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Development of Web-Based Plant Sensor Tool Data Processing Application

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Abstract. The rapid development of technology in the 4.0 era brings changes in the use of technology. The industrial 4.0 era makes IoT (Internet of Things) media a technology that can support all sectors of activity including the agriculture or farming sector. IoT media takes place in the form of plant sensor device that can be used to measure changes in environmental parameters. These changes include light intensity, temperature, humidity, soil fertility, are the supporting factors for plant growth. This study aims to design a website-based application that can read plant sensor data. Sensor device data is collected and downloaded in CSV (Comma Separated Values) format. Data processing requires the Naïve Bayes algorithm as a method for grouping parameter data. The results of the study are in the form of a website design that can help analyze the ideal environmental parameters for farming activities.
Keywords: Internet of Things, plant sensor device, environmental parameters, Naïve Bayes algorithm

INTRODUCTION

Plant maintenance is one of the important activities to control in farming activities. The rise of industrial 4.0 revolution era caused the world to experience an increase in technological development. In the 21st century now, the use of IoT (Internet of Things) technology is increasingly widespread and common. The implications of the IoT concept can also be applied in various sectors of life, including agriculture, such as farming activities. One example of IoT media facilities that are useful for the agricultural sector is a plant sensor device. The sensor is a device that can capture a physical signal detection and channel the signal into an electrical signal or other form of output [1]. Sensors can measure many variables, meaning that the vast amount of available data can be analyzed so that more information or knowledge can be used [2].

The parameters measured on the sensor have various functions including monitoring environmental changes such as changes in temperature, humidity, light intensity, soil pH levels, and even soil fertility levels [3] [4]. Changes in environmental parameters can indicate the role of the parameter attributes themselves as growth supporting factors in plants. The making of the application in this study aims to process data on plant environmental parameters, then assisted by calculations using the Naïve Bayes algorithm, the application can calculate the probability of plant growth development based on historical data that has been previously entered. In addition, application development is carried out on a website basis to make it easier for users to observe changes in environmental parameters that occur in each data from sensor devices.

METHOD AND MATERIALS

Data Collecting Method

The required data collection is done by using the fact-finding method. The fact-finding method is known as a formal process to collect facts about the system, requirements, and preferences through techniques such as interviews, questionnaires, and observations [5]. Through this method, the search and collection of general

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information can be more flexible [6]. The type of plant used as a growth measurement sample for this research is Capsicum frutescens or known as cayenne peaper as shown in Figure 1.

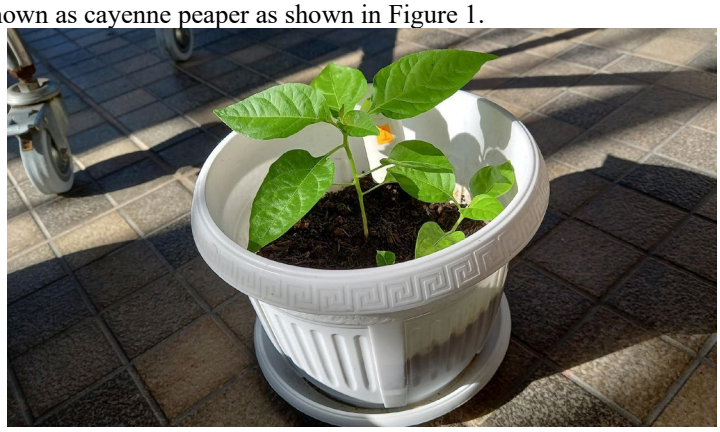

FIGURE 1. Experimental plants (Source: personal documentation)

Observations were conducted directly to collect data on the growth of the cayenne pepper plant such as stem height and number of leaves that grew and also data on environmental parameters of the cayenne pepper plant which included temperature, light intensity, soil fertility, and soil moisture. Recording data of environmental parameters that have been obtained using sensor equipment is collected in the form of a text file with Comma Separated Values or CSV format. Figure 2. shows an example of a raw data text file from an unprocessed plant sensor tool.

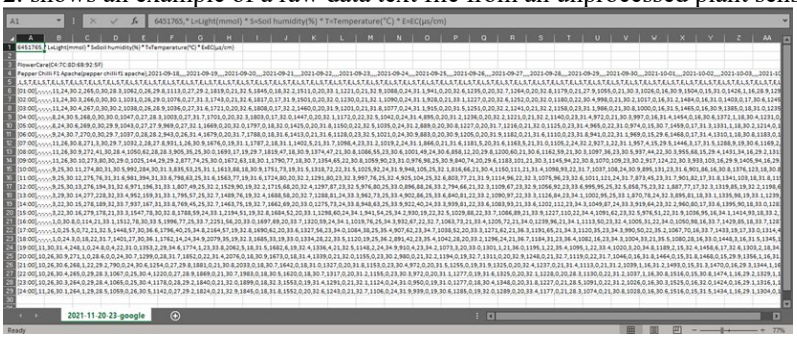

FIGURE 2. Example of a textfile of environmental parameter data

System Development Method

The application development uses the Naïve Bayes algorithm. The Naïve Bayes classification algorithm assumes all variables as independent by considering the value of the class variable [7]. Based on previous research [8], decision-making using the Naïve Bayes approach can work effectively through combining information from several frameworks. This algorithm construction model classifies simple probabilities based on Bayes' theorem which can be seen in Formula 1, where the calculation of a set of probabilities is carried out by calculating the frequency and combination of values in a data set [9].

$$P(b1|a1) = (P(a1 \mid b1)P(b1))/P(a1) \quad (1)$$

FORMULA 1. Bayes Theorem Classification [9]

The data from the CSV text file is preprocessed in the form of data cleaning and data transformation processes. Then, the text file data that has gone through the preprocessing stage is stored in the MySQL database. Processing using the Naïve Bayes algorithm is intended to group parameter data. This grouping is done to facilitate decision-making in determining plant growth factors based on the resulting probability calculations. Figure 3. is an example of data that has gone through the preprocessing stage and is ready to be processed in the next process.

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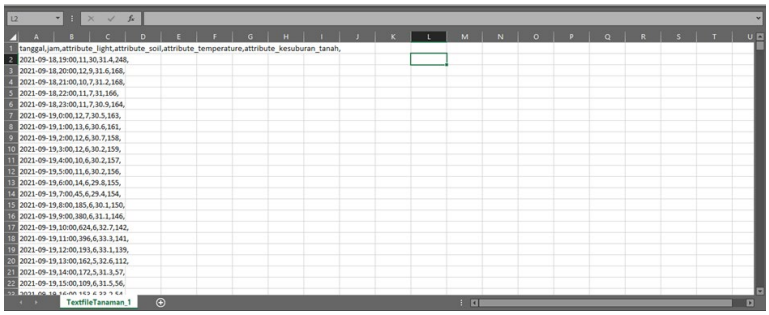

FIGURE 3. Example of a textfile from the preprocessing stage

Materials

The data collection process is carried out by processing data from sensor devices. The sensor device used is provided by Xiaomi Inc., called Xiaomi Mi Flora. Environmental parameter data was collected in the form of temperature (°C), light intensity (mmol), soil moisture (%), and soil fertility (µS/cm).

LITERATURE REVIEW

The sensor device can be utilized as a sensitive motion sensor terminal to provide real-time hazard warnings based on triboelectric interactions between living plants and the human body [10]. One example of a sensor tool that can be used to collect and store data on environmental parameters such as temperature, humidity, light intensity, and soil fertility levels in real time is the Xiaomi Mi Flora [11]. Figure 4. shows the shape of the Xiaomi Mi Flora sensor tool and smartphone as a medium for supporting experiments.

FIGURE 4. Experiment tools (Source: personal documentation)

Monitoring plant growth can be done through controlling environmental parameters such as humidity, temperature, water oxygen content, nutrient concentration (fertility of growing media), and light intensity [12] [13]. Web-based application development itself can help monitor environmental parameters in real-time.

According to research involving the Naïve Bayes algorithm [14], the selection of this algorithm has the potential to produce good accuracy for training data and has a fast modeling computation time with a high level of accuracy. Classification using this approach shows a reasonable performance because it divides the class into problem instances using the concept of conditional probability [15]. The Naïve Bayes classification is divided into two groups namely as multinomial and multivariate according to the method of calculating the probability for a known class, where all qualifications are important and independent of each other [16].

RESULT AND DISCUSSION

The result of this research is a web-based application that aims to see plant growth through probability calculations based on environmental parameter datasets collected from plant sensors. The plant environmental parameter dataset consisting of temperature, light intensity, soil fertility, and soil moisture is stored in the MySQL

database application for further processing. The flowchart of the course of application development can be seen in Figure 5.

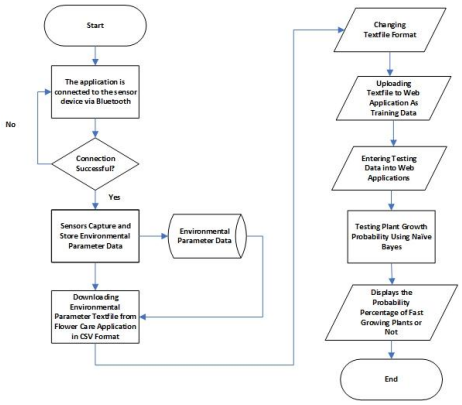

FIGURE 5. Application development flowchart

When running the application, the user must first enter an email address and password to sign in. If the user doesn't have an account yet, they can select the signup button to register in the system. Figure 6. shows the registration page and the main application page which contains features such as training data, probability testing (data testing), reports, and logging out of the account from the system.

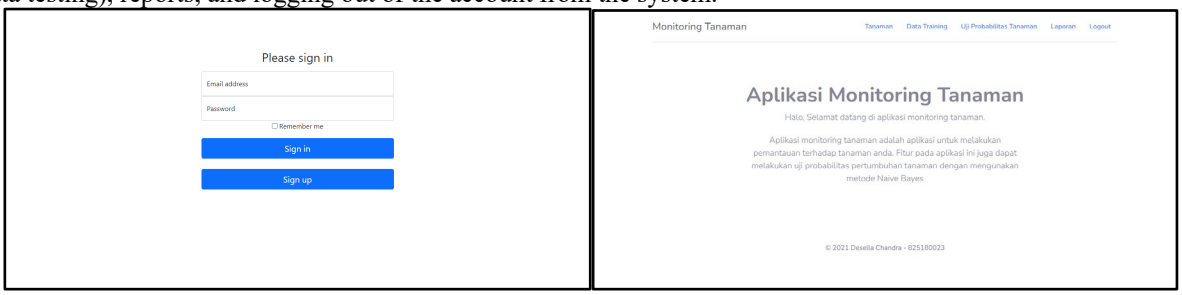

FIGURE 6. The registration page and the main page of the application

The next step when using the application is to fill in information about plants in the form of plant names, plant descriptions, and plant status on the plant page. The training data page is intended to read CSV textfile data from plant parameters where users can upload and save the textfile data. Figure 7. is a display of the plant page and the data training page.

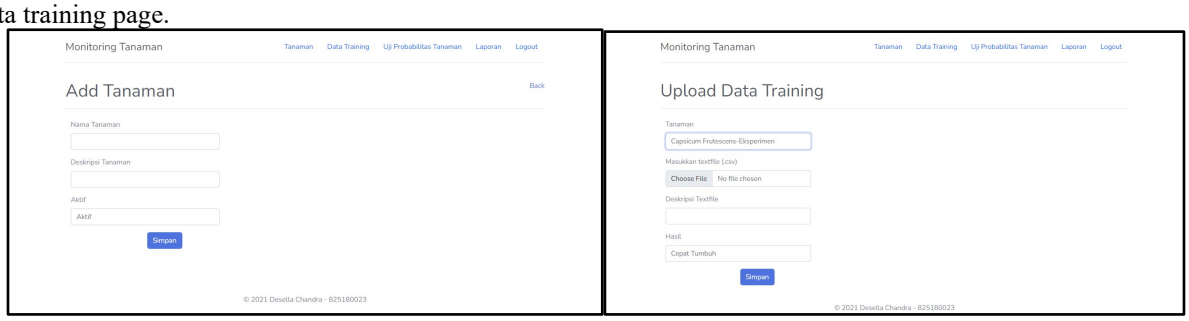

FIGURE 7. Plant page and data training page on the application

Furthermore, the probability test page is a testing data page based on the data training textfile that has been entered. On this page the system will calculate the probability of plant growth from the number of environmental parameters inputted beforehand, using the Naïve Bayes algorithm calculation. The probability test page and an example of the implementation of the probability calculation test are shown in Figure 8.

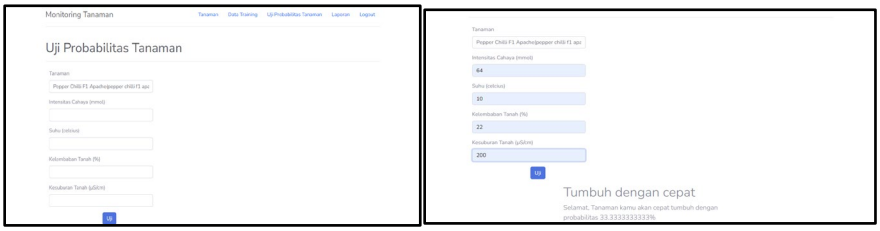

FIGURE 8. Probability test page and test implementation examples

The application has a plant report feature based on previously entered data. To use this feature, the user first selects the name of the plant contained in the system. For more specific plant textfile data, the user can enter the textfile code and the name of the intended textfile. The print button on the application is access to a report containing plant information and the display of environmental parameter data in graphical form. Figure 9. shows the view of the plant report page and Figure 10. shows the display of the plant data report.

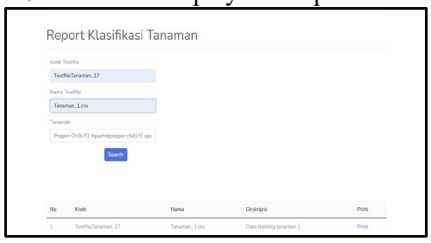

FIGURE 9. Plant report page

FIGURE 10. Plant report display

CONCLUSION

The result of this research is an application that can read environmental parameter data in the form of a CSV textfile which then processes the data by calculating probabilities using the Naïve Bayes algorithm and presenting information related to plant growth based on the data that has been collected. Through this research, researchers hope that the design and development of web-based applications can support the use of information from environmental parameter data generated by plant sensor devices.

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