MONITORING ESSENTIAL SOIL NUTRIENT BASE ON INTERNET OF THINGS ON DIPTEROCARPUS LITTORALIS PLANT

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ABSTRACT
Dipterocarpus littoralis known locally as pelahlar, is a producer of endemic commercial wood in Nusakambangan. Pelahlar habitat that is isolated in one island and a narrow genetic distribution causes the risk of extinction of this species to increasing. The effort to conserve rare flora can be done by monitoring and observing the balance of essential nutrients at the site of growth. Therefore, we need a system that is able to monitor the balance of essential nutrients and pH in the soil to support the growth of rare flora based on the Internet of Things (IoT). This system consists of a sensor station and a central gate station that are connected based on a star network because it is believed to reduce system power consumption. Scheduling of sending data from the sensor station to the gate station is determined by the results of competition between sensor stations based on the back off of each sensor station. through this scheme an increase in throughput and collision values is based on the number of sensor stations. We found that the more sensor stations that compete, the smaller the value of the throughput of the system.

Keywords: IoT, *Dipterocarpus littoralis*, star network, throughput

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INTRODUCTION

Soil is a component of plant growth that provides essential nutrient preparations that are very important to support development processes and plant growth. Good and fertile soils are soils which able to provide essential nutrients that are essentially sufficient and balanced to be absorbed by plants [1]. Essential nutrients consist of macronutrients needed by plants in large quantities and micronutrients, namely nutrients needed by plants in small amount [2]. The essential nutrient elements determine the survival of plants where their existence cannot be replaced and results in non-optimal growth and development if their needs for these elements are not fulfilled. Essential nutrients that are needed by plants are N, P, K, Ca and Fe [3]. N deficiency can cause yellowing of old leaves (chlorosis), P deficiency causes stunted plants, K deficiency can cause yellowing of old and young leaves (necrosis), Ca deficiency causes necrosis, and Fe deficiency indicates chlorosis. In addition to nutrients, pH is one of the parameters that can be used to diagnose plant growth problems. Soil reaction (pH) needs to be known because each plant requires a certain pH environment. There are plants that are tolerant of long pH shocks, but there are also plants that are intolerant of pH shocks [4]. Deficiency or excess nutrients can cause interference, poisoning and even death for plants.

Dipterocarpus littoralis, known locally as pelahlar, is one of the Meranti tribes. Pelahlar (Dipterocarpaceae) produces endemic commercial timber in Nusakambangan [5]. The isolated

pelahlar habitat is only in one island and the narrow genetic distribution causes the risk of extinction of this native Javanese Dipterocarpus species to increase sharply. In efforts to conserve rare flora, the death of an individual will have a major impact on reducing genetic diversity because it can increase the risk of extinction. From this problem, the development of an important nutritional balance monitoring system for *Dipterocarpus littoralis* using an Internet of Things (IoT) tool can be carried out.

The Internet of Things (IoT) creates a new world, where everything is able to be monitored so that it can help solve many current problems and is able to create new business opportunities. This "smart" new world will offer a large-scale change for the community and even be able to change the entire industry and business in depth. IoT will create practical and significant solutions with timely and higher quality information so that it helps us make better decisions faster with [6]. In addition, the concept of IoT has recently become increasingly popular allowing it to share information between two or more nodes (devices), in this case sensors, through wired or wireless methods [7]. Internet of Things (IoT) allows living and inanimate objects to be connected through the internet network. The main aim of IoT is to make things simpler by significantly increasing smart devices [8]. IoT technology has directed people to broad connections and smart services. Now it is being used widely in various smart applications and creates various business opportunities [9]. The IoT system can be used to monitor the balance of important nutrients and pH in the soil to support the growth and growth of rare flora such as *Dipterocarpus littoralis* and can also be used to optimize agricultural product [10]. Remote measurement or Telemetry is the process of measuring the parameters of an object (object, space, natural conditions) whose measurement results are sent to another place through the process of sending data using either with a cable or without a cable (wireless). Telemetry is expected to make it easier to measure, replace, and reduce obstacles to getting the information needed. In this research a system of integration between Telemetry and IoT was developed as a solution to the monitoring problem of *Dipterocarpus littoralis*.

In this work, we have proposed a plant monitoring system based on IoT and Telemetry, the proposed method helps monitor the balance of essential nutrients in the soil. The rest of the paper will show the proposed system model and network topology. In the next section the results of the proposed network topology simulation will be presented.

RESEARCH METHOD

This section will present important components for developing systems such as experimental and simulation development. The design of power sources, electronic circuits, and transceiver modules is what will be explained at the experimental section. Furthermore, the network topology design will be discussed in the simulation section.

A. Power Source

Power source is one important part of the device monitoring system, determining the source of power is influenced by the purpose and implementation of the system. In general, IoT devices are classified into two major groups, namely indoor and outdoor devices. Indoor system devices can utilize power sources through a network of power that has been installed in a building. But unlike things with outdoor devices, the source of power can come from batteries orcan be combined with energy generators such as Photovoltaic (PV). In this work a monitoring device that has a battery and PV as power source is developed.

This system uses PV with a capacity of 10W (PV). Assuming Peak Sun Harvest (PSH) of 4.5, we will get energy that can be harvested to determine the minimum battery capacity needed for the system with depth of discharge (dod) is 50% and Correction charge and discharge is 0.8.

B. Electronic Circuit and Transceiver Module

In this section a component of the design of hardware monitoring system that has been built will be presented. This system consists of two hardware devices namely the sensor station and the gate station. The sensor station (Figure 1) functions to measure several types of essential ground parameters and send measurement data to the gate station. There are several sensors available at the sensor station namely UV sensor, salinity (Na) sensor, humidity sensor, temperature sensor and soil PH sensor. Arduino Uno is used as a data processing center of the sensor station. Sensor station is supported by two types of power sources namely battery and PV. The capacity of the battery used is calculated using the equation.

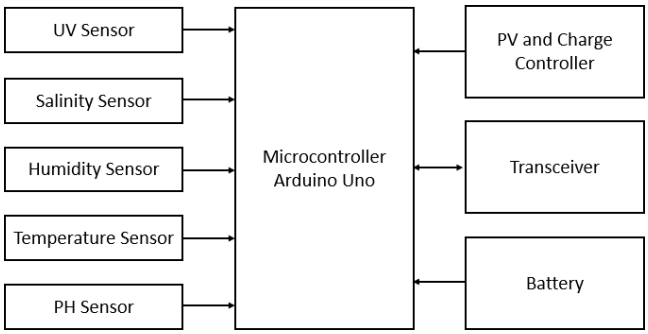

Figure 1. Design of sensor

Moreover, the Gate station (Figure 2) functions as a receiver of data transmission from the sensor station and is able to send data received to the internet network (IoT) so that the data can be visualized on a web server. Unlike the sensor station, NodeMCu is used as a data processing center at the gate station, NodeMCu was chosen because it is equipped with a wi-fi module that allows this microcontroller to be able to connect to the internet network.

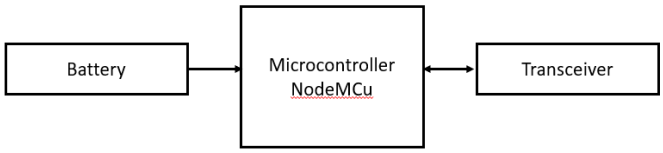

Figure 2. Design of gate

Sending data from the sensor station to gate stations is done using a transceiver module that works at a frequency of 433MHz. This module is only able to receive data and send data in turn (half-duplex).

C. Network

The communication network between several sensor stations and a gate station will be explained in this section. To make the communication system between the sensor station and gate station more efficient, a scheme for sending data is developed. The scheme that will be discussed in this paper is the scheme of sending data from several sensor stations to a gate station (star network) as shown in Figure 3. Communication between sensor stations and gate stations is done using a half-duplex radio transceiver, each sensor station must send data to the gate station alternately so that data collisions do not occur, causing data loss. To avoid these collisions, a scheduling method is proposed. The order of delivery schedule depends on the results of competition between sensor stations based on the back off value at each station.

Beside that with this concept it will be easier to explain the possibility of saturation throughput performance [11].

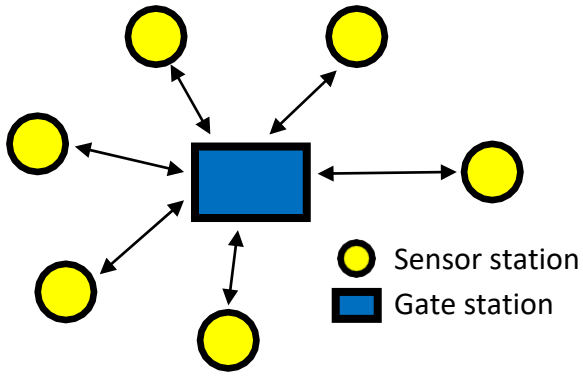

Figure 3. An illustration of an IoT network between gate station and six sensor stations

To determine the Sensor Station (SS) that will transfer the data, each SS will conduct a competition based on the respective back off value of the SS. This causes the Gate Station does not need to determine the schedule of the SS. But the weakness of this scheme is that it is possible for collision to occur between SS. The sensor station competition scheme in this system is shown in Figure 4.

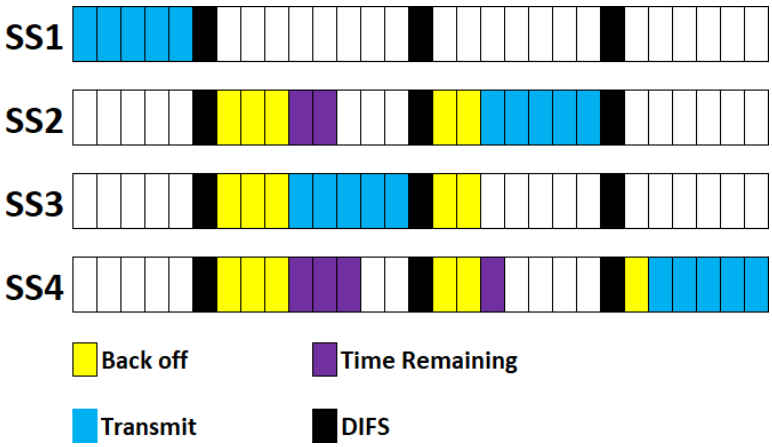

Figure 4. Multiple station station transmission case

In this scheme it is assumed that there is no hidden station and a slot has various lengths depending on the event and the inter-cycle separation constant of (DIFS)

FINDINGS AND DISCUSSION

This section will show hardware and the simulation results that have successfully been built. The system that has been built consists of a sensor station, gate station, web server, and network simulation between a gate station and sensor stations. Figure 5. is sensor station. Sensor station functions to measure several types of parameters while sending data to the gate station. There are several sensors that are in the sensor station namely UV sensor, salinity (Na) sensor, humidity sensor, temperature sensor and soil PH sensor. Then there is also a Arduino Uno as microcontroller that functions as a data processing center of the sensor station sensor equipped with 10 W photo voltaic as an energy provider and is equipped with a 433 MHz radio frequency as a vehicle for sending data to the gate station.

Figure 5. Sensor station

In addition, the Gate station (Figure 6) functions as a receiver of data transmission from the sensor station and is able to send data received to the internet network (IoT). So that the data can be visualized on a web server that has been built like as Figure 7 and web server was developed using the ubidots.com platform.

Using MATLAB, a simulation of 50 sensor stations and a gate station has been carried out as shown in Figure 8. By using the scheduling scheme proposed in this paper, sending data from several sensor stations to the gate station is based on the back off of each sensor station. It is seen that the more sensor stations that compete, the higher the possibility of collisions as well as throughput systems. A large decrease in throughput can occur along with the increasing number of sensor stations. Moreover, it gives knowledge to an engineer the effect of increasing the number of sensor stations on a gate station.

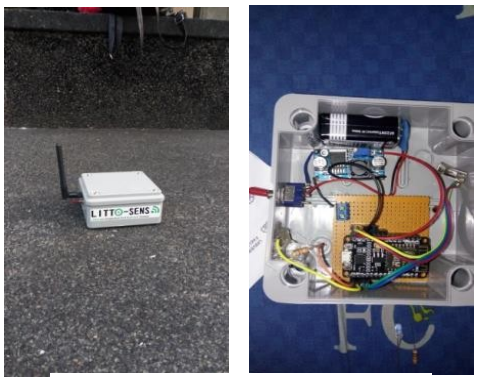

Figure 6. Gate station

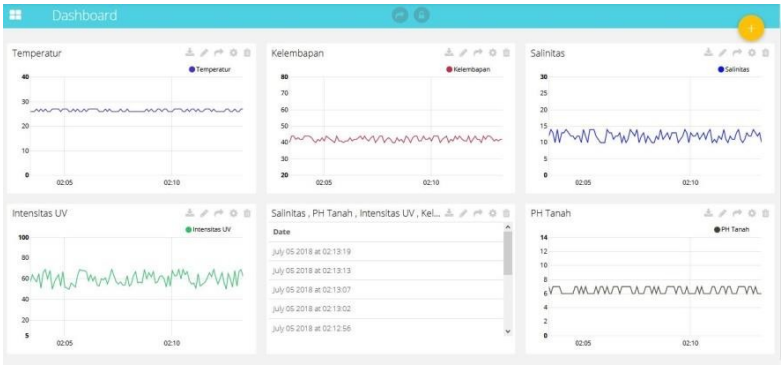

Figure 7. Dashboard of Web Server

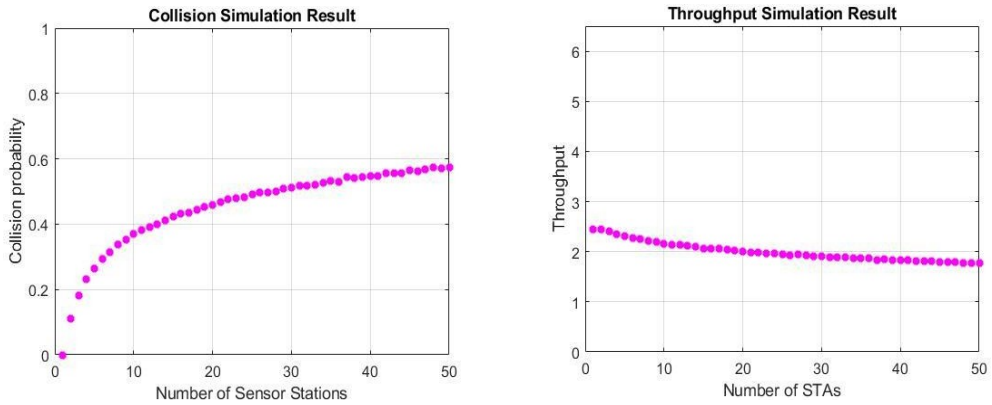

Figure 8. Collision and throughput simulation result

CONCLUSION

Essential nutrient monitoring system for plants, especially Dipterocarpus littoralis has been successfully built, this system consists of sensor stations, gate stations and web server dashboards that can be used to display parameters measured by the system. In addition, the proposed communication scheme shows that the more sensor stations that are used, the greater the possibility of collisions that occur and the smaller the value of the system throughput.

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