# CHAPTER V
# CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

Based on the results of the design, implementation, and testing that have been conducted, it can be concluded that the Internet of Things (IoT) system based on Interval Type-2 Fuzzy Logic using an ESP32 microcontroller has been successfully built and functions well in automatically monitoring and controlling light intensity, water level, and air temperature in the growing environment of Drosera sessilifolia. All sensors and actuators are able to operate in an integrated manner, allowing the system to adjust environmental conditions without requiring continuous manual configuration.

The application of the Interval Type-2 Fuzzy Logic method in this system demonstrates reasonably good performance in generating actuator control decisions. By considering sensor data uncertainty through Lower and Upper membership values, the system is able to make more flexible decisions regarding changes in environmental conditions. This enables actuators such as the heater, peltier, lights, pump, and fans to operate in accordance with the detected conditions and the requirements of the plant's growing environment. What is meant by 'flexible' is that the system does not immediately make a rigid decision merely because it crosses a specific numerical threshold. The system still provides tolerance for minor fluctuations in temperature or light, thereby avoiding abrupt activation or deactivation of the actuators. Consequently, the heater, peltier, lights, pump, and fans can operate in a way that better adapts to the environmental conditions and the plant's needs.

Furthermore, the IoT-based monitoring system via the Blynk platform has proven effective in displaying real-time information on environmental conditions and actuator status. Users can easily monitor light intensity, water level, and air temperature through an informative and user-friendly dashboard interface. With this system in place, the process of monitoring and controlling the growing environment of Drosera sessilifolia becomes more practical and efficient, supporting the application of sustainable plant cultivation in indoor environments.

## 5.2 Recommendation

Based on the research results that have been conducted, several recommendations that can be provided for future system development and refinement are as follows:

1. The system can be developed to have a larger plant capacity, for instance, by adding several sensor and actuator points within a single system or applying a multi-node concept, enabling it to manage more plants within one room.
2. Considering that air humidity is a factor involved in the growth of carnivorous plants, particularly Drosera, it is recommended to add an air humidity sensor so that environmental control becomes more comprehensive and closer to its natural habitat conditions.
3. The LDR sensor used could be replaced or supplemented with a lux-based light intensity sensor to obtain more accurate lighting data. In addition, a sensor calibration process needs to be carried out periodically to ensure the readings remain consistent.
4. Actuator control can be developed from an ON/OFF system into gradual or adaptive control, such as adjusting fan speed or pump operation duration, ensuring that changes in environmental conditions can occur more stably.
5. The IoT-based monitoring system can be improved by adding historical data graphs, automatic warning notifications, and system security features in the event of environmental conditions falling outside safe limits.
6. The developed system has the potential to be applied to other types of carnivorous plants, such as other species of Drosera or Nepenthes, thereby serving as a general solution for IoT-based indoor carnivorous plant cultivation.
7. The system can be developed to have a larger plant capacity, for instance, by adding several sensor and actuator points within a single system or applying a multi-node concept, enabling it to manage more plants within one room.
8. Considering that air humidity is a factor involved in the growth of carnivorous plants, particularly Drosera, it is recommended to add an air humidity sensor so that environmental control becomes more comprehensive and closer to its natural habitat conditions.

9. The LDR sensor used could be replaced or supplemented with a lux-based light intensity sensor to obtain more accurate lighting data. In addition, a sensor calibration process needs to be carried out periodically to ensure the readings remain consistent.
10. Actuator control can be developed from an ON/OFF system into gradual or adaptive control, such as adjusting fan speed or pump operation duration, ensuring that changes in environmental conditions can occur more stably.
11. The IoT-based monitoring system can be improved by adding historical data graphs, automatic warning notifications, and system security features in the event of environmental conditions falling outside safe limits.
12. The developed system has the potential to be applied to other types of carnivorous plants, such as other species of Drosera or Nepenthes, thereby serving as a general solution for IoT-based indoor carnivorous plant cultivation.