

Smart Irrigation and Fertigation

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Abstract: Intelligent irrigation system for fertigation system is a project that able to improve a new modern life, especially inconsistent crop production and the very high cost of fertilizers and pesticides. The objective of this project is to study about the fertigation system used in the agricultural sector in Malaysia and build a prototype of intelligent irrigation system for a fertigation. Irrigation systems are used for agricultural crops based on small scale leafy vegetables plant. The irrigation system will be activated based on set of schedule and solenoid valve is used to control water flow in the irrigation system. In this project a simulation based on Arduino Uno microcontroller has been develop using Proteus software. The primary goal of this initiative is to help facilitate modern farmers in the fertilization process.

Keywords: Fertigation, Sensor, Farmer

1. Introduction

Fertigation can be defined as a method of cultivation in which fertilizer (in the form of solution/nutrient) is distributed to the root zone of the plant through an irrigation system. Smart fertilization is a method of fertilizer application that uses an irrigation system to deliver dissolved fertilizer to crops. According to the plant growth cycle, it only provides the right combination of water and nutrients directly to the roots of each plant. It is ideal for commercial automated greenhouses, hydroponic enterprises, and agricultural land. Compared to traditional irrigation methods, intelligent fertigation system management is proven to produce better yields and quality for high value crops such as mustard, chili, cucumber and tomato. Crop modelling is the simulation and modelling of a crop yield as a function of local weather, soil conditions, and crop management strategies. Empirical models, statistical models, functional models, and mechanistic models are some examples. Precision agriculture is an empirical model that is based on soil moisture, local weather conditions, fertilizer treatment, and facility agriculture. Intensive labor engagement combined with sophisticated contemporary agriculture technology is referred to as facility agriculture. Precision agriculture is mostly based on climate data

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such as temperature and precipitation; crops require favorable local conditions and enough soil moisture levels to thrive.

1.1 Problem Statement

Farmers in the current era are experiencing various problems, especially inconsistent crop production and the very high cost of fertilizers and the first problem that arises is involving the output. Farmers have limited resources such as fertilizers, fertilizers, utilities and manpower. In addition, farmers lack commitment to maintain crop quality and consistency. In addition, farmers also have issues with land types that are not suitable for cultivating their crops as well as limited land resources. In fact, they also have to deal with a workforce that is less interested in agriculture as well as high demand for wages and undisciplined.

1.2 Objective and Project Scope

The objective of the project is to study the fertigation system used in the agricultural sector in Malaysia and build an intelligent irrigation system simulation for a fertigation system. The scope of the project is to study the irrigation system used by modern farmers in Malaysia. To build a smart irrigation system based on the Arduino Uno micro controller. Irrigation systems are used for agricultural crops based on leafy vegetables on a small scale. The irrigation system can control the amount in the fertilization system based on the set planting schedule. Fertilizer watering will be done periodically according to the prescribed irrigation schedule. In addition, a simple display of a web -based irrigation system will be built.

2. Materials and Methods

2.1 Materials

Table 1: Material of project

Item	Component	Quantity	Description
1	Arduino Uno	1	Processing data and signal
2	Solenoid valve	2	Acting as a valve
3	Ultrasonic sensor	1	To detect a water level
4	Temperature and humidity sensor	1	To measure a temperature and humidity
5	LED 1(yellow)	1	Acting as a water pump
6	LED 2 (red)	1	Acting as a fertilizer pump
7	LED 3 (green)	1	Acting as mixed pump
8	LED 4 (yellow)	1	Acting as solenoid 1
9	LED 5 (blue)	1	Acting as a solenoid 2
10	Resistor	6	Create a resistance in the circuit

Table 1 shows the component that we use for this project. Proteus software has been used for the simulation. Arduino Uno is used as a microcontroller to process data and the signal and solenoid valve is used to control open and close the channel of water and fertilizer. Next, the ultrasonic sensor is used to measure the water level in mixed tank. Moreover, the temperature and humidity sensor has been installed to measure a temperature and humidity at the surrounding. Then, there are 5 difference color

of LED. LED 1 acting as a water pump to pump the water from the water reserve to mixed tank and plant. LED 2 acting as a fertilizer pump to pump the AB fertilizer from tank A and tank B to mixed tank. Then, LED 3 acting as a mixed pump to pump the water and fertilizer from mixed tank to plant. Next, LED 4 and 5 acting as valve so when the valve active in simulation the LED 4 and 5 will turn on to make sign that the valve was functioning. Lastly the function of resistor is to create a resistance in the circuit.

2.2 Methods

For this project, a smart irrigation and fertigation system simulation has been developed. After identifying the problems that farmers in the current era are experiencing various problems, especially inconsistent crop production and the very high cost of fertilizers because the old method of fertilizing and poisoning involves very high costs and also this method does not bring the desired results because each crop does not receive enough and even fertilizer. There are some types of irrigation and fertigation system has been explored and the type of design is the most appropriate has been chosen. Based on that problem that farmer, a simulation of smart irrigation system with a water pump, water tank and sensor are applied in this project.

Some study, analysis and comparison has been done before select each component that is used in this simulation. After the final list of component and materials is compiled and all the component is connected in the proteus software. When all the component are connected, the assembly session of the simulation is done according to what we have been discuss.

Next, the coding based on the operation is created using the Arduino IDE and proteus. Once everything is ready to be tested, the first test session is conducted to identify problems and shortcomings in this simulation. After placing all the deficiencies and issue that arise, troubleshooting session are undertaken to resolve those problem. Next, a final test is made to ensure that this simulation can be operate as prescribed while achieving our objectives. In addition, the Blynk used to display the result and condition this system. The simulation process of this project can be demonstrated through the flow chart in **Figure 1** below.

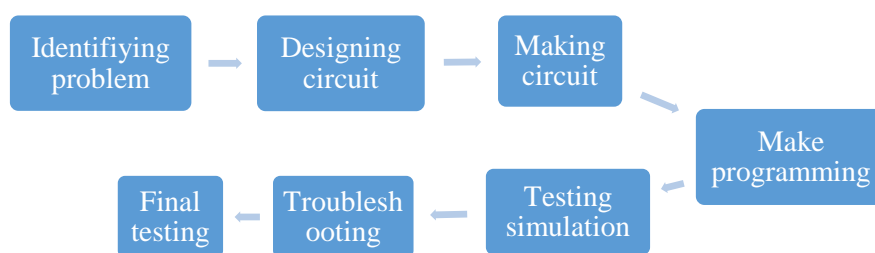


Figure 2.1: Flowchart for project construction

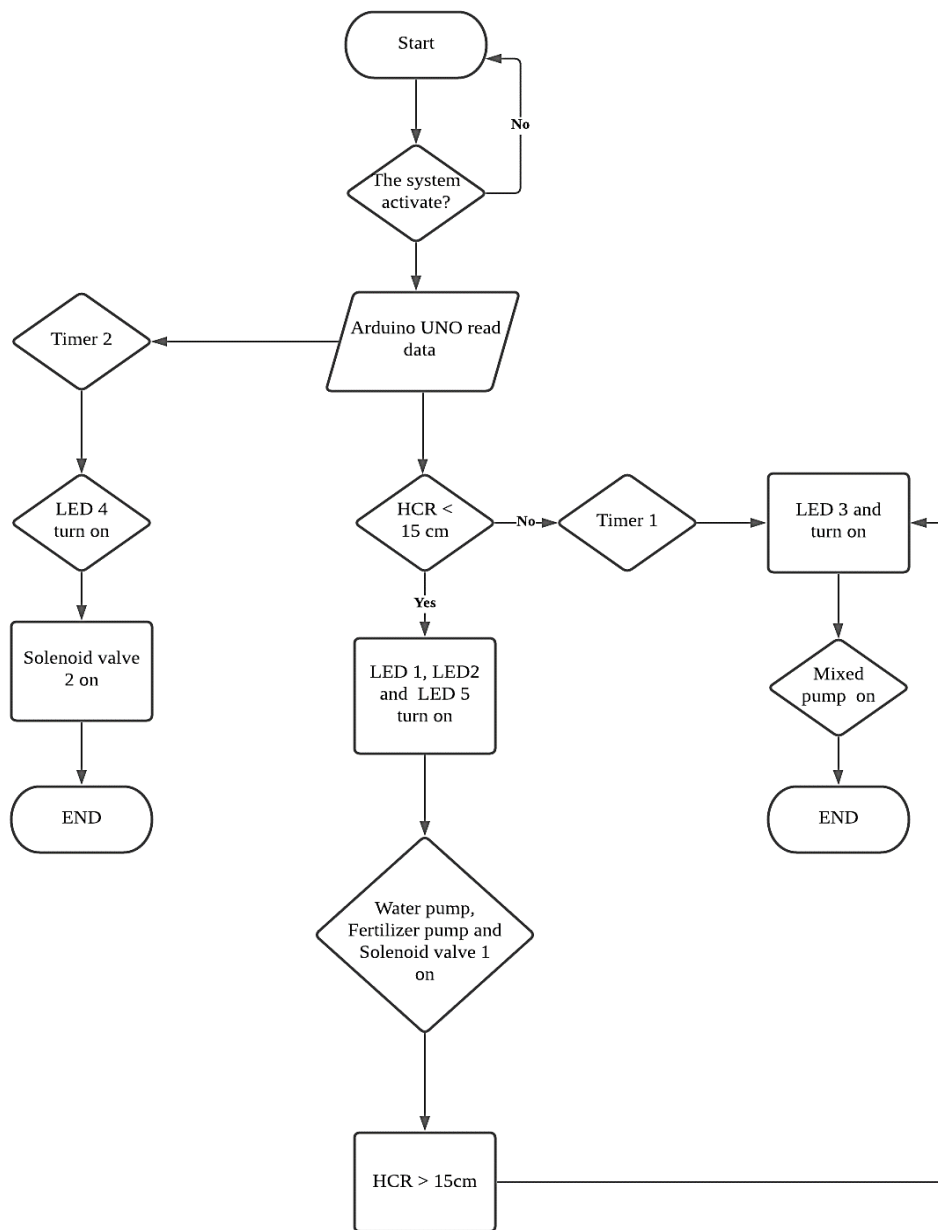


Figure 2: Flow chart

Table 2: Irrigation schedule

Day after planting	Estimated reading rate EC	Watering rate / day (ml)
1	1.8	500
7	2.0	500
14	2.2	600
21	2.4	800
28	2.6	900
35	2.8	1000
42	3.0	1000
49	3.2	1200
56	3.2	1400
64	3.2	1600
71	3.2	2000-25000

3. Results and Discussions

The smart fertigation and irrigation constructed. The first step in evaluating the irrigation system performance is to determine the smart irrigation and fertigation system functionality. The analysis was carried out in accordance with the project objective and scope as stated the chapter one. The performance analysis was carried out to see if the system that built was compatible with the user and complete the assignment.

Figures 3 until Figure 7(b) show the completely assembled for the smart irrigation and fertigation from the several views. The system has been installed with the kind of component as an Arduino Uno, temperature and humidity sensor and potentiometer.

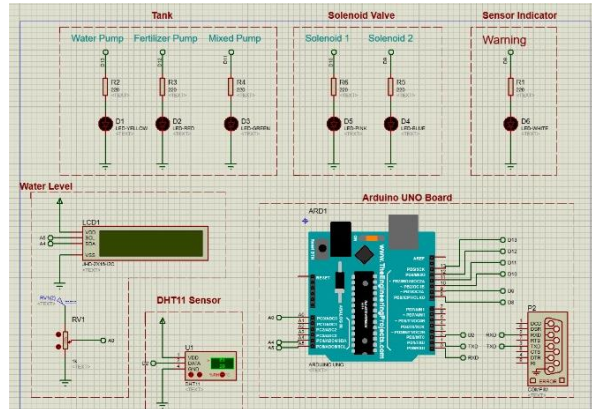
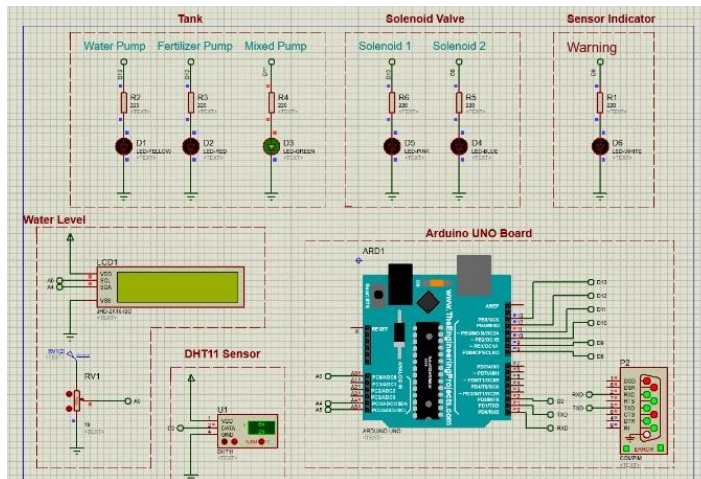
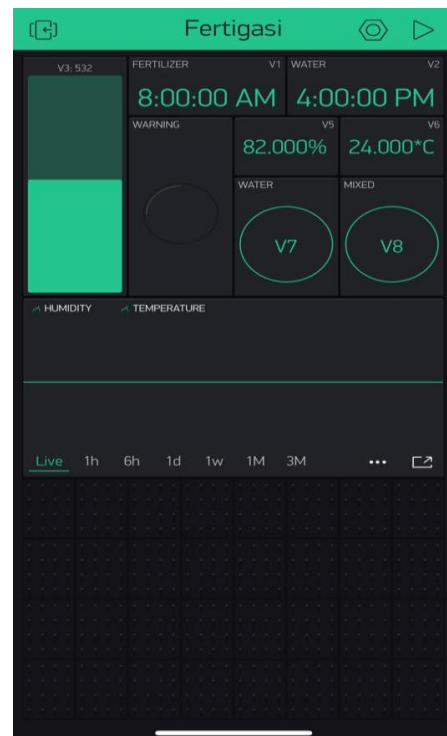


Figure 3: Simulation of fertigation and irrigation system



(a)



(b)

Figure 4: (a) Simulation of irrigation from tank to plan for the morning session, (b) The Blynk interface for simulation at figure 4(a)

The **Figure 4** shows about the irrigation at the morning session, the mixture of water and the fertilizer will be pumped to the plan. The time for irrigation for morning session is set at 8.00 a.m. it a good time for the put the fertilizer to the plan. In this simulation, the fertilizer pump will active when it reaches the time was set for irrigation. The water level in the mixed tank must always above the minimum capacity to make sure the fertilizer pump can active at the time was set. We are using the green colour Led as a fertilizer pump because proteus have the limitation in component. After the several testing, the Led not function because have the problem at the coding but after we doing the troubleshooting the Led was turn on that means the fertilizer was function like the instruction was given. Then at the same time the DHT11 sensor will sense and measure the temperature and humidity at the morning session. This sensor was connected to the Blynk widget. As the **Figure 4(b)** show the value that the sensor senses the temperature and humidity. So, the user will know the temperature and humidity at their farm.

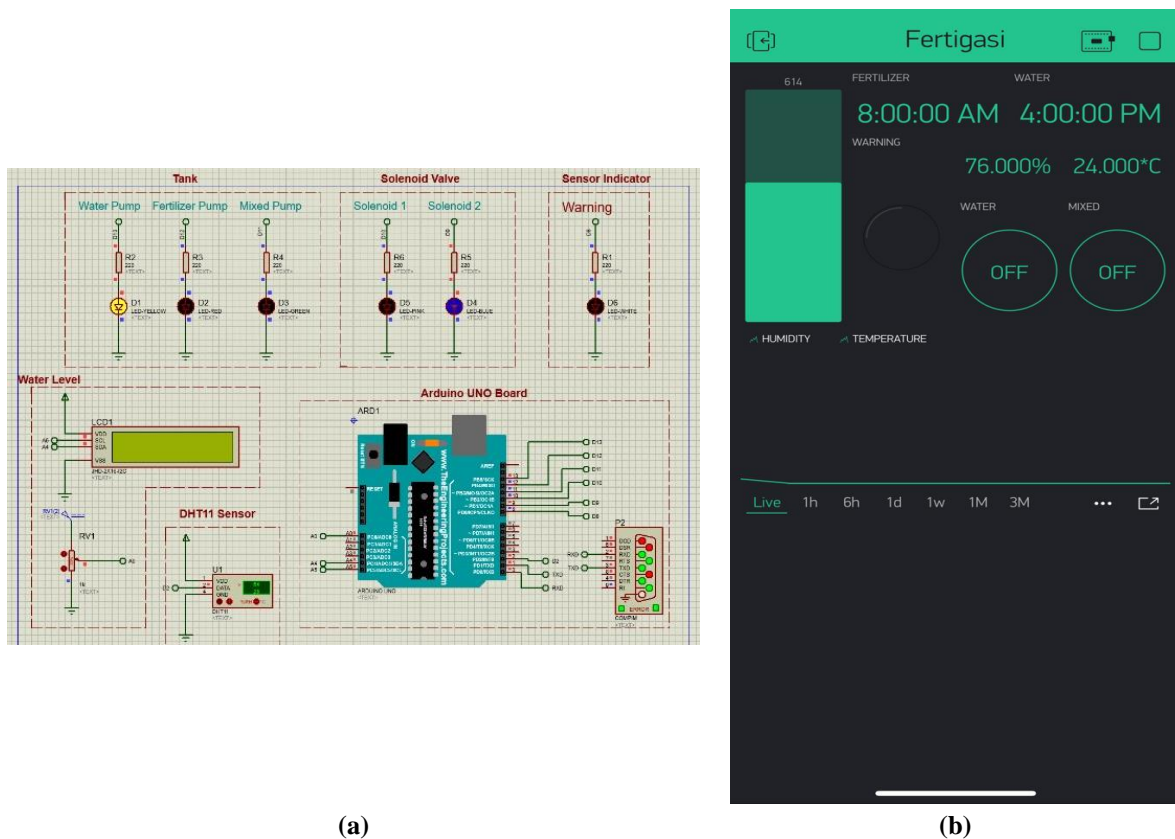
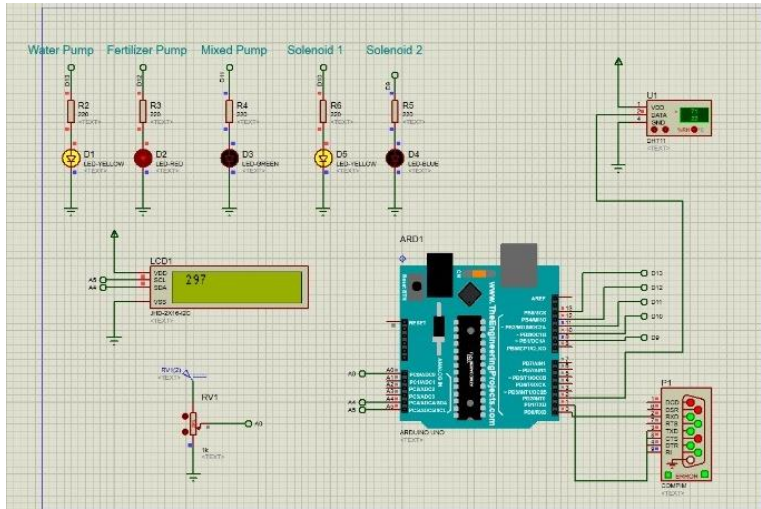
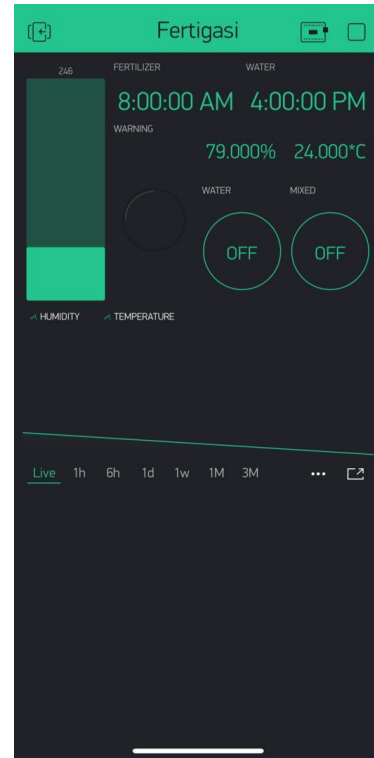


Figure 5: (a) Simulation of irrigation and Blynk interface from tank to plan for the evening session, (b) The Blynk interface for the simulation at figure 5(a)

The **Figure 5(a)** shows about the irrigation at the evening session, the water pump will pump the water from the reserve water tank to the plant. The time irrigation for the evening session is set at 4.00 p.m. The solenoid valve 1 will open to make sure the water will flow to the plant. The solenoid valve 2 will closed to avoid the water flow in to the mixed pump because at the evening session only the water will flow to the plant. In this simulation, led 1 will acting as a water pump and the led 5 will acting as the solenoid valve. After several testing, there have the little problem happen but after we doing the troubleshooting the problem was solve. The water pump and solenoid function like the instruction was given. Then at the same time the DHT11 sensor will sense and measure the temperature and humidity at the evening session. This sensor was connected to the Blynk widget. The **Figure 5(b)** show the value that the sensor sense for temperature and the humidity. It makes easier for the user to monitor their real situation at the farm while they're not there.



(a)



(b)

Figure 6: (a) Simulation if the water in the mixed tank not sufficient enough, (b) The Blynk interface for the simulation at figure 6(a)

The **Figure 6** shows about water level tank in mixed tank, the water and the fertilizer will be pumped into the mixed tank if the level water in mixed pump is not sufficient enough. In this simulation, the low level of mixed pump is set at 30% of maximum capacity of tank. At the first, ultra-sonic is used to measure the height of the tank. The maximum level of tank is measured to fund the maximum capacity of the tank. Then, low level is set based on 30% of minimum capacity of tank. After several testing, the uses of ultrasonic sensor, HS-SR04 module in proteus not function as predicted due to proteus limitation. Therefore, a potentiometer has been used as a substitute of ultra-sonic sensor. Potentiometer is connected to analog pin A0 at the Arduino board. It will give output from 0 to 1023 level as the output of analog to digital converter (ADC) in Arduino board. The minimum water level in mixed tank is 30% equal the 307 at the display. So, if the display shows the value below 307 that means is below than minimum water level in mixed tank so water pump and fertilizer pump will active to refill the mixed tank until it reaches the suitable EC rate.

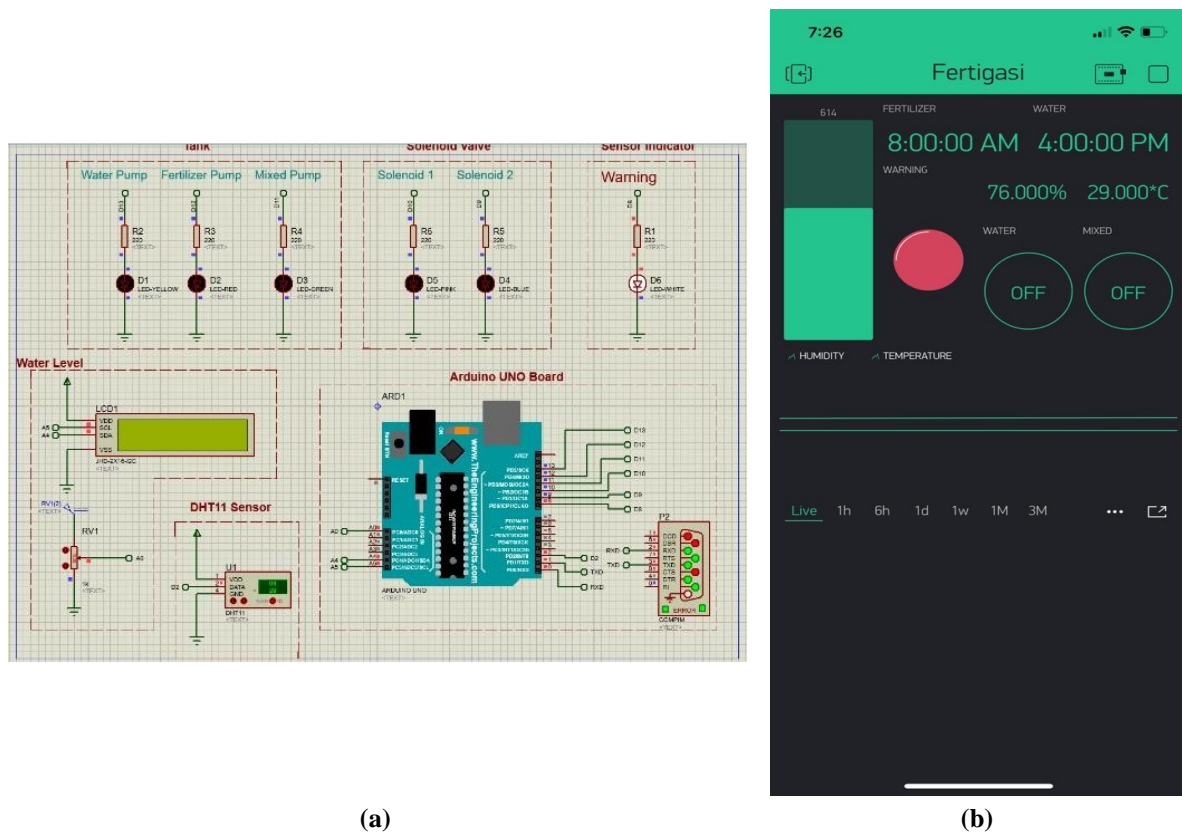


Figure 7: (a) Simulation for the sensor indicator, (b) The Blynk interface for the simulation at figure 7(a)

Figure 7(a) shows about indicator sensor, in this simulation Led 6 is connected to the DHT11 temperature sensor. When the temperature is more than 28 degrees Celsius, it will trigger LED 6 such as in **Figure 7(a)**. This LED is also connected to the Blynk LED widget. So, when this LED turns on, it will alert the user that the plant is exposed to a hot temperature and the user can take fast action to water the plant by himself. This is especially helpful during drought season if you want to make sure the plant is not dehydrated.

Table 3: Irrigation time

Irrigation time	Irrigation input
8.00 a.m.	Fertilizer + water
4.00 p.m.	Water

4. Conclusion

This proposed system mainly focused on automation of the drip irrigation and fertigation process using Arduino UNO. The implementation of demand-based algorithm saves processor machine cycles thereby increasing the lifetime of the Arduino UNO. The injection of exact amount of fertilizer to the crop in all phases balances the plant nutrient and reduces the soil erosion. Forwarding all the incoming notifications from Blynk to cloud storage provides the remotes access of data for the farmer. The proposed system greatly preserve water than traditional irrigation methods ensuring optimal growth in low cost, high reliability and accuracy.

Acknowledgement

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