was found that working distance decrease because obstruction.

### 4.2 The experiment working distance of moisture sensor

This section shows the experiment working distance of moisture sensor for open or close water flow. In this case, we studied the performance of watering systems in five trials and study distance of 10-100 meters. The experiment results are shown in table 3.

**Table 3. The experiment working distance of moisture sensor**

Order	Experiment	Distance (m)									
		10	20	30	40	50	60	70	80	90	100
1	working distance of moisture sensor No. 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
2	working distance of moisture sensor No. 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
3	working distance of moisture sensor No. 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
4	working distance of moisture sensor No. 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
5	working distance of moisture sensor No. 5	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗

From table 3 show the experiment working distance of moisture sensor. The experiment results working distance of moisture sensor of 0-90 meters.

### 4.3 The experiment working of water pump and solenoid valve

This section shows the experiment working of water pump and solenoid valve in different conditions. In this case, we studied the performance of watering systems in five trials and study operation of the water pump and solenoid valve in different conditions. The experiment results as shown in table 4-5.

**Table 4. Operation of the water pump in different conditions**

Experiment	Pump status	
	close	open
Experiment No.1 (wet)	✓	-
Experiment No.2 (dry)	-	✓
Experiment No.3 (wet)	✓	-
Experiment No.4 (dry)	-	✓
Experiment No.5 (wet)	✓	-

From table 4 show the experiment of the operating water pump in different conditions. The experiment results of the operating water pump in case of wet, water pump of close (OFF) and in case dry, the water pump of open (ON), respectively.

**Table 5. Operation of the solenoid valve in different conditions.**

Experiment	Solenoid valve status	
	close	open
Experiment No.1 (wet)	✓	-
Experiment No.2 (dry)	-	✓
Experiment No.3 (wet)	✓	-
Experiment No.4 (dry)	-	✓
Experiment No.5 (wet)	✓	-

From table 5 show the experiment operating of the solenoid valve in different conditions. The experiment results of the operating solenoid valve in case of wet, solenoid valve of close (OFF) and in case dry, the solenoid valve of open (ON), respectively.

This section, we studied performance of solar energy watering cassava crop systems with systems control using smartphone in Kamphaeng Phet, Thailand. The monitoring of watering cassava crop systems consist temperature, moisture sensor and humidity sensor, respectively. The experiment results as shown in figure 4.

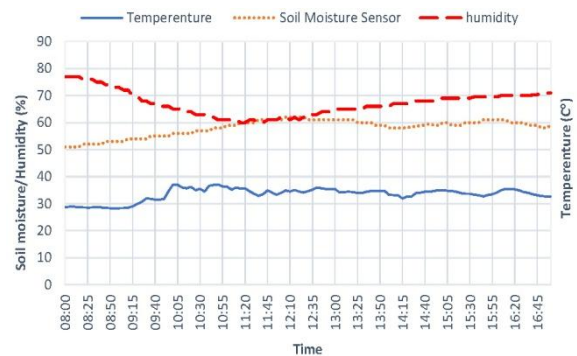


Figure 4. Monitoring of watering cassava crop systems

From figure 4 shows the experimental results of monitoring of watering cassava crop system by smartphone as follows: the average temperature of 36°C, average ambient humidity of 50%, and average soil moisture of 60%, respectively. Therefore, performance of the watering cassava crop systems with systems control using smartphone can use for the communities to reduce time, increase efficiency and increase the productivity of the community sustainably.

#### 4. CONCLUSION

The design and development of watering cassava crop systems with systems control using smartphone. This research using solar energy for management power energy. From the experiment results of the watering cassava crop systems as follow: smartphone can ON-OFF solenoid valve to open or close water flow of 0-50 meters (diameter =100 m) in case without obstruction, 0-30 meters (diameter = 60 m) in case with obstruction, working distance of moisture sensor of 0-90 meters, water pump and solenoid valve can work precisely, respectively. Moreover, the experimental results of monitoring of watering cassava crop system by smartphone as follows: the average temperature of 36°C, average ambient humidity of 50%, and soil moisture of 60%, respectively. Therefore, the watering cassava crop systems with systems control using smartphone can use for the communities to reduce time, increase efficiency and increase the productivity of the community sustainably.

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