Journal of Theoretical and Applied Information Technology
15th May 2022. Vol.100. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

IMPLEMENTATION MOBILE SMART FARMING MONITORING SYSTEM WITH LOW-COST PLATFORM USING BLYNK

[1]MOCHAMMAD HALDI WIDIANTO, [2]BUNARDI SANJAYA, [3]VANESSA AURELLIA, [4]SOFIE ADIRA CHRYSANTHIA

[1,2,3,4]Computer Science Department, School of Computer Science, Bina Nusantara University, Bandung Campus, Jakarta, Indonesia 11480

E-mail: [1]mochamad.widianto@binus.ac.id

ABSTRACT

The need to carry out plant care and monitoring is especially in demand by all circles in the household. Because some people reduce outside activities and do all internal activities, new activities such as taking care of plants occur. These activities are carried out by households and in buildings and workplaces. In this study, Research was conducted on implementing Low-Cost IoT tools by utilizing blynk to monitor them. Other Research was conducted specifically to discuss simple IoT monitoring tools, but it is not uncommon to discuss the price required to make these tools. This Research is needed because automation is needed for various industries. It's just that not everyone has the luck in providing money. Other needs, because lately many people are busy and need the remote control. In this Research, the focus is on making IoT with low-cost materials but still monitoring Blynk-based phones. The Research uses air, humidity, ultrasonic (air content), and temperature sensors. Testing using a BlackBox with test results ten times produces a water content of 20cm, soil moisture 60%, humidity 80%, and an average temperature of 21 C. But the study has a weakness in the number of sensors used and updating the database user needs to be expanded and repaired again. It is hoped that further Research can overcome this deficiency

Keywords: *Energy Harvesting, Smart GARNUS, IoT, Low-Cost*

1. INTRODUCTION

Plant care has become a hobby nowadays. It has been made easier by the many plants sold everywhere, including many types such as hydroponics, aeroponics, and making your ornamental plants. Most homemakers have done this hobby. Some have even become a business field by doing hybrids on ornamental plants.

Plant care has been started first in agriculture because Indonesia has good land, so many plantations and farms are owned, but the treatment is with care for household plants because the land is tens of kilometers long.

Plants and plantations are the foundation of a country's or a region's food sources, becoming the focus because every country wants to fulfil its food needs without facing other countries to fulfil them. One of the steps is to add land or open new land, but this is not an advantage because it can cause flooding, etc. With the advancement of technology, starting from steam engines, automatic machines, and robots. One very popular technology in various ways is the Internet of things (IoT), one of the future technologies, IoT can also be used in agriculture, but it has challenges and current issues in its application. [1]–[3]

IoT has also been researched on smart farming as in [4], such as making maintenance on ornamental plants by utilizing simple sensors and some simple microcontrollers. In addition to discussing IoT, the basis of sensors is usually found in the wireless sensor network (WSN) [5], assuming it is not yet connected to the Internet, WSN can also perform automation functions but not focus on its connection to the Internet. But this component is an important component, even a very large energy use is contained in this component.

Another component that is the center of IoT is the microprocessor, most of which are of many types, ranging from light processes to heavy processes. Another thing for communication, if there is no internet, can use technology wide area. One of them utilizing Lora [6], [7] By utilizing this communication, it is possible to solve the problem of unstable Internet.

Furthermore, the results of the components can be displayed on the website, mobile OS, and mobile Android. This display function helps the user to see or react to the results. Utilizing mobile monitoring makes it easier for users because everyday users use their respective cellphones and are never far from this device.

IoT technology has made a new impact during this century and will be influential in the next decade. New industry sources have provided various IoT deployment applications. The average figure is 30 billion devices in 2020, with several possible applications for business leaders to implement.

When discussing smart concepts, there are many. One of them is in smart agriculture, utilizing IoT, which can automate, maintain, and monitor, of course, with a low-cost platform. Utilizing sensing on temperature, temperature, acid, pH, and lighting. As is done in the following figure for the selection of sensors and components that can be used in IoT [8] in Figure 1:

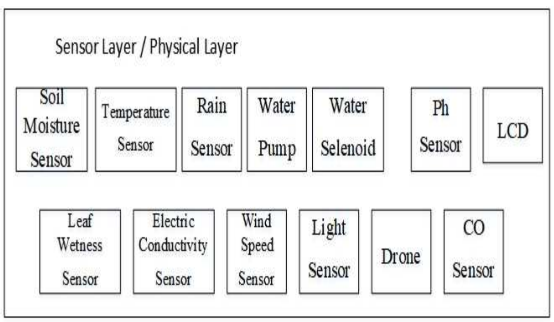

Figure 1. Component and Sensor in Smart Farming [8]

After knowing Figure 1, which is one of the sensor needs in smart agriculture (the concept of the author's assumptions for research) with soil, temperature, rain sensors, pH, CO2, etc., this scheme is the basic scheme for making smart agriculture. But keep in mind that not all sensors are cheap. For developing countries themselves, it is necessary to look for components and sensors that are not too expensive.

Low-cost devices have weaknesses, namely durability and are easily damaged, so it is necessary to look at the quality. Still, low-cost devices can already connect to the Internet. According to the study pathfinding, Early Warning utilize Augmented Reality (AR), smartphone applications, and IoT [9]. This research not only utilizes IoT, but can also be combined using AR technology

Mobile devices that are easy to operate based on Android are already many Android users, and various kinds of devices support this operating system. Meanwhile, the IoS standard can be used, but not many applications are circulating yet. In conducting monitoring and automation, blynk can be used [10] [11] and [12]. Using the website is too big because it uses the HyperText Transfer Protocol (HTTP) protocol with a heavy TCP (Transmission Control Protocol/Internet Protocol) communication system, while the IoT system does not need to use large documents. This is done at a different layer from layer 1. The following is the layer of the application service adapting in the Research [8] seen in figure 2

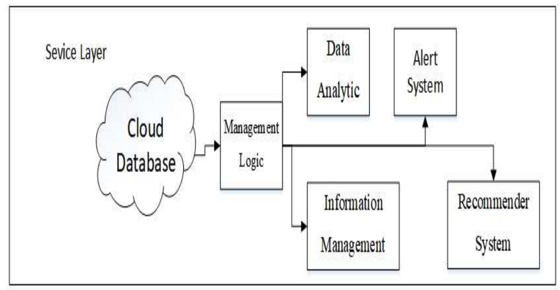

Figure 2. Services Layer in Smart Farming [8]

Figure 2 shows the service layer, which usually contains the cloud, management logic and data analytics, and data management. On [13], IoT has also been carried out to implement educational Research. The research uses smart mirrors for education, but it is felt that smart mirrors are not suitable if used in agriculture

According to [14] doing Research using IoT on dairy farming. According to Research [15], do smart farming with IoT technology for improvement agriculture. Furthermore, Research on designing smart agriculture with the concept for precise agriculture [16]. Then with this Research, the design of smart agriculture is increasingly diverse

But researching smart farming [17], [18] is about ethics and the intelligence method (deep learning) for smart farming. But how to apply it with low-cost tools and suitable models. But there are still few studies that take material on low-cost devices with mobile-based devices.

This problem occurs in countries with middle economic conditions [19], [20] with middle incomes. Applying smart devices needs to think about the price offered. Another problem besides price is the application to mobile because most of the population already uses cellphones as a source of primary needs. So we need a smart agricultural application that is low-cost and mobile-based.

The need to make automation applications is very important, especially those applied to plants with blynk [21], [22], then the need for automation

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

also needs to be accompanied by inexpensive devices as described in the previous statement. So we need an inexpensive and IoT-based automation tool to apply this need anywhere in various areas, not just advanced cities.

Bulbasaur is an automated plant watering and monitoring system designed to treat plants regularly. This system utilizes Internet of Things technology to be controlled and can report plant conditions remotely via the Internet, in contrast to previous Research that focused on the web [4], because the web is not practical and can not be applied anywhere. Or Research that uses the waterfall method, such as [23]. This Research is difficult because the nature of the waterfall is only one way and difficult to implement if using tools that need changes. So Bulbasaur research uses only a frame of mind. (but this research is still not in accordance with the assumptions of the concept of Figure 1)

The researcher uses a cloud system that functions to process data from the microcontroller and the BLYNK application as end-user media to monitor the park's state. The microcontroller the author uses to process the data is an Arduino with a WEMOS ESP32 module with a probe soil moisture sensor, ultrasonic sensor HC-SR04, and humidity sensor DHT-22 and temperature. The data will be processed and sent to users via the Internet and received by the BLYNK application.

For this reason, this study will conduct smart agriculture using low-cost mobile-based devices. Phase 1 will introduce an introduction to what will be done. Stage 2 conducts a literature review of existing and subsequent Research. Phase 3 will explain the methodology for making mobile-based smart agriculture. In stage 4 the author will discuss the results used. Stage 5 is the conclusion drawn by the author.

2. LITERATURE REVIEW

The many uses of Smart Agriculture have indeed become part of people's Research, by utilizing IoT devices for smart agriculture, Research on farming has been widely carried out as in [24], [25] using the unmanned aerial vehicle (UAV) or Drone

In this session, several authors on low-cost smart farming using blynk mobile application. The following is a summary table from previous studies in Table 1:

Tabel 1. Literature Review

No	Ref	Conclusion	Comparison
1.	[26]	Leveraging blynk on home management automation	The author focuses on low-cost smart agriculture
2	[15]	Carry out smart agriculture management with a very detailed system	This Research utilizes a low-cost device
3	[27]	weather data, watering using GSM and sensor	Do not use weather data in this study
4	[28]	automatic sprinklers pumped the water	Like automatic sprinkler but focuses on blynk.
5	[12]	Focus on the data recording and humidity applied in the blynk	The author of this study focuses on using multiple sensors to treat plants and low-cost
6	[11]	Doing smart farming research using esp 8266 and humidity sensors and soil moisture level	Not only using humidity and soil, but using a water pump, ultrasonic and low-cost

So that the development of applications that focus on mobile-based smart agriculture by utilizing blynk is carried out. To realize the purpose

Journal of Theoretical and Applied Information Technology
15th May 2022. Vol.100. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

of the paper, the search after asking for several purposes such as:

- O1. Identification of parameters for smart agriculture based on mobile blynk
- O2. Implementation of the proposed platform and evaluation;

3. METHODOLOGY

In this chapter, the methods used in this study will be carried out, measuring from the problem solving, a research mindset framework thinking can be studied for ways of thinking from [29]. Research is made thinking framework as shown in Figure 3 below :

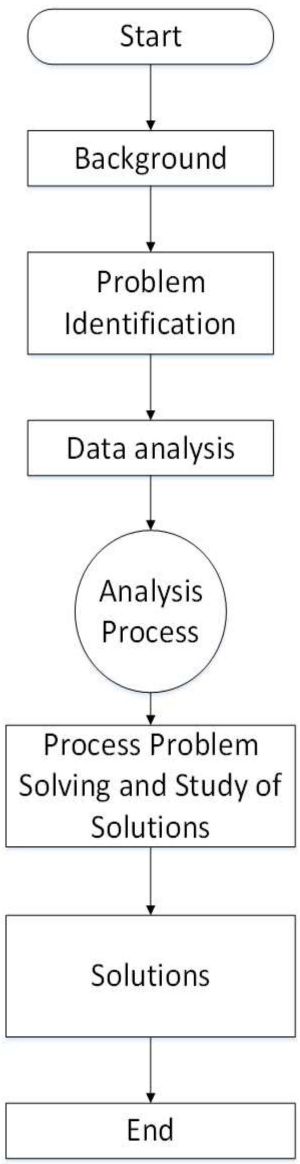

Figure 3. Thinking framework

Figure 3 shows that completing this Research has a pattern:

- Background

Identify why this Research is being carried out, whether it is useful or can be carried out. Helpful Research. Of course, by looking for previous Research to suit your needs

- Identification of problems

After searching for previous Research, what problems can be solved, of course, according to the user's needs.

- Data analysis

In this section, we search for the components needed to make low-cost IoT devices by utilizing mobile blynk

- Process analysis

After looking for suitable components, an analysis of the use of the tool is carried out, whether it is by the needs or not. Then an experiment is carried out to enter everything, and coding is carried out

- The process of problem-solving and study solutions

After that, an experiment was conducted to solve the problem by testing tools such as BlackBox.

- Solution

In the end, a solution search will be carried out so that a good conclusion is obtained according to the user's needs solutions

3.1 Devices

Each plant pot will be given a microcontroller. WEMOS ESP32 module with a probe soil moisture sensor, ultrasonic sensor HC-SR04, a humidity sensor DHT-22 and temperature. In addition, there are other components such as resistors, cables, power supply, water storage, water pumps, breadboards, and faucets.

The most important component in making IoT is the microcontroller. In this study, which is used by Uno as the processor, as shown in Figure 4 below:

Journal of Theoretical and Applied Information Technology
15th May 2022. Vol.100. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

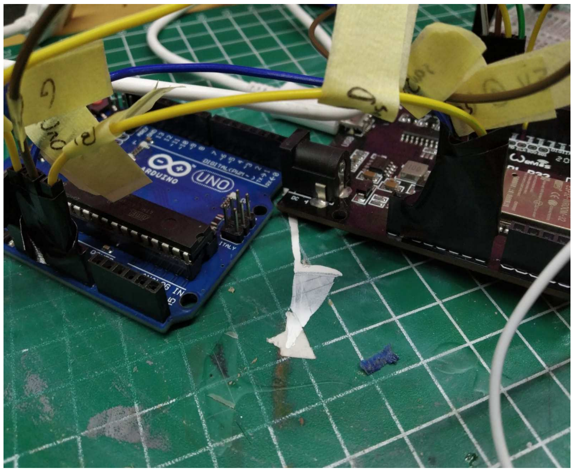

Figure 4. Microcontroller Device

In Figure 4,. According to [30] Arduino is a complex circuit board in the form of open-source electronics. Each principal component is an AVR microcontroller chip from the Atmel company. Understanding Arduino is a microcontroller type, memory, and communication device that can be programmed. The purpose of this tool can be programmed so that the electronic circuit can understand what the user commands, then can carry out the process so that it can produce the output that the user requires. The microcontroller is the source/brain of the functioning of a device. If there is no tool, the command center is out of control.

Furthermore, the study used a WEMOS type Wi-Fi module, as shown in Figure 5.

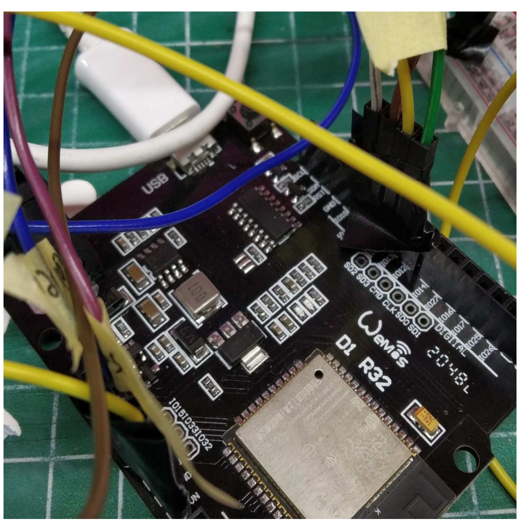

Figure 5. Wi-Fi Device

In Figure 5, as previously explained, WEMOS ESP32 is a Wi-Fi module connected to Arduino, allowing the microcontroller to make remote connections. Meanwhile, an ultrasonic sensor was also used in this study, as shown in Figure 6 below:

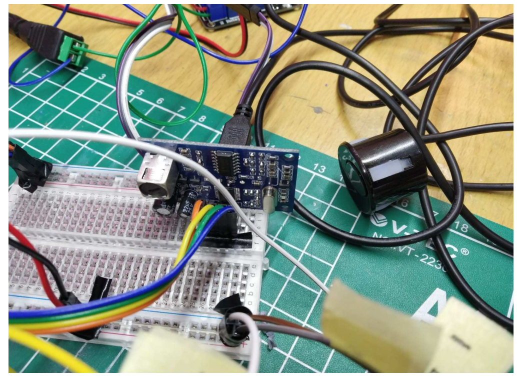

Figure 6. Ultrasonic Sensor SR04T

Figure 6. Sensor SR04T is an ultrasonic sensor module used for distance measuring devices. In the Bulbasaur system, this sensor measures water depth in the storage. Furthermore, temperature and humidity sensors measure temperature and humidity, as shown in Figure 7.

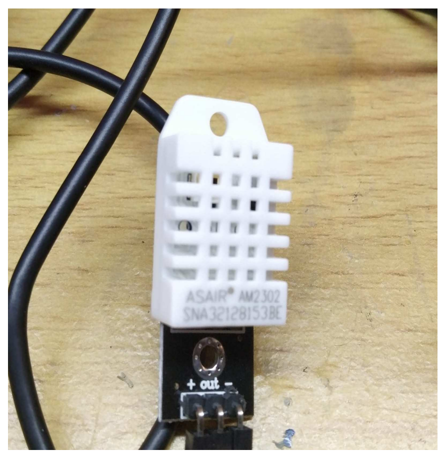

Figure 7. Temperature and Humidity Sensor DHT-22

Figure 7 shows the DHT-22 sensor is a sensor for measuring air temperature and humidity in which there is an NTC thermistor. Furthermore, a moisture sensor for the soil is also used, in Figure 8:

Journal of Theoretical and Applied Information Technology
15th May 2022. Vol.100. No 9

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

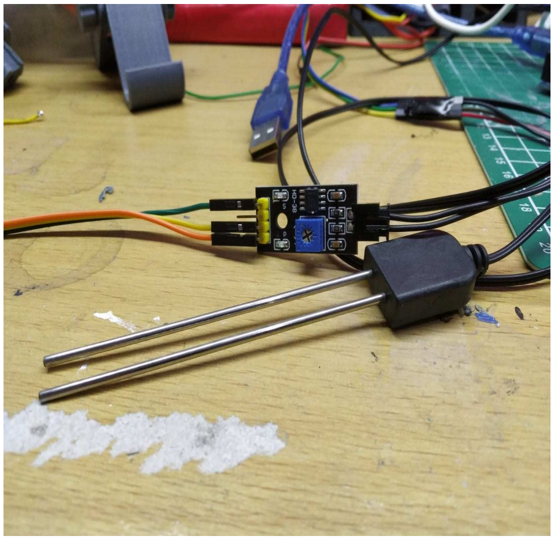

Figure 8. Soil Moisture Sensor Probe

In Figure 8, the researcher uses a soil moisture sensor to estimate the amount of water in the soil. Furthermore, components for relays are also used, as shown in Figure 9.

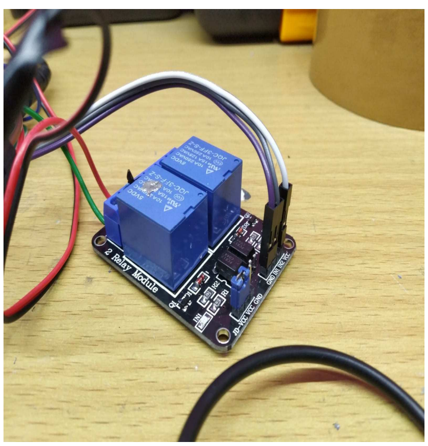

Figure 9. Relay

Figure 9 for the relay is an electrical switch that allows electric current to flow or not and is controlled by a low voltage source such as the 5V output from the Arduino pin. Simply put, we can regulate the flow of electricity with a higher voltage by using a low voltage current from Arduino. In this Research, a relay is used to control the water pump for watering the plants. Then a water pump is also added, as shown in Figure 10 below:

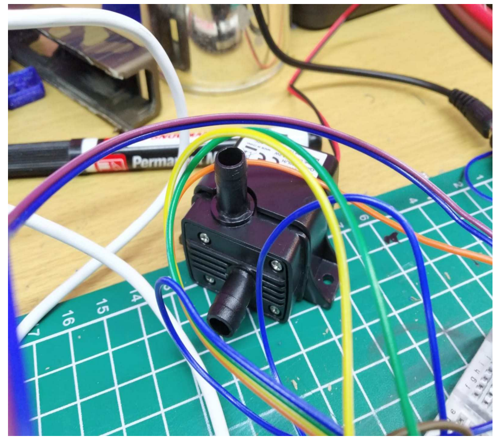

Figure 10. Water Pump

Figure 10. The pump we use for watering plants is a small pump that uses a DC with a voltage of 12V and a current of 2A.

3.2 Use Case Diagram

After selecting the components and conducting an analysis of the needs, at this stage, the researcher conducts a use case diagram [31] that will represent what activities are carried out by the author in planning this research tool, as shown in Figure 11 below.

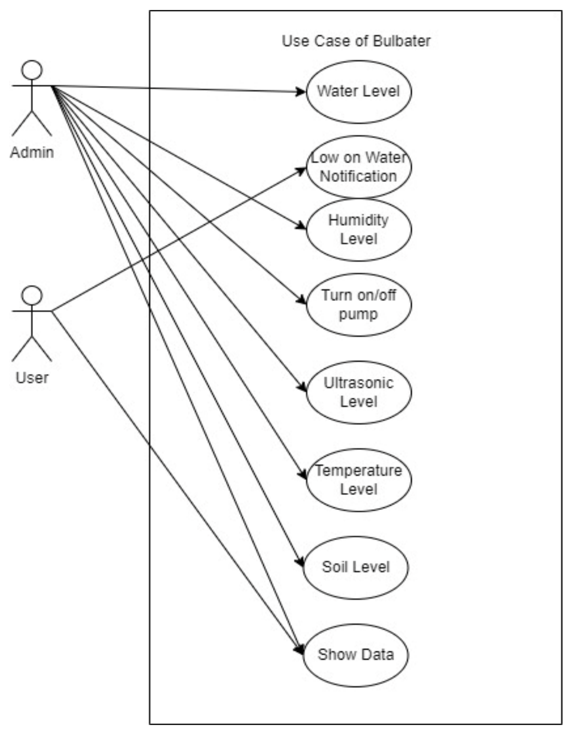

Figure 11. Use Case Diagram

Figure 11 shows a simple use case of IoT Bulbasaur by utilizing a mobile application with

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

blynk. Admin as the center of the process can see all levels such as water, humidity, soil, ultrasonic, and temperature, while a user can see the water level and its data. It is used as a simple requirement of the plant so that the manufacture

3.3 *Prototype Design and Schematic Design*

The design of the prototype can be shown in Figure 12 and the schematic diagram in Figure 13, which is used to carry out the initial design for making a tool called the Bulbasaur using software application.

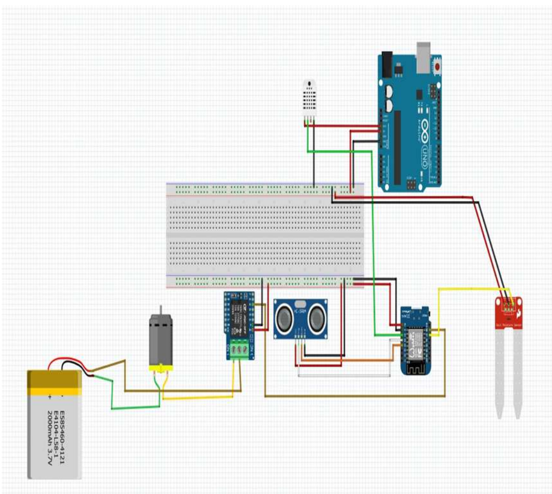

Figure 12. Prototype Design

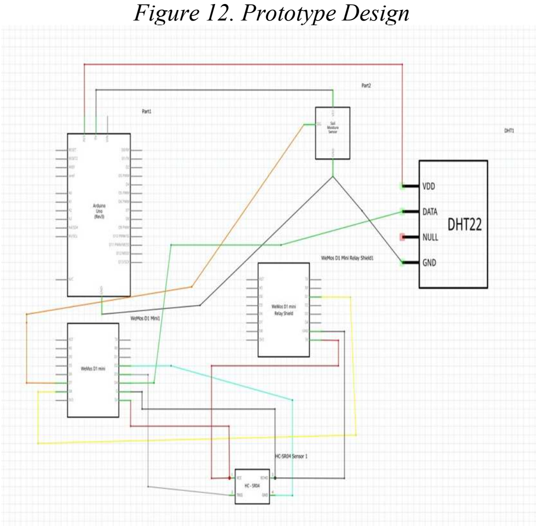

Figure 13. Schematic Wiring

Figures 12 and 13 are the initial designs of making Bulbasaur, using Wi-Fi and showing data via blynk. This Research hopes to show good results through thought and estimated results. In this Research, many sensors and microcontrollers are also used. Testing IoT tools will use Black Box[32], [33] testing.

The system features that will be tested with the black box include:

- Temperature monitoring feature
- Water monitoring feature
- Soil humidity monitoring feature
- Water humidity monitoring feature

As for the system evaluation, the evaluations that will be carried out include:

- Evaluation of the success of reading water values
- Evaluate the success of reading the temperature value
- Evaluate the success of reading soil humidity
- Evaluate the success of reading water humidity

4. EXPERIMENTAL RESULT

A. Bulbasaur Hardware

The hardware used in the simulation results is shown in Figure 14 below:

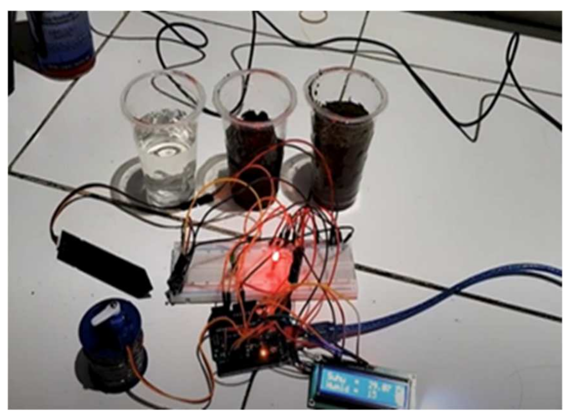

Figure 14. Bulbasaur Results

Figure 14 shows the Bulbasaur tested and generated on the LCD and remote results carried out on the Mobile Blynk. This study conducted two experiments in this study. The first experiment aimed to ensure that the sensor results were accurate and that these results could be sent to the BLYNK application.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

B. First Experiment

The first experiment used red and green LED lights as indicators. When the sensor measures the lack of moisture in the soil, a green LED will light up as a sign that the water pump is running. When the soil is moist enough, the red LED will light up. As in picture 15.

C. Second Experiment

The second experiment is aimed at ensuring the functionality of the entire system. The soil moisture sensor will work as per the first attempt. Then in this study using a distance sensor in the form of ultrasonic so that water level measurements can be carried out. If there is enough water for watering, the water pump will open until a good humidity level is reached. On the other hand, if it is found that there is not enough water, then the water pump will not be opened. The system also successfully sends temperature, humidity, and water level data to the BLYNK application. As in picture 14.

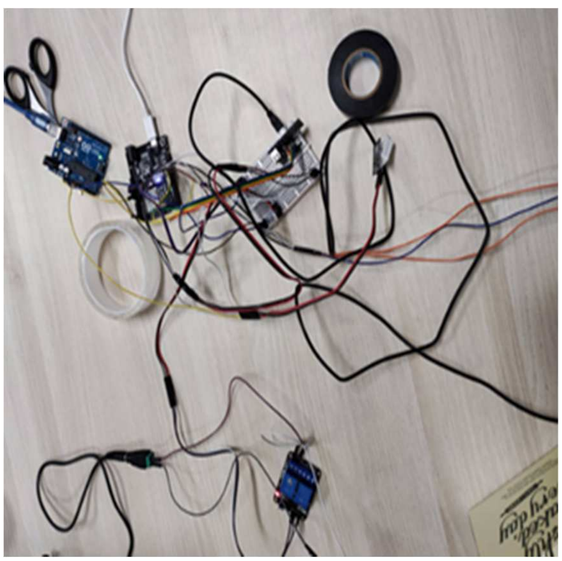

Figure 15. Experiment Result

In the experiment in Figure 15, the results are following research needs

D. Third Experiment

The third experiment is to carry out monitoring by displaying it into a mobile application in the form of a number, as shown in Figure 16

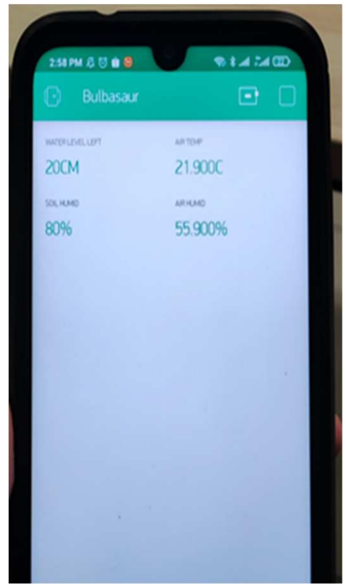

Figure 16. Bulbasaur *application results*

Figure 16 shows if the blynk application can display monitoring results in the form of temperature, humidity, etc. different from Research that only utilizes monitoring on the website [4], which only focus on the web. This Research focuses on mobile utilizing blynk. So it can be seen that the need for remote monitoring has been provided according to user needs.

E. Fourth Experiment

The last experiment using Black Box [32], [33] . To see all application needs in table 2, table 3, table 4, and table 5:

Table 2. The success of temperature check

Evaluation to-	Temperature Success Status	Temperature value
1	Success	21,9
2	Success	21,4
3	Success	21,5
4	Success	21,3
5	Success	21,6
6	Success	21,8
7	Success	21,1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

8	Success	21,6
9	Success	21,7
10	Success	21,9

Table 3. The success of checking the water level

Evaluation to-	Water level Success Status	Water Level
1	Success	20 cm
2	Success	20 cm
3	Success	20 cm
4	Success	20 cm
5	Success	20 cm
6	Success	20 cm
7	Success	20 cm
8	Success	20 cm
9	Success	20 cm
10	Success	20 cm

Table 4. The success of checking soil humidity

Evaluation to-	Success Status of soil humidity	Value of soil humidity
1	Success	80%
2	Success	80%
3	Success	80%
4	Success	80%
5	Success	80%
6	Success	80%
7	Success	80%
8	Success	80%
9	Success	80%
10	Success	80%

Table 5. The success of the water humidity check

Evaluation to-	Success Status of water humidity	Value of water humidity
1	Success	60%
2	Success	60%
3	Success	60%
4	Success	60%
5	Success	60%
6	Success	60%
7	Success	60%
8	Success	60%
9	Success	60%
10	Success	60%

Tables 2-5 show the success of the 10 trials, such as the average temperature at 21C, the water level at 20 cm, then soil humidity at 80%, and finally water humidity at 60%.

But this Research has weaknesses such as:

- Is the data produced following the needs of the plant
- Incomplete automation

5. CONCLUSION

Bulbasaur is an application that is used for simple plant care and monitoring with very cheap materials and is a mobile-based application utilizing Blynk. The application solves monitoring problems without using a website and simply using a mobile application.

The materials used are simple sensors and microcontrollers, sensors in detecting water level, air humidity, soil humidity, and temperature. The microcontroller uses Wemos as Wi-Fi and microcontroller. After that, monitoring will be tried on the display using the blynk application

This Research also aims to create a low-cost component by utilizing monitoring on blynk. With the results of the BlackBox experiment and carried out 10 times in the form of successfully checking the temperature with an average of 21 C. Soil humidity with an average of 80%, then the water level assessment is always the same if there is no increase in water at 20CM, the water humidity is around 60 %.

This Research has answered the problems described in the previous section, such as; low price, mobile-based automation, and ease to use. This Research has solved the previous research problem, which was only website-based. This Research was also successfully tested in BlackBox testing and several other experiments.

After knowing the test results and the success of the needs in this study. The author also has some further research that can be used, such as:

- Add light and carbon dioxide sensors
- Add MQTT
- Added features to blynk
- Create a special database for the application
- Create the assumptions of suitable in the concept of Figure 1

REFERENCES:

[1] E. P. Yadav, E. A. Mittal, and H. Yadav, "IoT: Challenges and Issues in Indian Perspective," in *2018 3rd International Conference On Internet of Things: Smart Innovation and Usages (IoT-SIU)*, 2018, pp. 1–5. doi: 10.1109/IoT-SIU.2018.8519869.

[2] K. Chopra, K. Gupta, and A. Lambora, "Future Internet: The Internet of Things-A Literature Review," in *2019 International Conference on Machine Learning, Big Data, Cloud and Parallel Computing (COMITCon)*, 2019, pp. 135–139. doi: 10.1109/COMITCon.2019.8862269.

[3] M. Ayaz, M. Ammad-Uddin, Z. Sharif, A. Mansour, and E. H. M. Aggoune, "Internet-of-Things (IoT)-based smart agriculture: Toward making the fields talk," *IEEE Access*, vol. 7, pp. 129551–129583, 2019, doi: 10.1109/ACCESS.2019.2932609.

[4] M. Haldi Widianto, A. Istiqomah Arrahmah, S. Jason Santosa, and G. Kurniawan, "IOT BASED LOW-COST PLATFORM FOR SMART ORNAMENTAL PLANT MONITORING SYSTEM," *Journal of Theoretical and Applied Information Technology*, vol. 31, p. 24, 2021, [Online]. Available: www.jatit.org

[5] V. Potdar, A. Sharif, and E. Chang, "Wireless sensor networks: A survey," in *2009 International Conference on Advanced Information Networking and Applications Workshops*, 2009, pp. 636–641. doi: 10.1109/WAINA.2009.192.

[6] A. Augustin, J. Yi, T. Clausen, and W. M. Townsley, "A study of Lora: Long range & low power networks for the internet of things," *Sensors*, vol. 16, no. 9, p. 1466, Sep. 2016, doi: 10.3390/s16091466.

[7] G. Codeluppi, A. Cilfone, L. Davoli, and G. Ferrari, "LoraFarM: A LoRaWAN-based smart farming modular IoT architecture," *Sensors* , vol. 20, no. 7, p. 2028, 2020, doi: 10.3390/s20072028.

[8] A. Triantafyllou, D. C. Tsouros, P. Sarigiannidis, and S. Bibi, "An architecture model for smart farming," in *2019 15th International Conference on Distributed Computing in Sensor Systems (DCOSS)*, 2019, pp. 385–392. doi: 10.1109/DCOSS.2019.00081.

[9] M. H. Widianto, T. E. Suherman, and J. Chiedi, "Pathfinding Augmented Reality for Fire Early Warning IoT Escape Purpose," *International Journal of Engineering Trends and Technology*, vol. 69, no. 7, pp. 190–197, 2021, doi: 10.14445/22315381/IJETT-V69I7P226.

[10] M. Sheth and P. Rupani, "Smart Gardening Automation using IoT with BLYNK App," in *2019 3rd International Conference on Trends in Electronics and Informatics (ICOEI)*, 2019, vol. 2019-April, no. Icoei, pp. 266–270. doi: 10.1109/icoei.2019.8862591.

[11] M. Kanaiya, G. Bhatt, M. Mayur Chavda, Y. Bhatt, and S. Pathan, "Implementation of Smart Farming Monitoring and Controlled using IOT BLYNK App on ESP8266 Platform," *IJSRD-International Journal for Scientific Research & Development|*, vol. 7, no. 10, pp. 2321–0613, 2019, [Online]. Available: www.ijsrd.com

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[12] P. Serikul, N. Nakpong, and N. Nakjuatong, "Smart Farm Monitoring via the Blynk IoT Platform : Case Study: Humidity Monitoring and Data Recording," in *2018 16th International Conference on ICT and Knowledge Engineering (ICT&KE)*, Jan. 2019, vol. 2018-November, pp. 70–75. doi: 10.1109/ICTKE.2018.8612441.

[13] M. H. Widianto, Ranny, N. F. Thejowahyono, and S. B. Handoyo, "Internet of things based on smart mirror to improve interactive learning," *International Journal of Emerging Trends in Engineering Research*, vol. 8, no. 9, pp. 4900–4907, 2020, doi: 10.30534/ijeter/2020/02892020.

[14] M. O. Akbar *et al.*, "IoT for Development of Smart Dairy Farming," *Journal of Food Quality*, vol. 2020, 2020, doi: 10.1155/2020/4242805.

[15] E. Said Mohamed, A. A. Belal, S. Kotb Abd-Elmabod, M. A. El-Shirbeny, A. Gad, and M. B. Zahran, "Smart farming for improving agricultural management," *Egyptian Journal of Remote Sensing and Space Science*. Elsevier B.V., 2021. doi: 10.1016/j.ejrs.2021.08.007.

[16] D. Budaev *et al.*, "Conceptual design of smart farming solution for precise agriculture," *International Journal of Design and Nature and Ecodynamics*, vol. 13, no. 3, pp. 307–314, 2018, doi: 10.2495/DNE-V13-N3-307-314.

[17] S. van der Burg, M. J. Bogaardt, and S. Wolfert, "Ethics of smart farming: Current questions and directions for responsible innovation towards the future," *NJAS - Wageningen Journal of Life Sciences*, vol. 90–91, Dec. 2019, doi: 10.1016/j.njas.2019.01.001.

[18] Z. Unal, "Smart Farming Becomes even Smarter with Deep Learning - A Bibliographical Analysis," *IEEE Access*, vol. 8, pp. 105587–105609, 2020, doi: 10.1109/ACCESS.2020.3000175.

[19] "Indonesia Loses Upper-Middle Income Status Amid Pandemic - Bloomberg." https://www.bloomberg.com/news/articles/2021-07-08/indonesia-loses-prized-upper-middle-income-status-amid-pandemic (accessed Mar. 09, 2022).

[20] "Indonesia is Stated as Lower Middle Income Country, Undip and Three State Universities in Central Java Recommended Five Strategic Policies - Universitas Diponegoro." https://www.undip.ac.id/language/en/post/21253/indonesia-is-stated-as-lower-middle-income-country-undip-and-three-state-universities-in-central-java-recommended-five-strategic-policies.html (accessed Mar. 09, 2022).

[21] S. Choosumrong and N. Pinnok, "Implementation of Web Technology for Smart Farming Monitoring and Controlled using IoT Blynk App and NodeMCU esp8266," in *International Symposium on Geoinformatics for Spatial Infrastructure Development in Earth and Allied Sciences*, 2021, pp. 1–7.

[22] B. N. Mohapatra, R. V. Jadhav, and K. S. Kharat, "A Prototype of Smart Agriculture System Using Internet of Thing Based on Blynk Application Platform," *Journal of Electronics, Electromedical Engineering, and Medical Informatics*, vol. 4, no. 1, pp. 24–28, Jan. 2022, doi: 10.35882/jeeemi.v4i1.2.

[23] A. Darisman and M. H. Widianto, "Design and Development of Pharmaceutical Company Information System Based on Website using the Waterfall Model," *International Journal of Recent Technology and Engineering*, vol. 8, no. 4, pp. 3989–3993, 2019, doi: 10.35940/ijrte.d8610.118419.

[24] J. P. Sinha, "Aerial robot for smart farming and enhancing farmers' net benefit," *Indian Journal of Agricultural Sciences*, vol. 90, no. 2, pp. 258–267, 2020, [Online]. Available: https://www.researchgate.net/publication/339952793

[25] F. A. Almalki, B. O. Soufiene, S. H. Alsamhi, and H. Sakli, "A low-cost platform for environmental smart farming monitoring system based on iot and uavs," *Sustainability*, vol. 13, no. 11, p. 5908, 2021, doi: 10.3390/su13115908.

[26] H. Durani, M. Sheth, M. Vaghasia, and S. Kotech, "Smart Automated Home Application using IoT with Blynk App," in *2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT)*, Sep. 2018, pp. 393–397. doi: 10.1109/ICICCT.2018.8473224.

[27] S. K. Nagothu, "Weather based smart watering system using soil sensor and GSM," in *Weather based smart watering system using soil sensor and GSM*, Oct.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

2016, pp. 1–3. doi: 10.1109/STARTUP.2016.7583991.

[28] I. S. Nasution, M. R. Iskandar, and D. S. Jayanti, “Internet of things: Automatic sprinklers in prototyping greenhouse using smartphone based android,” in *IOP Conference Series: Earth and Environmental Science*, Feb. 2020, vol. 425, no. 1. doi: 10.1088/1755-1315/425/1/012069.

[29] B. Glatzeder, V. Goel, and A. Müller, *Towards a Theory of Thinking: Building Blocks for a Conceptual Framework*. Springer, 2010. doi: 10.1007/978-3-642-03129-8.

[30] S. Widodo, M. M. Amin, A. Sutrisman, E. Cofriyanti, and R. M. Puji, “Implementation of Parking Portal Door Security System Using RFID and Password Based on Microcontrollers in Sriwijaya State Polytechnic,” in *Journal of Physics: Conference Series*, May 2020, vol. 1500, no. 1. doi: 10.1088/1742-6596/1500/1/012114.

[31] “UML 2 Use Case Diagramming Guidelines.” http://www.agilemodeling.com/style/useCaseDiagram.htm (accessed Feb. 19, 2022).

[32] M. E. Khan and F. Khan, “A Comparative Study of White Box, Black Box and Grey Box Testing Techniques,” *International Journal of Advanced Computer Science and Applications(IJACSA)*, vol. 3, no. 6, 2012, doi: 10.14569/IJACSA.2012.030603.

[33] M. E. Khan, “Different Forms of Software Testing Techniques for Finding Errors,” *IJCSI International Journal of Computer Science Issues*, vol. 7, no. 3, pp. 1–16, 2010.