nRF24L01 Distance and Error Link when Operated on Orange Plant Garden

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Abstract. The environmental conditions of the plantation area significantly affect the quantity and quality of fruit. Not only that, but the survival of plants will also be supported by the support of environmental conditions. Nowadays, wireless technology is proliferating. Wi-fi, remote control, cell phones are wireless technology products. Wireless technology was developed on the use of electromagnetic waves as a career for the data transmission. Electromagnetic waves are strongly influenced by the medium in its propagation but do not need a medium to propagate. Data will not be received/sent if electromagnetic waves are obstructed. Buildings, metal plates, leaves, trees will provide different attenuation of the electromagnetic waves. Wireless technology is beneficial if applied in plantation areas. In this study, research has been conducted on data errors due to the environment and distances that are out of reach. The primary device as a sender and receiver of data is the nRF24L01 module, which works at 2.4 GHz frequency. Data cannot be sent/received at close range because it is blocked by a building, and can reach one kilometer when used on the outskirts of the Malang Balitjestro orange plantation.

1. Introduction
In recent years, the development of radio wave-based data delivery technology has become a scientific focus because of the wide delivery range and low power consumption, so this technology is applied especially for plantation area. nRF24L01 is a radio wave-based wireless technology that has a data delivery range reaching 1 km away in the open area \cite{1}. One of the citrus plantations is in Balitjestro Indonesia which has up to 211 varieties of Indonesian Tangerine variety \cite{2} located at an altitude of $\pm$ 950 m above sea level in the village of Tlekung, Junrejo District, Batu, East Java \cite{3}. Environmental conditions of citrus plantations that change there require monitoring for changes in citrus plants can be anticipated.
2. Proposed System

The system was proposed in two separate main parts. The first part was the transmitter part that consist DHT22, OLED 0.96”, Arduino Nano, and nRF24l01 (+Pa+Lna). The Other part was the receiver that consist Arduino Nano, OLED 0.96”, and nRF24l01 (+Pa+Lna). The diagram block shown in Figure 1.

2.1 Transmitter Node

Proposes Transmitter Node consists of DHT22 to measure current temperature and humidity, OLED 0.96” to displayed data on transmitter, Arduino Nano as the brain of the system, and nRF24l01 (+Pa+Lna) to transmit data that has been processed by Arduino Nano.

2.2 Receiver Node

Proposed receiver node consists of Arduino Nano, nRF24L01+Pa+Lna module, OLED 0.96” and a personal computer (PC). Receiver circuit design shown in Figure 3. The nRF24L01 (+Pa+Lna) module is used for receive data from the transmitter, the received data then processed by the Arduino Nano and the data is displayed on OLED 0.96” and laptop using a PLX-DAQ as graphical user interface.
2.3 PLX-DAQ

PLX-DAQ was graphical user interface (GUI) that developed using microsoft excel. The software allows received data to be displayed in a user-friendly platform via computer port. Beside of that, some of basic function of this GUI are to provide connection between receiver node and the PC, and to log all received data to Microsoft excel format (.xlsm). The GUI refresh in one second interval, updating to the latest received data on a real time. Thus, more accurate data can be achieved.

3. Research Methods

3.1. Experiment Design
This research is conducted in Balitjestro Indonesia with the description of citrus trees there as follows: Height 318 cm, canopy width 275 cm, and age 11 years (2009-2020). The transmitted nodes are placed at varying distances ranging from 100 m to a distance that has errors on the data that is authenticated to the receiver node.

4. Result and Discussion
The system was already full testing done before used to minimize error and fatal malfunction in both transmitter node and receiver node. The system was placed at Orange Garden in Balitjestro Indonesia at Tlekung village Batu. The average of orange plant was 11 years old and 300 cm high. The power supply from transmitter node used two 18650 battery (7.4 V) and the receiver node connected to PC by USB cable from arduino to supply the power. The PLX-DAQ as the GUI was launched to record all data that receive from transmitter and processed in microsoft excel. Then distance and condition between transmitter node and receiver node varied until the GUI displayed a constant value which represent error of signal or the transmitter reach maximum range.

4.1 Sensor Calibration
The Calibration was done using HANNA HI 8566 Thermohygrometer and obtained the following results.

| Table 1. Temperature Calibration |
|----------------------------------|
| No. | Temperature Sensor (°C) | Thermometer (°C) | Error (%) |
|-----|-------------------------|------------------|----------|
| 1   | 31                      | 30.6             | 1.3      |
| 2   | 31                      | 30.7             | 0.9      |
| 3   | 31                      | 30.8             | 0.6      |
| 4   | 31                      | 30.9             | 0.3      |
| 5   | 31                      | 31               | 0        |

| Table 2. Humidity Calibration |
|-------------------------------|
| No. | Humidity Sensor (%) | Hygrometer (%) | Error (%) |
|-----|---------------------|----------------|----------|
| 1   | 70                  | 69             | 1.4      |
| 2   | 69                  | 68.9           | 0.1      |
| 3   | 69                  | 68.8           | 0.2      |
| 4   | 69                  | 68.7           | 0.4      |
| 5   | 69                  | 68.6           | 0.5      |
4.2 The nRF24L01 Distance and Error Link

| No. | Distance | Temperature (°C) | Humidity (%) | Explanation                        |
|-----|----------|------------------|--------------|------------------------------------|
| 1   | 100      | 35               | 45           | Transmitted smoothly               |
| 2   | 200      | 35               | 47           | Transmitted smoothly               |
| 3   | 210      | 35               | 47           | Transmitted smoothly               |
| 4   | 220      | 35               | 48           | Transmitted smoothly               |
| 5   | 230      | 35               | 50           | Transmitted but there is additional delay |
| 6   | 240      | 34               | 51           | Transmitted but there is additional delay |
| 7   | 250      | 34               | 51           | Transmitted but there is additional delay |
| 8   | 260      | 34               | 52           | Transmitted but there is additional delay |
| 9   | 270      | 34               | 52           | Transmitted but there is additional delay |
| 10  | 280      | 34               | 51           | Transmitted but there is additional delay |
| 11  | 290      | 33               | 52           | Transmitted but there is additional delay |
| 12  | 300      | 33               | 51           | Transmitted but there is additional delay |
| 12  | 310      | 33               | 51           | Transmitted but there is additional delay |
| 14  | 320      | 33               | 51           | Transmitted but there is additional delay |
| 15  | 330      | 0                | 0            | Not Transmitted                    |

5. Conclusion

The main goal of this research is to develop and implement nRF24L01 distance and error link when operated on orange garden. From the result obtained throughout the test and system operated, it can be concluded: 1) The developed system work well, this can be known from the system’s capability to transmit and receive data via a radio waves at a certain maximum distance. 2) nRF24L01 (+Pa+Lna) maximum distance transmitted at 200-300 m line of sight, this value may differ from another conducted research due to differences in implemented programs and the other condition. 3). The error link occurs at adistance of 200 to 300 m.

References

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