Development of a Prototype Learning Model for the Hydroponic System based on Arduino Nano

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Abstract. Technological developments have brought convenience to human life. Many things can be done today to solve human problems more efficiently without spending a lot of money, time, and energy. One of these technological developments can be found in agriculture. An automatic tool project based on the Arduino nano microcontroller will monitor hydroponic plants, assisted by sensors to detect water level, the temperature around the plant will be detected by a sensor DHT-22, the level of light intensity using the sensor BH1750 water level and room temperature will be displayed on nextion 3.5” as a human-machine interface. The purpose of designing this tool is to realize an automatic hydroponic system with LED light as a substitute for sunlight, a pH sensor to read the acidity level of a solution for plants, a ppm sensor to see the viscosity level of a solution for plants, and several motors to provide nutrition in a proper manner automatic and also to maintain water circulation, here is also provided a human machine interface to see the condition of the plant along with planting media and solutions. Based on the value of the test results, the entire hydroponic system is able to work well, all values that affect hydroponic plants are always in their proper condition. The temperature in this hydroponic environment is continuously monitored by using the DHT-22 sensor which aims to get a temperature that is always as stable as from a temperature range of 27°C to 35°C, the expected pH is in the range of 6.5 to 7.4, and the ppm required for hydroponic plants is ranging from 1050 ppm to 1400 ppm.

1. Introduction

Technological developments have brought convenience to human life. Many things can be done today to solve human problems more efficiently without spending a lot of money, time, and energy. One of these technological developments can be found in agriculture. Previously, farming activities were still carried out in a conventional way without the intervention of sophisticated technology, agricultural methods had to painstakingly hoe the hot sun, watered them, added fertilizers, and also needed quite a lot of planting media, so that it was less efficient and took a long time, success in farming may not necessarily get results according to plan [1], [2].

Plant care activities are routines carried out to keep plants healthy and well-groomed including aspects, namely watering, rejuvenating, fertilizing, and others. There are so many types of plants with different forms of treatment and all treatments are usually done manually, even though the types of plants are very diverse, water remains the main source of life for all plants to help the photosynthesis process, especially in hydroponic plants that live relying on nutrients from water [3]–[5].

Hydroponic plants have various types of growing media such as rockwell, sponge, coconut powder, and others. In hydroponic plant care, it is very important to pay attention to the time when water must
be added and replaced with nutrients, and it will be very troublesome if the plant owner has a lot of hydroponic plants, to water a lot of hydroponic plants, it is necessary to do an automatic system that can avoid manual hydroponic watering [6]–[8].

In relation to this description, an automatic tool project based on the Arduino nano microcontroller and the ATmega3288 board will be built as the datasheet Arduino Mega as the brain tool will monitor hydroponic plants, assisted by sensors to detect water level, the temperature around the plant will be detected by a sensor DHT-22, the level of light intensity using the sensor BH1750 water level and room temperature will be displayed on nextion 3.5 " As a human-machine interface [9], [10].

![Figure 1. System Circuit Block Diagram](image)

2. Material and Method

In this study, the scope of the applied research object is adjusted to the problem to be studied, namely, the level of led light efficiency for plants, where the sensor used is the lux meter sensor. In addition, the object of research to be examined is the speed of the control system and nutrient provision for hydroponic plants using pH and ppm sensors and controlled by a human-machine interface to monitor conditions in the hydroponic plant media to be studied. This research uses software used to carry out programming and electrical wirings such as Arduino IDE, proteus, and fritzing, while the hardware used is in the form of measuring instruments for current and voltage such as avo Meter and in the form of measuring instruments for calculating liquid volume, namely measuring cups and measuring instruments also a lux meter light meter [11], [12].

In this design, there are several stages or steps that the researcher does, starting from the planning process, designing, testing to the final result. The purpose of designing this tool is to realize an automatic hydroponic system with LED light as a substitute for sunlight, a pH sensor to read the acidity level of a solution for plants, a ppm sensor to see the viscosity level of a solution for plants, and several motors to provide nutrition in a proper manner automatic and also to maintain water circulation, here is also provided a human-machine interface to see the condition of the plant along with planting media and solutions.
The first step in designing a monitoring system and an automatic nutritionist is to create a block diagram which is a basic overview for designing and making a tool. A block diagram is a diagram of a system, in which the main parts or functions represented by blocks are connected by lines, which show the relationships of the blocks. The design of this device is done to make a model that really has the same function as the original and works optimally. In Figure 3, it is explained how Arduino nano is connected to the pH sensor and manages the information obtained from the information, in its management the information obtained is displayed directly on the human-machine interface as information for the user, besides that the information obtained is managed to become action on one of the actuators namely the motor pomp2, and pomp3 which have the following logic.

Where is the pomp2 motor which functions to reduce the pH in the water reservoir for nutrients, while for pomp2, it functions to increase the pH in the nutrient storage water for hydroponics. The relationship between Arduino and several actuators including, a relay that functions as a driver for pomp1, a fan that functions to control the temperature in the hydroponic environment, a led that functions for led lighting and several motors for circulating nutrient water, and also a motor that functions to control the temperature in the hydroponic environment add nutrition. This automatic hydroponic system program is made with the Arduino IDE application using the C++ programming
language, the next program will be uploaded to the Arduino Uno as a microcontroller. To program data transmission of several conditions in the environment and hydroponic nutrient water, the program is created using the Nextion application which is the default software from the LCD maker.

![Program work scheme](image)

**Figure 4.** Program work scheme

The program flowchart above is an automatic hydroponic system program flow along with state monitoring, starting from the program running. The program that is first executed will initialize the input and output components that will be used, such as LEDs, ppm sensors, pH sensors, temperature sensors, light intensity sensors, and several other actuators such as relays and fans, then the program will process and read various data generated by some sensors which later become an action for several actuators. In the looping process, the program will run the motor pomp0 which functions as circulation from the reservoir to the water for nutrition, besides that the looping process also continues to run on the human-machine interface indicator.

### 3. Results and Discussion

To find out the results of the system created, a 30-day record is carried out on the accuracy of the sensors used and also see the correctness of the values displayed on the human-machine interface.

| Day | Light intensity | Temp. | pH | ppm  |
|-----|-----------------|-------|----|------|
| 1   | 6033            | 27,7  | 6,9 | 1282 |
| 2   | 7284            | 30,8  | 6,6 | 1287 |
| 3   | 6154            | 34,6  | 7,0 | 1132 |
| 4   | 6905            | 29,1  | 7,2 | 1147 |
| 5   | 6511            | 27,8  | 6,8 | 1138 |
| 6   | 6886            | 33,9  | 7,0 | 1301 |
| 7   | 7919            | 33,7  | 7,2 | 1317 |
| 8   | 6482            | 29,9  | 6,9 | 1325 |
| 9   | 7400            | 32,8  | 7,0 | 1363 |
| 10  | 6024            | 32,3  | 6,6 | 1278 |
| 11  | 7242            | 30,2  | 7,1 | 1230 |
| 12  | 6351            | 34,1  | 6,9 | 1386 |
| Day | Light intensity | Temp. | pH | ppm  |
|-----|-----------------|-------|----|------|
| 13  | 6421            | 29.4  | 6.7| 1337 |
| 14  | 7265            | 30.2  | 6.8| 1385 |
| 15  | 7493            | 27.3  | 6.5| 1181 |
| 16  | 7641            | 27.6  | 7.0| 1093 |
| 17  | 6254            | 31.4  | 6.6| 1348 |
| 18  | 7627            | 32.7  | 6.9| 1320 |
| 19  | 7872            | 31.0  | 7.0| 1381 |
| 20  | 6792            | 30.8  | 7.2| 1262 |
| 21  | 7393            | 34.4  | 6.5| 1347 |
| 22  | 7803            | 30.2  | 7.2| 1156 |
| 23  | 7823            | 28.6  | 7.1| 1304 |
| 24  | 6528            | 30.5  | 6.6| 1333 |
| 25  | 6079            | 31.4  | 6.9| 1114 |
| 26  | 7287            | 28.8  | 6.8| 1073 |
| 27  | 6781            | 29.6  | 6.9| 1229 |
| 28  | 7532            | 34.4  | 7.2| 1268 |
| 29  | 7986            | 28.5  | 7.3| 1095 |
| 30  | 7619            | 27.1  | 7.3| 1400 |

Based on the value of the test results, the entire hydroponic system is able to work well, the light intensity produced by the LED which functions as a substitute for the sun for the photosynthesis process works as it should with the help of the lux sensor which functions to monitor light intensity, the temperature in this hydroponic environment is continuously monitored by using the DHT-22 sensor which aims to get a temperature that is always as stable as from a temperature range of 27°C to 35°C, with the help of a fan that functions to regulate the temperature in the hydroponic environment, the pH required by the hydroponic plant, the writer tries to create a system that can regulate the conditions pH by using a pH sensor as a reference value and also several motor pumps that function to stabilize the pH, the expected pH is in the range of 6.5 to 7.4, and for the viscosity level itself is always monitored for 30 days to produce a similar value. The ppm required for hydroponic plants is ranging from 1050 ppm to 1400, using a PPM sensor as viscosity monitoring and also motor pomp which aims to stabilize ppm in nutrient water for hydroponics.

4. Conclusions

Based on the value of the test results, the entire hydroponic system is able to work well, all values that affect hydroponic plants are always in their proper condition. The temperature in this hydroponic environment is continuously monitored by using the DHT-22 sensor which aims to get a temperature that is always as stable as from a temperature range of 27°C to 35°C, the expected pH is in the range of 6.5 to 7.4, and the ppm required for hydroponic plants is ranging from 1050 ppm to 1400 ppm.

References

[1] R. Nalwade and T. Mote, “Hydroponics farming,” in 2017 International Conference on Trends in Electronics and Informatics (ICEI), 2017, pp. 645–650.
[2] S. Umamaheswari, A. Preethi, E. Pravin, and R. Dhanusha, “Integrating scheduled hydroponic system,” in 2016 IEEE International Conference on Advances in Computer Applications (ICACA), 2016, pp. 333–337.
[3] P. Musa, H. Sugeru, and H. F. Mufza, “An intelligent applied Fuzzy Logic to prediction the Parts per Million (PPM) as hydroponic nutrition on the based Internet of Things (IoT),” in 2019 Fourth International Conference on Informatics and Computing (ICIC), 2019, pp. 1–7.
[4] M. N. R. Ibrahim, M. Solaludin, and S. Widodo, “Control system for nutrient solution of nutrient film technique using fuzzy logic,” Telkomnika, vol. 13, no. 4, p. 1281, 2015.
[5] P. Sihombing, N. A. Karina, J. T. Tarigan, and M. I. Syarif, "Automated hydroponics nutrition
plants systems using Arduino uno microcontroller based on android," in Journal of Physics: Conference Series, 2018, vol. 978, no. 1, p. 12014.

[6] A. P. Montoya, F. A. Obando, J. G. Morales, and G. Vargas, “Automatic aeroponic irrigation system based on Arduino’s platform,” in Journal of Physics: Conference Series, 2017, vol. 850, no. 1, p. 12003.

[7] M. Mediawan, M. Yusro, and J. Bintoro, “Automatic Watering System in Plant House-Using Arduino,” in IOP Conference Series: Materials Science and Engineering, 2018, vol. 434, no. 1, p. 12220.

[8] V. Palande, A. Zaheer, and K. George, “Fully automated hydroponic system for indoor plant growth,” Procedia Comput. Sci., vol. 129, pp. 482–488, 2018.

[9] G. D. Ramady, R. Hidayat, R. Syafruddin, A. G. Mahardika, and R. R. Hakim, “Sistem Monitoring Data pada Smart Agriculture System Menggunakan Wireless Multisensor Berbasis IoT,” in Prosiding Seminar Nasional Teknol, 2019, vol. 4, pp. E51–E58.

[10] R. Hidayat, H. S. Winangun, N. S. Lestari, and G. D. Ramady, “Development of BTS Site Smart Key Based on Internet of Things,” in 2019 International Seminar on Application for Technology of Information and Communication (iSemantic), 2019, pp. 507–512.

[11] T. Namgyel et al., “IoT based hydroponic system with supplementary LED light for smart home farming of lettuce,” in 2018 15th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTICON), 2018, pp. 221–224.

[12] B. Siregar, S. Efendi, H. Pranoto, R. Ginting, U. Andayani, and F. Fahmi, “Remote monitoring system for hydroponic planting media,” in 2017 International Conference on ICT For Smart Society (ICISS), 2017, pp. 1–6.