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INTERNET OF THINGS-BASED DURIAN FALL DETECTOR TO HELP FARMER HARVEST EFFICIENTLY USING WEMOS D1R2

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Abstract. *Durian (Durio Zibethinus) is a fruit that is loved and sought by many people, especially in Asia, and many of them are looking for the best quality durian. The best quality of durian fruit is when the fruit has just fallen from the tree. To support durian farmers and consumers to obtain the best quality durians, we proposed a durian fall detector device so that it can immediately find out if the durian fruit has fallen from the tree. The tool uses an Internet of Things system that uses Arduino WeMos D1R2 and is equipped with an accelerometer, gyroscope, and ultrasonic sensors to detect vibration and distance, which will send notifications to durian farmers via mobile to immediately collect the newly fallen durians. The system has been implemented with 82% accuracy and is accompanied by a buzzer to make it easier for durian farmers to find durians that have just fallen by its sounds.*
Keywords: Internet of Things, Durian, WeMos, Gyroscope, Ultrasonic sensor, Blynk platform

1. **Introduction.** Internet of Things (IoT) is a concept that aims to expand the benefits of Internet connectivity and devices connected to it [1]. IoT can be used to control electronic devices or equipment by connecting them to the Internet and then monitoring and operating them remotely [2]. It is undeniable that such rapid technological advances must be used, studied, and applied in everyday life. An example of technological development that can be utilized from this Internet connection is being able to monitor home energy usage, which can be operated online via mobile, so that it can make it easier for users to monitor home conditions and energy usage, such as able to control the air conditioner remotely at any time and anywhere with notes that the location to be applied has an adequate Internet network [3]. While in another study "Home security alarm", this control system technology is carried out from a cellphone that is connected to the home alarm system, which will provide notifications via telegram application [4]. Now IoT has become a part of everyday life and helps the activities of many people. Many research results from the IoT have been applied in various fields, such as in construction, agriculture, marine, and health care [5].

In the field of agriculture, especially in the plantation sector, durian fruit is one of the fruits that has a lot of demand in the market. This fruit grows in Southeast Asia and has a unique smell and taste that is in demand by many people; it even has the title "King of Fruits" [6]. Many durian fruit lovers are looking for the best quality of this fruit. The way to get the best quality from this durian fruit is to wait for it to ripen naturally and

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fall from the tree by itself. However, to meet demand in the market, durian farmers take the durian that is still hanging on the branch and ripen it with carbide. This causes the quality of the taste of durian to decrease and is detrimental to farmers and durian lovers [7]. Many researches have studied the ripeness level of durian fruit. However, if the durian naturally falls from its tree, the ripeness level will also be high. That is why this research on the durian fall detector was carried out. And we did not find studies like this. We found a tool to detect fruit fall in general, but there is no specific research paper about it. To answer the problems above, we use Arduino WeMos D1R2. Arduino WeMos D1R2 is one of the components of the IoT that can be applied as a remote controller with an Internet network that can be applied to electronic equipment [8]. These devices can be accessed with Internet services via Android/iOS smartphones with Internet Protocol so that the level of energy efficiency and working hours of durian farmers can be more effective [9]. This technology is suitable to use because it will make it easier for durian farmers to carry out their work.

Based on the problem we described earlier, this research was made to design a smart system and create a mobile application program using Arduino WeMos D1R2 as a remote durian detector with an Internet network. This research was conducted for a smart system in agriculture to help durian farmers monitor durian fruits by using the IoT durian fall detector device, which will monitor durian fruit in real time and notify durian farmers via application when the durian fruit falls from its branch.

2. Proposed Method.

By using a vibration sensor module with an accelerometer and gyroscope, also an audio sonic sensor, and an ultrasonic sensor, the device collects information on whether the durian is still hanging or has fallen from the branch [10]. When the durian falls, the device will send a notification to the user's smartphone. With the WeMos D1R2 microcontroller that is equipped with built-in Wi-Fi [11], WeMos can send data that has been obtained to the Blynk cloud in real time. Blynk is a platform that can control electronic devices remotely using its iOS and Android apps over the Internet. It consists of three major components in the platform: the Blynk App, which is used to create the interface and control the device; the Blynk server, which handles communication between the app and hardware; and Blynk libraries, which enable the communication for hardware with the server using commands [12-14]. In that way, using an Internet connection, the user can access the Blynk application using his smartphone from home to check when and how many durian fruits have fallen from the branch.

2.1. The architecture of IoT durian fall detector.

IoT durian fall detector has 5 layers of architecture, which can be seen in Figure 1. Among them there are the perception layer, network layer, cloud layer, and application layer, where each layer has its function and use. In the first layer, namely perception, there are 2 sensors, namely HC-SR04 (ultrasonic sensor), GY-521 (gyroscope & accelerometer), and a WeMos D1R2 microcontroller which has a role in durian detection in real time. The gyroscope measures the direction and reads movement based on gravity. It measures direction based on the angular momentum principle and has sensitive outputs on the angular velocity of the x, y, and z axes [15]. While the accelerometer is used to measure the vibration of a structure and analyze the change in motion and acceleration [16]. And the ultrasonic sensor is used to find the distance to objects according to the principle of sonar, just as dolphins or bats do. It offers a non-contact object detection range of 2-400 cm with the simplicity of use and high accuracy and stability of reading. It produces 8 short ultrasonic pulses at a frequency of 40 kHz so that sound can be accurately reflected from obstacles and received back by the sensor [17]. The distance set by the ultrasonic sensor to detect between the device and the durian is 50 cm. For the gyroscope sensor we set to 50°/s or revolution per second (RPS), and for the accelerator sensor we set to 50 m/s^2 to detect whether there is

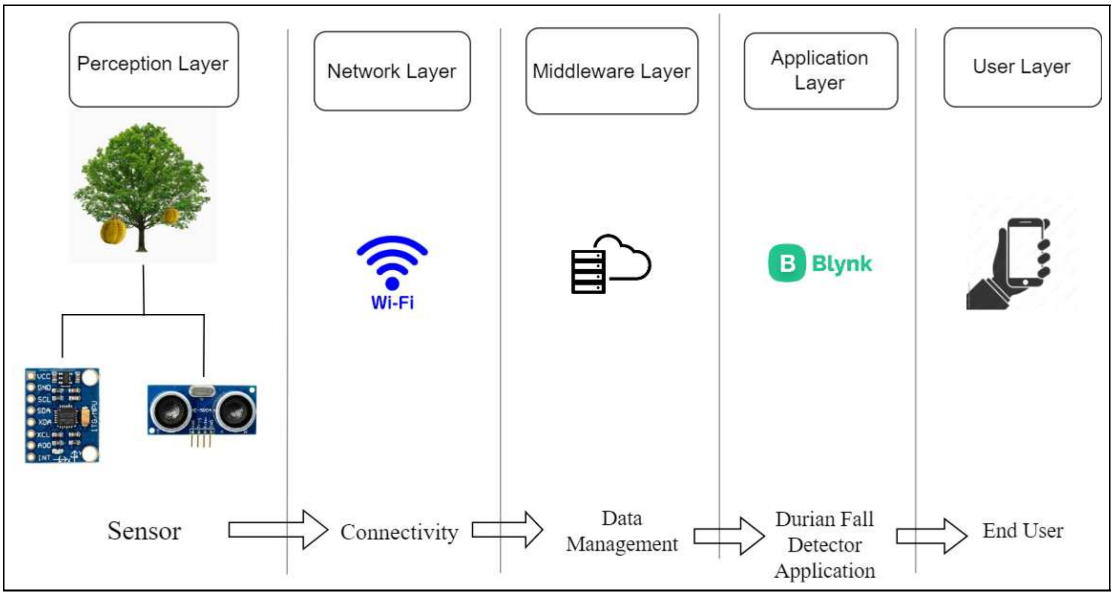

FIGURE 1. The architecture of IoT durian fall detector

vibration or not in the branch. After the data is obtained, the collected data will be sent by the network layer via the Internet network which uses Wi-Fi as the medium and will be sent to the cloud layer as an intermediary between the device and the user application, and if it has been successfully sent, it will be passed back to the application layer, showing the processed data, in the form of the number of fallen durians and notifications to the user's smartphone, so that the user can immediately harvest the durian that has fallen and is ready to be sold or eaten.

2.2. **Sketch of IoT durian fall detector.** A sketch of the IoT durian fall detector can be seen in Figure 2. In this study, the WeMos D1R2 microcontroller is the main brain. WeMos D1R2 requires a 9 V power supply as its power, which can adjust the ultrasonic sensor and gyroscope sensor to get data in the form of distance and vibration. After the device is installed according to the instructions, the durian will be fully monitored every second WeMo sends data to Blynk Cloud via an Internet connection or Wi-Fi available around the device. Blynk Cloud will send the data to the Blynk Apps that have been installed on the user's smartphone as data on the number of fallen durians and notifications to the user. The device prototype can be seen in Figure 3.

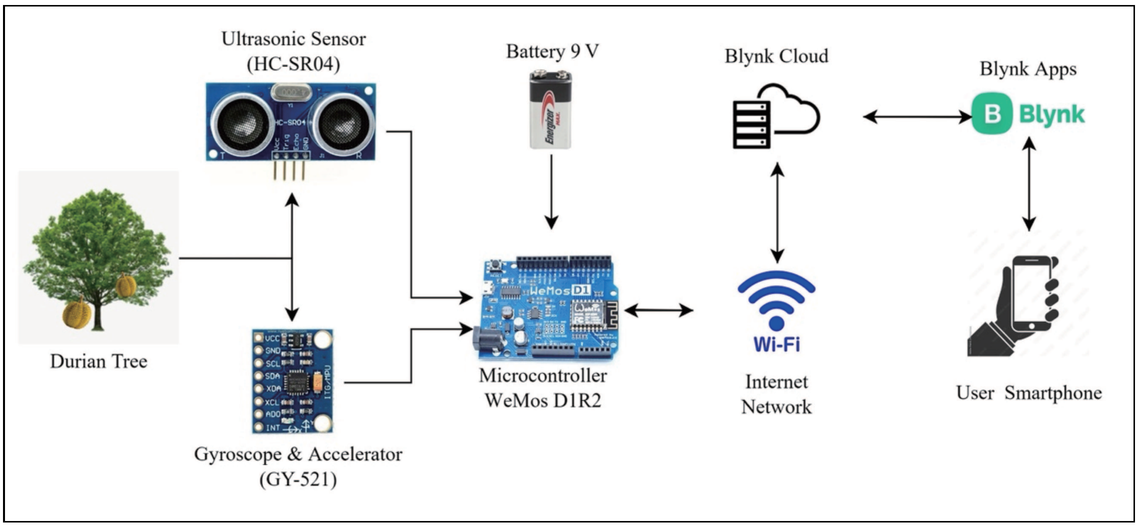

FIGURE 2. Sketch of durian fall detector

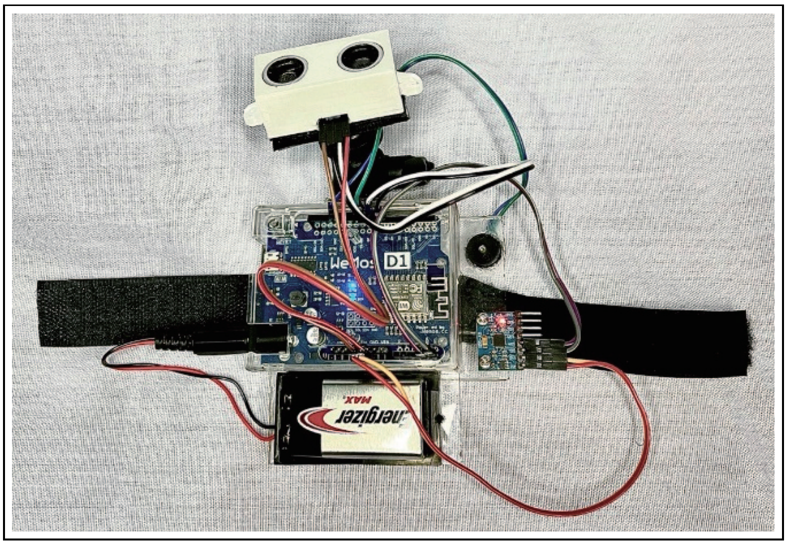

FIGURE 3. Durian fall detector device prototype

2.3. **Flowchart of IoT durian fall detector.** Flowchart is a graphical representation of the sequence of procedure on the system that can portray the work of the program structure and its other alternatives in the operation to analyze its function [18]. The following is the flowchart of IoT durian fall detector.

The flowchart in Figure 4 shows how the IoT durian fall detector system works. At the start, the device is turned on using a 9 V electric battery power. Then the device is automatically connected to Wi-Fi around the device whose SSID and password have been set, and then check the installation position on the device, whether it is good or not. If it is not good, the position must be readjusted again until the user application says, "Device is all set", as shown in Figure 5. If so, the device is ready to use as it should and can be left. The device will read durian vibration, rotation, and distance data using the sensors at any time. If the requirements for a fallen durian have not been met, the device will continue to collect the data, and if all the sensors get data that matches the conditions, a durian can be declared fallen from its stem. After that, the device will send this data to the Cloud and proceed to the user application, which then, on the user's smartphone application, it will increase the number of durians that fall. And the user will receive

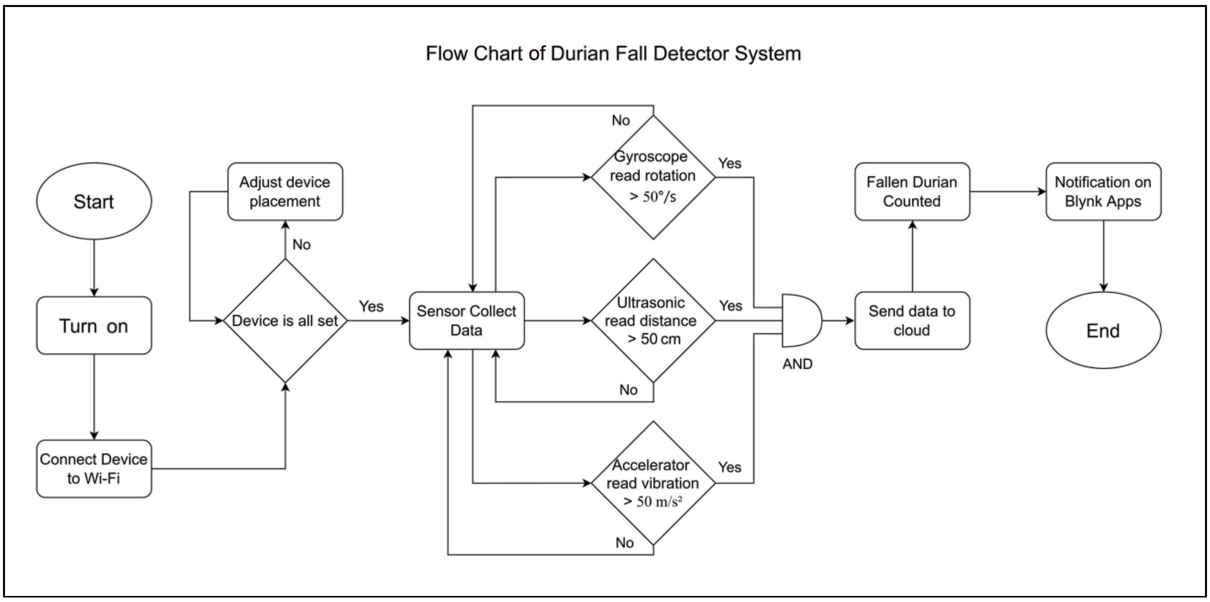

FIGURE 4. IoT durian fall detector flowchart

FIGURE 5. Blynk mobile apps, device is ready to use, Power ON

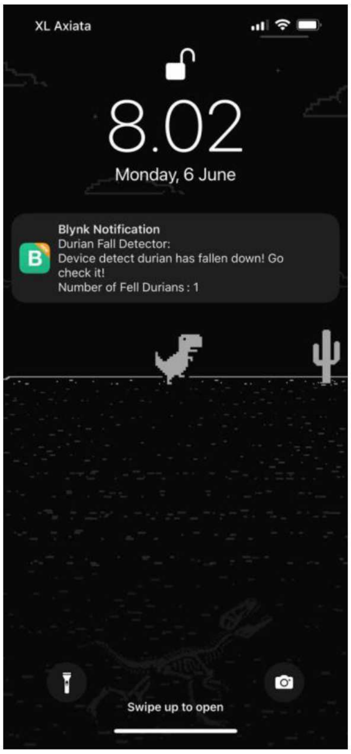

FIGURE 6. Blynk mobile apps notification if durian fall detect

FIGURE 7. Blynk mobile apps playing sound on device, Power OFF

a notification from the Blynk application stating the number of fell durians, which can be seen in Figure 6. If the notification has been sent, the device will turn off the sensor function to save battery energy. We also added a Find Device feature to make it easier for durian farmers to find where the durian fruit has fallen, using the 3.3 V Active Buzzer as a sound machine generator. In the application, a button will be given for the device to turn on the sound, which can be seen in Figure 7. This feature can help shorten the search time for the device and the fallen durian.

3. **Experiment Results.** We conducted this experimental research on a type of durian *Kane*. In this experiment, we could not directly test the original durian that had not fallen from the branch. However, instead, we used a simulation of the durian fall as close as possible to the original using a rope which can be seen in Figures 8, 9, and 10. We did the test 10 times per durian, and we used 5 kinds of durian which have different weights and various places and situations, which can be seen in Table 1.

In our experiments, the success rate of our IoT durian fall detector test is 82%, by conducting 50 trials with 41 successfully detected and 9 errors, which can be seen in Table 1. The tests we did on each durian had different errors. We discovered that one of the problems that happened was that the falling durian was not recognized. After we examined it better, what happened was that the branch of the 1.85 Kg durian was too large, so the gyro and accelerator sensor did not detect any motion at all. Thus, the requirement that the durian fell is not met so it is not detected as a fallen durian. Then in the other case of durian which one is weights 2.65 Kg, we found that there was 1 error that occurred. We realized that the error that occurred was that the durian fall had not been detected, which was caused by another object that replaced the durian as the object measured by the ultrasonic sensor, and in our case, the leaves and twigs of the next tree replaced the fallen durian. So the durian fell was not detected, then another error occurred. We realized that the error occurred due to the temporary loss of the Wi-Fi

FIGURE 8. Device IoT durian fall detector on set

FIGURE 9. Device IoT durian fall detector on set (Zoom In)

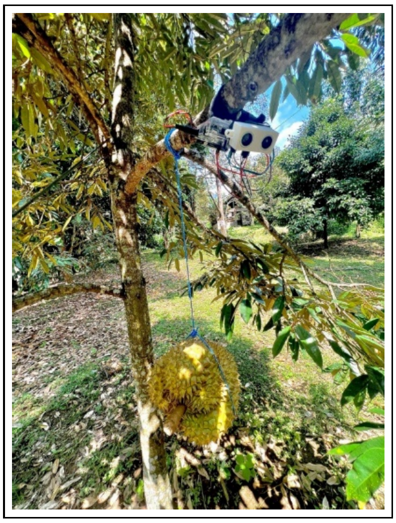

FIGURE 10. Durian has fallen.

TABLE 1. Result of experiment

Number of test	Weight				
	1.85 Kg	2.65 Kg	3.20 Kg	4.05 Kg	4.80 Kg
1st	Detected	Detected	Error	Detected	Detected
2nd	Error	Detected	Detected	Detected	Error
3rd	Detected	Detected	Detected	Detected	Error
4th	Detected	Detected	Error	Detected	Detected
5th	Detected	Detected	Detected	Error	Detected
6th	Detected	Detected	Detected	Detected	Detected
7th	Error	Detected	Error	Detected	Detected
8th	Detected	Detected	Detected	Detected	Detected
9th	Detected	Error	Detected	Detected	Detected
10th	Detected	Detected	Detected	Detected	Detected
Accuracy	**80%**	**90%**	**70%**	**90%**	**80%**
Average accuracy	**82%**				

signal when the durian fell. The loss of the Wi-Fi signal makes the device unable to send up-to-date data to the cloud so that the fallen durian is not detected.

We found 3 errors on durian 3.20 Kg. One of the errors occurred because the ultrasonic sensor was distorted by intense winds, and the gyroscope sensor was also active due to the shaking from the wind, so the device found that the durian fruit had fallen, even though it was the wrong count because durian has not fallen yet. The other error occurs due to the exhaustion of the 9 V battery, so the device is completely dead and cannot function properly. Still, the user can check if the device is offline, which is no signal or out of battery on the Mobile Apps. We understand that there are still many shortcomings in this research. With the various errors we encountered, the shortcomings that we realized included the insensitivity of the existing sensors, other objects that could be detected incorrectly, Wi-Fi connectivity in villages and forests, and other sources.

4. **Conclusions.** The project has implemented a durian fall detector device that can sense when and where durian will fall from the tree with an accuracy of ∼82%. The system also provides a sound generator and sends notifications to the user's mobile phone to notice when the durian has fallen and to help shorten the time to search for the fallen durian. With this research, we hope to help durian owners and farmers in harvesting durian more efficiently and practically. Likewise, the quality of the durian harvested will increase because the durian fruit ripens naturally on the tree so that consumers can also get durian fruit with a high value in terms of taste. We realize that this research project is still very new and vulnerable, and there are still many things that need to be improved in terms of the system, application, and user experience.

In future research and development, there are a few things that need to be improved, such as a tracking feature for durian fruit that has fallen by displaying the location of the fallen durian from the map and enhancing the device such as improving the power supply system, also improving and stabilizing the Internet connection on the device.

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