**International Journal of Research In Vocational Studies (IJRVOCAS)**
VOL. 3, NO. 4, 2024: IJRVOCAS –Special Issues –INCOSTIG–PP. 46~51
Print ISSN 2777-0168| Online ISSN 2777-0141| DOI prefix: 10.53893
https://journal.gpp.or.id/index.php/ijrvocas/index

# Smart Garden on Chili Plants Based on IoT

**Erwinsyah Simanungkalit[1,*], Mardhiatul Husna[2], Jenny Sari Tarigan[3] & Suriadi[4]**

[1,3,4] Business Management, Commercial Administration, Politeknik Negeri Medan, Medan, Indonesia.
[2]MICE, Commercial Administration, Politeknik Negeri Medan, Medan, Indonesia.

## Email address:

erwinsyahsimanungkalit@polmed.ac.id
[*]Corresponding author

## To cite this article:

Simanungkalit, E., Husna, M., Tarigan, J. S., & Suriadi. (2024). Smart Garden on Chili Plants Based on IoT. *International Journal of Research in Vocational Studies (IJRVOCAS),* 3(4), 46–51. https://doi.org/10.53893/ijrvocas.v3i4.146

**Received**: 09 14, 2023; **Accepted**: 10 20, 2023; **Published**: 01 30, 2024

**Abstract:** Abstract:Cultivating chili plants requires special attention such as temperature and soil humidity. Internet of Things (IoT) technology is a technology that allows objects around us to be connected to the internet network. The widespread adoption of various internet of things technologies has a very pronounced influence in the domestic sector such as home and smart car applications, and the agricultural sector is no exception.Temperature monitoring system, humidityIoT-based soil pan on chili plants (smart garden) is an IoT-based monitoring system design to control temperature and soil moisture on chili plants which can make it easier for farmers to measure soil and plant conditions and to make it easier for farmers to monitor the quality of their agricultural land. The process of creating a monitoring system design begins with interviews to collect primary data and literature studies to collect secondary data. Then carry out system design, tool assembly and implementation. The system for monitoring and controlling temperature and soil moisture using IoT can be run using Windows operating system software. The hardware used is the DHT11 temperature sensor, Moisture Sensor, Arduino, and Nodemcu ESP8266. This system utilizes a pump and fan for its hardware, using an automatic system implementation from a microcontroller so that it can make the hardware run without user intervention.If the humidity value displayed on the LCD is <70% then the pump will be on and the plants will be watered, and if the humidity is >80% then the pump will be off and stop watering.

Keywords: Smart Garden, Temperature, Soil Humidity, Arduino

## 1. Introduction

Chili is a fruit commodity that cannot be separated from daily needs. This plant is widely used to meet the need for vitamins and minerals needed for growth and health. Consumer needs high in chilies makes these fruits increasingly rare was discovered, causing the price of chilies on the market to soar high and making it difficult for consumers to meet their daily needs. In Indonesia, chili plants are farmers' favorite plants to plant. Chili plants provide a high economic effect because the need for chilies in Indonesia is very high. The production level of chili plants in Indonesia is classified as very low, with average production reaching 6.7 tons per hectare. Talking about agriculture, of course it cannot be separated from the various types of plants available, one of which is the chili plant. Temperature is one of the main factors that play an important role in the survival of living things. The growth and development of a plant is determined by climate or air temperature. Air temperature affects life activities in plants, including decreasing the photosynthesis process[1].

The ideal temperature for red chili plants is around 24oC-28oC[2]. The growth temperature during the vegetative or growth phase is around 21oC -27oC, while for the generative or fruiting phase it is around 16oC -23oC. If the temperature is too low or too high it will damage the quality of the fruit produced. A sudden drop in temperature will inhibit fruit growth[3].High temperatures will also quickly result in the intensity of pest and bacterial attacks becoming faster, this will result in wilting of the chili plant roots[4]. Cultivating chili plants requires special attention such as soil moisture, soil pH, light intensity and temperature. In general, plants need water twice a day, namely in the morning and evening[5]. Soil moisture states that the amount of water stored between soil pores is very dynamic, this is caused by evaporation through the soil surface and percolation.[6].Humidity is the amount of water content in the air at a location. The amount of air humidity depends on the entry of water vapor into the atmosphere due to evaporation of water in oceans, lakes and rivers. In addition, there is a transpiration process, namely evaporation from plants. The amount of water in the air depends on many factors, including water availability, steam source, air temperature, air pressure and wind[1].Soil pH or what is often called the acid content of the soil can affect the level of soil fertility. Regions in Indonesia generally have acidic soil types. Soil acidity (soil pH) in our country ranges between 3.0-9.0, soil pH between 4.0- 5.5 is included in the acid soil category, and a pH of 6.0-6.5 is considered normal soil even though it still has a degree of acidity.[7].

Meanwhile, light intensity is the amount of energy received by a plant per unit area and per unit time (cal/cm²/day). The amount of light intensity received by plants is not the same for every place and time[8]. Apart from these three factors, the temperature where you plant chilies must also be maintained. The ideal temperature for chilies is 24°-28°C[9]. If the plant does not get moisture, soil pH and good light intensity and temperature, the plant cannot grow well; the plant will be slow to bear fruit and may not even bear fruit at all. When the weather is hot, soil moisture is low, while when it rains, soil moisture is high[10]. So the level of soil moisture becomes difficult to control. This is one of the impacts of people's ignorance/mistakes when measuring and controlling the correct soil pH, temperature, soil moisture and light intensity factors for chili plants even though the factors are soil pH, temperature and humidity. Soil, and the right light intensity is a combination that must be known when researching the growth and development of plants to be cultivated. With the increasing progress in technology nowadays, this can be done by creating a system or tool based on the Internet of Things (IoT) which can monitor in real time the condition of agricultural land by utilizing sensors for soil moisture, soil pH, light intensity and temperature.[11].IoT has developed rapidly and created a giant network where every device is connected and has the ability to communicate with each other.

This leads the automation system to the next level where each device can communicate with each other and make its own decisions without human intervention. Unconsciously, IoT has become an important aspect in people's daily lives[12]. How IoT works, every object connected to the internet can be accessed anytime and anywhere. Based on the background of the existing problem, problem identification can be formulated, namely the existence of people's ignorance/people's mistakes when measuring and controlling the correct factors of soil pH, temperature, soil moisture and light intensity on the growth and development of chili plants. The goal to be achieved in this research is to be able to design a system that can control soil pH, temperature, soil moisture, and light intensity in a smart garden to make it easier for farmers cultivating chili plants to take measurements so that not many of the plants planted die. From the problems that have been described, it can be concluded how to design build an IoT-based monitoring system to control soil pH, temperature, soil moisture and light intensity on chili plants which can make it easier for farmers to measure and monitor conditions land and plants and to make things easier for farmers monitor the quality of their agricultural land. Internet of Things (IoT) allows all objects to communicate with each other via the internet[13].The core device of this internet of things is NodeMCU. NodeMCU is a small, open source device equipped with WiFi, making it easier for us to control and monitor wirelessly[5]. The internet of things concept is able to produce an effective and efficient monitoring system because it is not constrained by distance so that plant owners can monitor plants[14]. So the use of the Internet of Things can help farmers to plant chili plants.

A monitoring system is an element that is designed to work in an organized manner, interacting with each other component and one other component in order to collect data on an activity so that the activity is in accordance with the plan[1].

The purpose of the monitoring system is to ensure that an activity runs according to applicable procedures so that the activity will run according to what has been planned. In its application, the temperature and humidity monitoring system for chili plants is based on the internet of things (IoT) using ESP8266 as the main component. In the journal "Design of Soil Temperature, Soil Moisture and Resistance Measuring Instruments"[15], research has been carried out to create a tool to measure soil temperature, soil moisture and resistance, with the measurement results displayed on a Liquid Crystal Display (LCD) screen.

Based on this, in this research a soil temperature and humidity monitoring tool will be designed whose measurement results will be displayed on a Liquid Crystal Display (LCD) screen and can also be accessed via an Android-based application. The addition of the access feature via the Android application aims to make monitoring activities easier, so that monitoring activities can be carried out remotely. The sensor used to measure temperature is the DHT22 sensor and to measure soil moisture using the YL-69 humidity sensor. The measurement results from this monitoring tool will then be displayed on the Liquid Crystal Display (LCD) screen, and can be accessed via an Android-based application.

## 2. Research Methods

Research methods are the methods used by researchers in compiling reports. The methods used by researchers are divided into several stages as shown in Figure 1.

1). Observation/Observation, this method is carried out to see the conditions of development in the world of science and digital libraries followed by the development of increasingly sophisticated internet technology. From the problems raised in the Introduction, researchers collect data that can help to provide alternative solutions.

The data in question is data about web technology which focuses on web service data, semantic web, linked data, ajax and others. From several observations and considerations, the technology that will be used is linked data. 2). Literature/library studies, by collecting information about methods and formats of bibliographic metadata for library collections from book references, scientific works and other relevant sources. Collecting information related to linked data from various sources, reviewing and learning, as basic capital in system development. 3). Problem analysis, at this stage an analysis of the problem of bibliographic data resource sharing between libraries will be carried out, analysis of data presentation using linked data in order to determine the right problem solving to solve it, also including identifying system limitations and development strategies used. 4). Design and Implementation of System Development, application software development process using a prototyping model. The prototyping method is a method that can be described as a process of creating a model of the system to be developed. By using the prototyping method, application developers and users can interact with each other during the system creation process. The prototyping method chart can be seen in Figure 1.

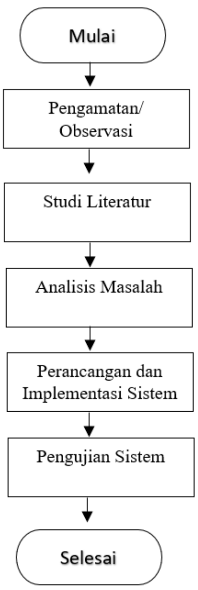


***Figure 1.*** *Prototype Model*

### 2.1. Research design

The design of the tool in the form of an automatic watering tool for chili plants is based on Wemos D1 using a soil moisture sensor. This tool has four inputs, namely two DHT11 sensors and two humidity sensors, where one of the humidity sensor pins uses MCP3008 because the Wemos D1 only has one analog pin, so this MCP3008 is needed to convert data from analog to digital. The output of this tool is that the value will be displayed on the LCD and monitored in the blynk application, if the humidity is <70% then the pump will be on, and if the humidity is >80% then the pump will be off. The following is a flow diagram of the system to be designed. The internet of things-based smart farming design can be depicted in a block diagram as follows

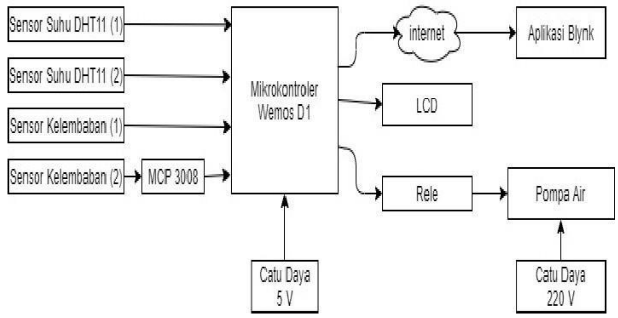


***Figure 2.*** *Smart Garden Block Diagram*

### 2.2. Flow chart

The flow chart of this research is as follows:

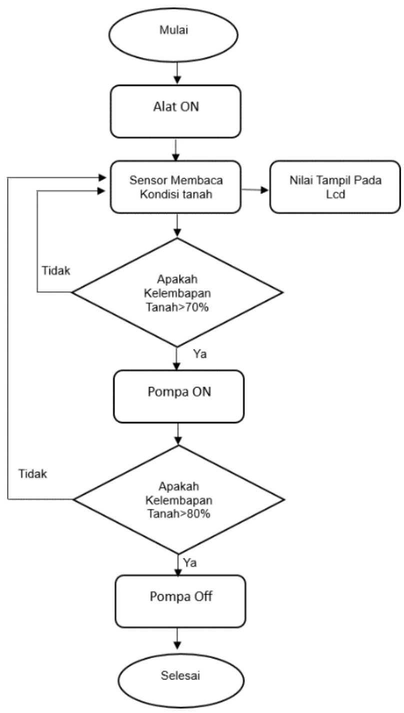


***Figure 3.*** *Smart Garden Block Diagram*

In creating a system, steps are needed so that all the tools can work according to what we want. In this system the pump will work if the humidity is <70% and the pump will stop working if the humidity is >80%. Because the ideal conditions for growing chilies are no more than 80%.

### 2.3. Hardware Implementation

To be able to install and arrange the hardware with the right and appropriate cable connections, a circuit design is created as a map for what will be built. In figure 3 is a series of tools used in an IoT-based monitoring system for soil pH, light intensity and humidity in chili plants. The placement of connections between tools is very important so that they fit the system. The images can be seen in the image below

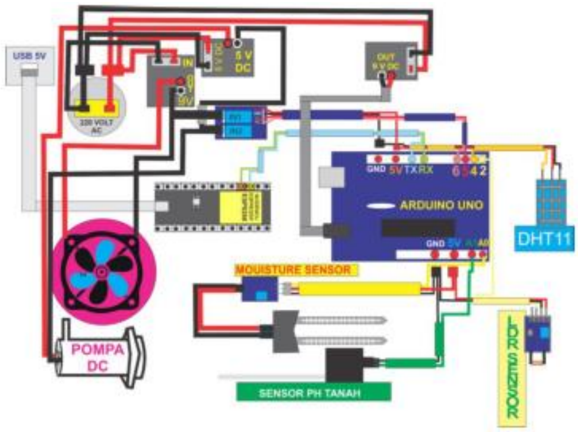


***Figure 4.*** *Tool Set*

## 3. Results And Discussion

This implementation will explain in detail the application of the IoT-based Soil pH and Humidity Monitoring System for Chili Plants (smart garden). The software that was built is adapted to the existing procedures and processes in the system that has been designed so that this application is expected to be useful for monitoring soil temperature and humidity in the chili planting area and controlling it via wireless with an Android display. The application developed can be run using the Windows operating system software. The hardware used is the DHT11 temperature sensor, Moisture Sensor, Arduino, and Nodemcu ESP8266. This system utilizes a pump and fan for its hardware, using an automatic system implementation from a microcontroller so that the hardware can run without user intervention.

### a. Temperature and Humidity Testing

The aim of testing the DHT11 sensor is to obtain the accuracy value of the DHT11 sensor by comparing the environmental temperature and humidity values on the DHT11 sensor with a digital thermometer. Testing was carried out at 08.00-16.00 with data collection carried out every two hours for four days. Table 1 shows the results of temperature testing on the DHT11 sensor. There are 10 environmental temperature and environmental humidity data that are compared with a digital thermometer. Error and accuracy measurements use equations 1 and 2.

$$Kesalahan\,\% = \frac{Selisih\ suhu\ atau\ kelembapan}{Syhu\ atau\ kelembapan\ termodigital} x\ 100$$

$$Akurasi\ Sensor\ \% = 100 - Kesalahan$$

***Table 1.*** *Trials with Digital Thermometers*

| Day | Time | Digital Thermometer | |
|---|---|---|---|
| | | Temperature (oC | Humidity (%) |
| | 08.00 | 28.1 | 71 |
| | 10.00 | 29.1 | 68 |
| 1 | 12.00 | 37.9 | 42 |
| | 14.00 | 31 | 55 |
| | 16.00 | 28.9 | 66 |
| 2 | 08.00 | 28.1 | 69 |
| | 10.00 | 29.1 | 72 |
| | 12.00 | 30.3 | 71 |
| | 14.00 | 28.2 | 83 |
| | 16.00 | 33.9 | 65 |

***Table 2.*** *Tests with Sensors*

| Day | Time | Temperature and Humidity Sensor | |
|---|---|---|---|
| | | Temperature (oC | Humidity (%) |
| | 08.00 | 27.7 | 70 |
| | 10.00 | 29 | 72 |
| 1 | 12.00 | 34.6 | 43 |
| | 14.00 | 29.9 | 59 |
| | 16.00 | 29.4 | 53 |
| 2 | 08.00 | 28.1 | 66 |
| | 10.00 | 29.2 | 78 |
| | 12.00 | 34.7 | 59 |
| | 14.00 | 26.2 | 95 |
| | 16.00 | 35.6 | 66 |

***Table 3.*** *Difference between Thermometer and Sensor Tests*

| Day | Difference | |
|---|---|---|
| | Temperature (oC | Humidity (%) |
| | 0.4 | 1 |
| 1 | 0.4 | 4 |
| | 3.3 | 1 |
| | 1.1 | 4 |
| | 0.5 | 13 |
| | 0 | 3 |
| 2 | 0.1 | 6 |
| | 4.4 | 12 |
| | 2 | 12 |
| | 1.7 | 1 |

***Table 4.*** *Thermometer and Sensor Test Errors*

| Day | Error | |
|---|---|---|
| | Temperature (oC | Humidity (%) |
| 1 | 1.42 | 1.40 |
| | 1.36 | 9.52 |
| | 8.70 | 2.38 |
| | 3.54 | 7.27 |
| | 1.73 | 19.69 |
| 2 | 0 | 4.34 |
| | 0.34 | 8.33 |
| | 14.52 | 16.90 |
| | 7.09 | 14.45 |
| | 5.01 | 1.53 |
| Average | 4.37 | 8.58 |

The table above shows that the temperature and humidity sensors have good accuracy for use in monitoring and control systems for chili plants. The average temperature measurement error on the DHT11 sensor is 4.37% with the highest error value being 14.11%. The average humidity measurement error on the soil moisture sensor is 8.58% with the highest error value being 19.69%. The accuracy of temperature measurements using the DHT11 sensor is 95.63%, while the accuracy of humidity measurements using the soil moisture sensor is 91.42%.

**b. Pump Testing**

This test is carried out to find out whether the pump is active and produces water if the humidity is <=70%. The test results can be seen in the table below

***Table 5.*** *Pump Test Results*

| No | Humidity Sensor | Information |
|---|---|---|
| 1 | 73.41 | Pump ON |
| 2 | 65.20 | Pump ON |
| 3 | 54.06 | Pump ON |
| 4 | 51.45 | Pump ON |
| 5 | 81.04 | Pump OFF |
| 6 | 38.61 | Pump ON |
| 7 | 80.04 | Pump OFF |
| 8 | 80.10 | Pump OFF |
| 9 | 53.37 | Pump ON |
| 10 | 62.95 | Pump ON |

The first test carried out was by connecting the Arduino Mega device with a Relay. In this research, the relay is used as an electronic switch used to control the water pump (DC Water Pump). If the average soil moisture value is less than 70% with dry soil conditions then the pump will be watered and if the soil moisture is equal to 71% -100% then no watering will be carried out. The test results to determine the time needed for the pump to be active when watering plants are as shown in Table 2.

## 4. Conclusion

This research produces an IoT-based temperature and humidity monitoring system for chili plants (smart garden). This system is expected to make it easier for farmers to measure and monitor the condition of the soil and chili plants and to make it easier for farmers to monitor the quality of their agricultural land. This monitoring system is assembled using various sensors added to the Arduino UNO, including the DHT11 sensor to identify temperature, the soil moisture sensor for humidity.

## 5. Acknowledgments

The researcher would like to thank P3M Medan State Polytechnic for providing assistance and direction so that this research could be completed on time.

## REFERENCES

[1] F. Faisal and A. Rauf, "RESPONSE OF RED CHILLI (Capsicum annuum L.) TO VARIOUS CONCENTRATIONS OF LIQUID ORGANIC FERTILIZER,"*Agrotekbis E-Journal of Agricultural Sciences.*, vol. 9, no. 6, pp. 1318–1326, 2021.

[2] B. Samadi,*Commercial Cultivation of Red Chilies*. Yogyakarta: Nusatama Library Foundation, 1997.

[3] AK Nalendra and M. Mujiono, "IOT (INTERNET OF THINGS) DESIGN FOR CHILDREN PLANT IRRIGATION SYSTEMS,"*Gener. J.*, vol. 4, no. 2, pp. 61–68, 2020, doi: 10.29407/gj.v4i2.14187.

[4] L. . FA Caesar Pats Yahwe, Isnawaty, "Design of a Prototype System for Monitoring Soil Moisture via SMS Based on Plant Watering Results. Soil Moisture Monitoring System via SMS Based on Plant Watering Results,"*semantics*, vol. 2, no. 1, pp. 97–110, 2016, doi: doi: 10.1016/j.ccr.2005.01.030.

[5] A. Azurianti, R. Wulansari, FNF Athallah, and S. Prijono, "The Relation Study of Soil Nutrient to Productivity of productive Tea Plants in Pagar Alam Tea Plantation, South Sumatra,"*J. Land and Resources. Land*, vol. 9, no. 1, pp. 153–161, 2022, doi: 10.21776/ub.jtsl.2022.009.1.17.

[6] CW Suci and S. Heddy, "The Effect of Light Intensity on the Performance of Croton Plants (Codiaeum variegetum),"*J. Crop Production.*, vol. 6, no. 1, pp. 161–169, 2018.

[7] N. Mukhayat, WP Ciptadi, and RH Hardyanto, "IoT-Based Soil pH Monitoring System, Light Intensity and Humidity

in Chili Plants (Smart Garden),"*Pros Series. Semin. Nas. Din. Inform.*, vol. 5, no, pp. 179–184, 2021.

[8] H. Karamina, W. Fikrinda, and AT Murti, "The complexity of the influence of temperature and soil moisture on soil pH values in crystal variety guava plantations (Psidium guajava l.) Bumiaji, Batu City,"*Cultivation*, vol. 16, no. 3, pp. 430–434, 2018, doi: 10.24198/cultivation.v16i3.13225.

[9] S. Dwiyatno, E. Krisnaningsih, D. Ryan Hidayat, and Sulistiyono, "S Smart Agriculture Monitoring Plant Watering Based on the Internet of Things,"*PROSISKO J. Pemb. Ris. and Obs. Sis. Comput.*, vol. 9, no. 1, pp. 38–43, 2022, doi: 10.30656/prosisko.v9i1.4669.

[10] AA Ayuningtyas, "Application of the Internet of Things (IoT) in Efforts to Create a Digital Library in the Era of Society 5.0,"*J. Library Science*, vol. 11, no. 1, pp. 29–36, 2022.

[11] Adhelia-09011181621009, "Internet of Things whitepaper,"*Cyber Resil. Syst. Networks*, vol. 2019, no. July 2016, pp. 1–150, 2009.

[12] M. Iqbal, "Design of a Hydroponic Smart Garden Monitoring and Control System with Labview,"*J. Inform. and Media Computing Discussion …*, vol. 16, 2022.

[13] Lutfiyana, N. Hudallah, and A. Suryanto, "Design of Soil Temperature, Soil Moisture and Resistance Measuring Instruments,"*Tech. Electro*, vol. 9, no. 2, pp. 80–86, 2017.

[14] A. Perwitasari and MA Irwansyah, "Prototype Model and Use Case Analysis in Software Requirements Engineering for Submitting Population Documents,"*J. Education and Research. Inform.*, vol. 7, no. 2, p. 175, 2021, doi: 10.26418/jp.v7i2.47976.