Automated hydroponics nutrition plants systems using arduino uno microcontroller based on android

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Automated hydroponics nutrition plants systems using arduino uno microcontroller based on android

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Abstract. Technological developments today make the combination of science is very common, including in Computer Science and Agriculture to make both of science need each other. This paper aims to develop a control tool for the flow of nutrients of hydroponic plants automatically using Arduino microcontroller and controlled by smartphone. We use an Arduino Uno microcontroller to automatically control the flow of nutrient solution with *logic if else*. The microcontroller can also send data of fluid level (solution) and temperature around the plant to smartphone android of the owner of the hydroponics plant. The height of the nutrient solution (water) is detected by the Ultrasonic sensor HC-SR04 and the temperature is detected by the temperature sensor LM35. Data from the sensor will forward into Arduino Uno and displayed in liquid crystal display (LCD) then via wireless fidelity (WIFI) ESP8266 module will transmit the height of the nutrient solution and the temperature around of the plants to Android smartphone.

1. Introduction

Plant care is a routine and important activity to keep plants healthy and well groomed. Plant care includes many aspects i.e. watering, rejuvenation, fertilizer, and others. So many types of plants with different forms of treatment are different and all treatments are usually done manually. Although the types of plants are very diverse, water remains the main source of life for all plants to help the photosynthesis process, especially in plants Hydroponics that lives rely on nutrients from the water.
Hydroponics plants have various types of planting media such as Rockwell, sponge, coconut and other coconut powder. In the treatment of plants, Hydroponics is very important to consider the timing of when the water should be added and replaced nutrients, and it would be very inconvenient if the plant owner has Hydroponics plants with a lot. To watering a lot of hydroponics plants, need to do an automatic system that can automatically to hydrate the hydroponics if necessary.

With the development of computer science especially on microcontroller, then automatic watering system for plant hydroponics is very possible to do. Base on the description above, is needed a revolution in agriculture industry. In related with this description, will be built the project of automated tools based on the Arduino Uno Microcontroller and the ATmega328 board as a data sheet. The Arduino Uno as the brain of the tool will monitor the hydroponics plants, assisted by proximity sensor (Ultrasonic HC - SR04) to detect the height of water. The temperature around the plants will be detected by sensors (LM - 35). The height of water and the temperature room will be displayed on the LCD microcontroller. All of the data will be sent to the smartphone Android by using the WIFI (Wireless Fidelity) network.

2. Related Work

In some literature, Hydroponics is one of the best alternatives for plants on narrow land. There have been several papers published in several journals in hydroponics systems in recent years; they suggest how hydroponic plant systems work. To supply hydroponic plant nutrients is very appropriate if done by using microprocessors for nutrient control [2]. According to Kumar and Cho, that waste nutrients from hydroponics plants can be reused [3]. In terms of processor-based hydroponic growth spaces, it is more easily controlled via a virtual instrument system using Lab VIEW [4].

Another paper is the development of an automatic microcontroller system for Deep Water Culture (DWC), this paper provides a basic idea of hydroponic water culture. This paper also discusses the methodology used to measure pH values of the sensors and also maintains water levels in hydroponic reservoirs [5]. Other studies are related to the hydroponic nutrient solution control system and factor analysis that influences it. This paper also addresses the difficulties of control that occurred during automation [6].

The other work related to this project is work with control and monitoring of plants in real time has been performance by Dan Wang, Jinling Zhao, Linsheng Huang, Deheng Xu in 2015 [7]. This research focuses on monitoring the data of aquaponic plants which will be sent to smartphones trough the internet of things. The next related is works about automatic addition of nutrients have been made by Rajeev Lochan Mishra and Preet Jain in 2015 [8] which uses electrodes as a benchmark of the amount of nutrients, then if the nutrients under the pump conditions will turn on to add the nutrient. Related works about aotomatic plant watering has been perfomance by Devika et al [9], and the watering object using a plant grown on soil where the humidity sensor will detect the soil moisture level, if the soil is not moist / dry then the system will automatically do the watering.

3. Hydroponics Nutrition Plants Systems and prototype

This automatic hydroponics system plant is placed in a special chamber or vessel and the nutrients are sent directly to the hydroponic roots at any given time. Arduino Uno microcontroller will control the flow of water (nutrients) on the vessel automatically, and the microcontroller can be controlled from Android smartphone. To run this project, the program module has been embedded in this system. Arduino Uno microcontroller is used in real-time to set Alarms on nutrient pumps. When the alarm is on Enabled, Relay will be activated and the nutrient pump will drain the Nutrition solution on the hydroponics plant. When the alarm is deactivated, the relay will be extinguished and the nutrient pump will stop supplying.

To support this project, has designed a virtuino application on Android smartphone that serves to see the water level and temperature around the Hydroponics plants. Before starting the design of a virtuino application, it first provides the data storage using the features of thingspeak.com.

In Figure 1, it is shown that a simple of the hydroponic flow system starts from the detection of a proximity sensor and a temperature sensor. The sensor will detect the water level in the hydroponic tube and the temperature sensor to detect the room temperature. The sensor detection results will be connected with a Relay connected to the microcontroller port. When the relay port pin is lower than the specified height, the water flow will be run on the water pump to irrigate the hydroponics plant.

When the relay of port pin is high, it means the water level is above of the specified height, and then the water pump will stop running water. Thus the water circulation will flow regularly. To support this system, we also use the LCD screen to display the time and date at any time of the process. The nutrient pumps are used not only to increase water but also to add nutrients to the hydroponic tube. The water pumps are used for water recirculation and relays are used to regulate both pumps (pumps for water entry and exit of water).

3.1 General Architecture and program module

The general architecture of automated hydroponics nutrition plants systems is shown in figure 1 below.

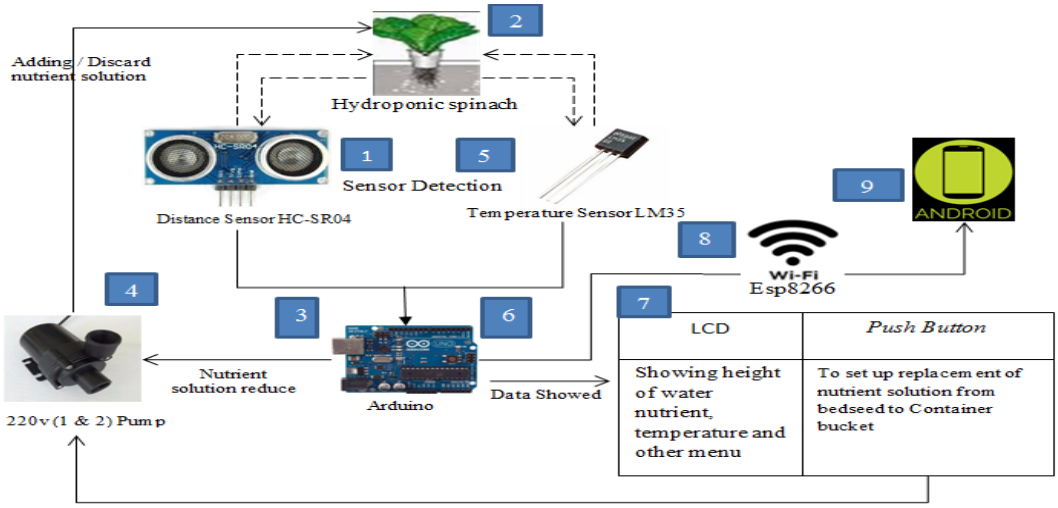

Figure 1. The General Architecture of Automated Hydroponics Nutrition Plants Systems

The system mechanism is follows; Ultrasonic sensor (HC - SR04) detects the height value of nutrient solution in hydroponic plants by the parameter of the high of water (in Cm) unit and the temperature. The sensor (LM-35) will detects the temperature in units of °C range. The ultrasonic sensors will measure the distance of water based on ultrasonic wave. The distance between transmit time and receive time becomes a representation of the distance of the water.

In Figure 3 shown above is a representation of the hydroponic water flow system. The system starts working by using of sensors connected to the electrode. The output of this electrode will be forwarded to the microcontroller as an entry point to be processed by the Arduino Uno Microcontroller system's brain. The microcontroller receives this voltage and compares it with the preceding value and makes a decision based on that input. Based on this input the decision is made by the microcontroller whether to drain the water at the pump or not. All of the commands on Arduino Uno microcontroller can be controlled from a smartphone based Android.

3.2 The Program module

The program module to support this project has been embedded in Arduino Uno microcontroller is presented in the Figure 2 below.

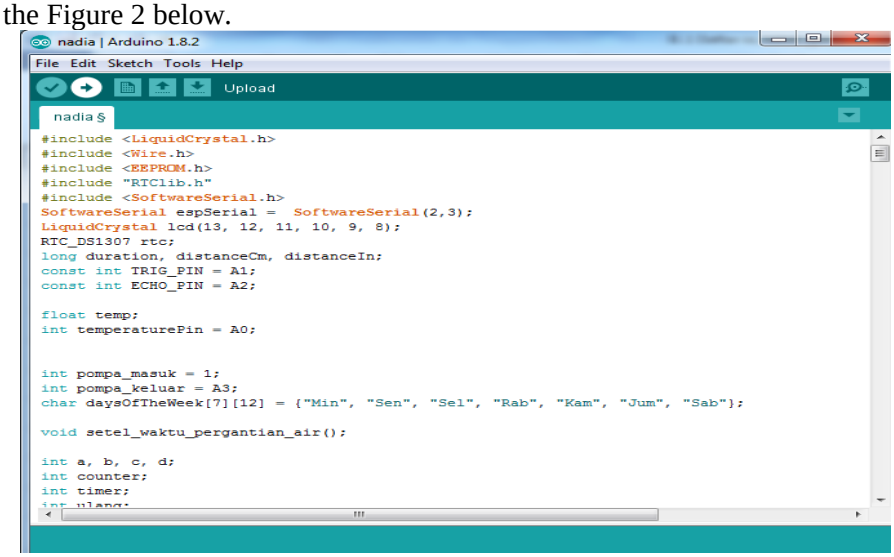

Figure 2. The program module

4. The Experimental set up and Result

The design and implementation of the hydroponics nutrition system automatically using arduino uno microcontroller performed is shown in Figure 3 below. Generally, this hydroponic plant requires five things: nutrition food, water, light, air, and support. We can provide everything in this hydroponics system. We see that this hydroponic plant grows well with proper water and nutrient usage because it is controlled by the microcontroller. We observed that the rate of hydroponic plant growth was faster when compared to plants with soil-grown systems.

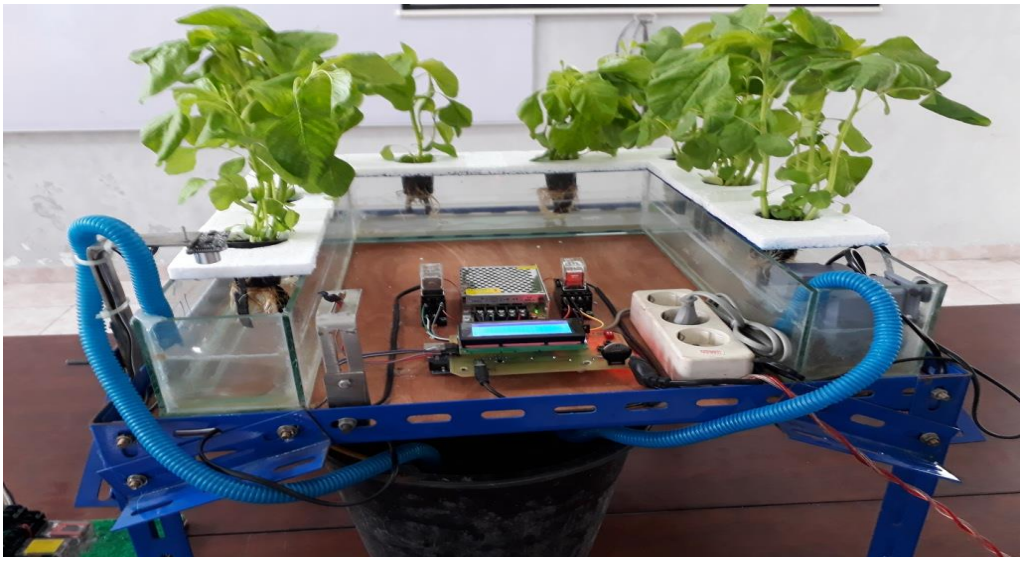

Figure 3. The Experimental set up

In the table 1 below shows the WiFi module will send the water level information and the temperature values of the plants area. This value will be compared to the value in LCD microcontroller (in thingspeak.com module) and on Android smartphone application. This value is directly obtained from the sensor and sent to the Arduino. The data resulted shown in the Table 1 below. Table 1 also shows a variation of water level. After the water level 5 cm in the nutrient tube then the pump stops and water does not flow anymore. The average temperature for 5 number of test is obtained 28,426 °C.

Table 1. The Data resulted in Arduino Uno Microcontroller.

Number of tests	Time (WIB)	Benchmark (LCD)		Data in our Arduino Microcontroller (*thingspeak.com)*			Data in Android App		
		Temperature	Height (Cm)	Temperature	Height	Delay/ Second	Temperature	Height (Cm)	Delay/ Second
1	**06.00**	27,30°C	0	27,30°C	0 Cm	3	27,30°C	0	5
2	**12.00**	34,41°C	5	34,41°C	5 Cm	2	34,41°C	5	6
3	**18.00**	29,20°C	4	29,20°C	4 Cm	3	29,20°C	4	4
4	**00.00**	25,10°C	5	25,10°C	5 Cm	1	25,10°C	5	2
5	**06.00**	26,12°C	5	26,12°C	5 Cm	3	26,12°C	5	4

To detect the height of water used ultrasonic sensors. Ultrasonic sensor is the main component used in determining the flow of hydroponic nutrition. Ultrasonic sensors work by detecting physical quantities into electrical quantities. The result of sensor detection is shown in Table 2 below.

Table 2. The result of sensor detection

Number of tests	Time (WIB)	Height (Cm)	Information
1	**06.00**	0	The sensor can detect that the water spool is empty so the pump is on and fills the water up to 6 cm
2	**12.00**	5	At the first 6 a clock the sensor has detected that the water has been reduced in the nutrient tube.
3	**18.00**	4	At the second 6 a clock the sensor has detected that the water has been reduced in the nutrient tube.
4	**00.00**	5	At the third 6 a clock the sensor has detected that the water has been reduced in the nutrient tube.
5	**06.00**	5	At the first 6 a clock after one circle the sensor has detected that the water has been reduced in the nutrient tube

The relationship of water height in the nutrient tube with time is recorded continuously by the ultrasonic sensor on a number of measurements and the results are shown in figure 4.

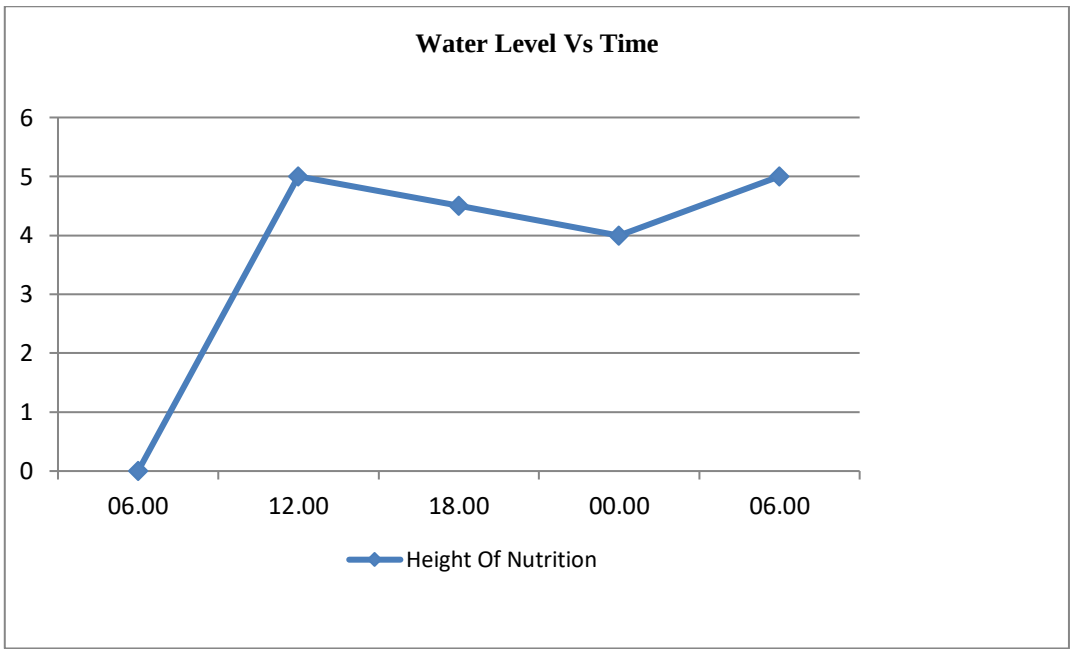

Figure 4. The water level detected by the ultrasonic sensor

In the hydroponic nutrient tube has been determined that the maximum water level is 6 cm. The sensor will detect if there is a decrease the water level in hydroponic nutrition tube. If the water level has decreased, then the sensor will report the resulted and automatically the water pump will be turned on to increase the water level on the hydroponic nutrient tube.

5. Conclusions

An automation system for hydroponic plant irrigation using Arduino Uno Microcontroller based on Android is presented in this paper. Nutritional water flow system by utilizing sensor distance has been successfully done. The water level in the hydroponic tube can be adjusted according to the need of hydroponic, and this is made into a basic guideline for watering or not. The sensor results are sent to

Arduino Uno microcontroller and communication with an Android smartphone. Likewise, the temperature setting has been successfully done well. The room temperature can be determined according to his needs. In our experiments, it was shown that the mixture of water and nutrients was automatically transferred to plant roots in hydroponic tubes. The water level is maintained up to 6 cm in hydroponic tubes because the system will drain water periodically if there is a water shortage.
For future research, it is expected that future developers can to detect acidity levels of pH solution, and viscosity, oxygen, and other aspects. Our automation system is still on a small scale, so it is expected to be developed to make it on a wider scale. In this project, the system only uses the program on Android as a real-time information panel. So it is expected that in advanced research make the tool and system able to make information panel with other operating systems that can be used as a standard system.

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