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Internet of Things (IoT)-Based Temperature and Humidity Monitoring System for Chicken Coops

Muhammad Alfarisi[1], Samsuddin[1], Susmanto1

[1]Department of Computer Engineering, Universitas Serambi Mekkah, Banda Aceh23245, Indonesia

Corresponding Author: samsuddin@serambimekkah.ac.id

Abstract

Inappropriate temperature and humidity conditions in poultry houses can cause stress, reduce chicken health, and increase the risk of disease and mortality. This study aims to design and develop an Internet of Things (IoT)-based temperature and humidity monitoring system that monitors environmental conditions in real time and provides early warnings when measured values exceed predefined thresholds. The system was developed using a NodeMCU ESP8266 microcontroller, a DHT22 sensor, a 16×2 I2C LCD, RGB LEDs, a buzzer, and the Blynk application for remote monitoring, while the collected sensor data were stored as a dataset to support Machine Learning analysis. The implementation results indicate that the system can monitor temperature and humidity in real time, display measurement data on both the LCD and the Blynk application, and generate alerts when environmental conditions fall outside the specified limits. Therefore, the proposed system can assist poultry farmers in monitoring poultry house conditions more effectively, enabling faster response to environmental changes, maintaining a stable poultry house environment, and reducing the risk of chicken mortality.

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1. Introduction

The poultry coop environment plays a crucial role in supporting the health and survival of livestock. Environmental factors such as uncontrolled temperature and humidity can induce stress in chickens, lower their immune systems, and increase the risk of disease, ultimately leading to higher mortality rates (Maulana et al. 2020).

Coop temperatures outside the ideal range can cause physiological disorders in chickens, such as heat stress or cold stress. These conditions lead to reduced appetite, suboptimal growth, and even death, a scenario that frequently occurs in farms that have not yet implemented continuous environmental monitoring systems (Rohman and Isnain 2025).

In addition to temperature, air humidity is another critical parameter affecting poultry health. High humidity levels can trigger the growth of pathogenic microorganisms and heighten the risk of respiratory diseases, whereas excessively low humidity can cause respiratory tract irritation and discomfort in chickens (Farhan et al. 2025).
In practice, monitoring coop temperature and humidity is still largely conducted manually or without real-time tracking, causing farmers to realise environmental changes often too late. This delay in detecting coop conditions has the potential to amplify the risk of livestock mortality due to non-ideal conditions (Abdillah 2024).
The advancement of Internet of Things (IoT) technology offers an opportunity to overcome these challenges through an environmental monitoring system capable of operating automatically and in real time. IoT-based systems enable continuous collection of temperature and humidity data while presenting this information on digital devices easily accessible to farmers (Lengkong and Tombeng 2025).
Several studies in Indonesia demonstrate that implementing an IoT-based temperature and humidity monitoring system can assist farmers in keeping the coop environment within ideal ranges, thereby positively impacting livestock health and reducing mortality risks (Ariefin, Bina, and Informatika 2023).
Based on these problems, an IoT-based temperature and humidity monitoring system is required to track coop environmental conditions in real time, present easily understandable information, and provide early warnings when coop conditions exceed ideal limits, as an effort to prevent livestock mortality (Fajri and Rasyad 2023).
Research in Indonesia shows that unmonitored fluctuations in temperature and humidity are often the primary cause of declining health in both broiler and layer chickens. This situation is further exacerbated when farmers lack fast and accurate information regarding coop environmental conditions (Maulana et al. 2020). However, many small- and medium-scale farms still rely on manual or mechanical monitoring, which often leads to delayed data collection and late corrective action. This issue highlights an urgent need for an integrated, effective, and user-friendly IoT-based temperature and humidity monitoring system suited for modern livestock farming environments (Septian, Sari, and Setiawan 2025).

2. Methodology

This study employed a Research and Development (R&D) approach to design and implement an Internet of Things (IoT)-based temperature and humidity monitoring system for chicken coops. The research methodology consisted of three main stages: research method, system design, and data collection with the implementation of the Random Forest algorithm. The developed system was designed to monitor environmental conditions in real time, store monitoring data, and classify chicken coop conditions based on temperature and humidity parameters.

2.1 Research Method

This study employed a Research and Development (R&D) method with a quantitative approach to design, develop, and implement an Internet of Things (IoT)-based temperature and humidity monitoring system for chicken coops. The R&D method was selected because the primary objective of this study was to produce a functional monitoring system capable of measuring environmental conditions in real time.
The quantitative approach was applied since the data collected consisted of numerical measurements obtained from the DHT22 sensor, including temperature expressed in degrees Celsius (°C) and humidity expressed as percentage relative humidity (%RH). These data were analysed objectively to evaluate the performance of the developed monitoring system and to support the implementation of the Random Forest algorithm for classifying chicken coop conditions.
The research procedure consisted of several stages, including system design, hardware and software implementation, data collection, data preprocessing, machine learning model development, and system evaluation.

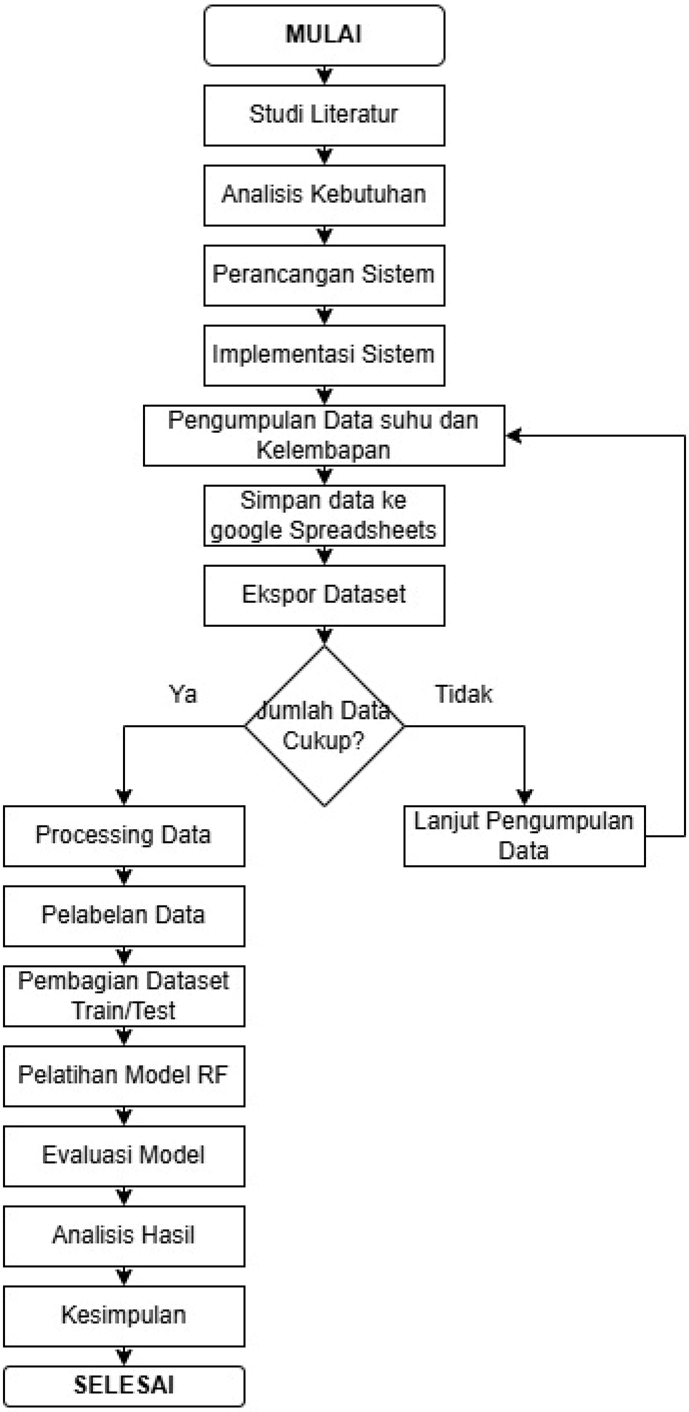

Fig. 1. Research methodology of the proposed study.

As illustrated in **Fig. 1**, the research began with problem identification and a literature review to establish the study's theoretical foundation. The next stage involved designing the IoT-based monitoring system, followed by hardware and software implementation. After the system was successfully developed, temperature and humidity data were collected from the chicken coop and stored in a Google Spreadsheet. The collected dataset was then pre-processed before being used to train and evaluate the Random Forest model. Finally, the system performance and classification results were analysed to assess the effectiveness of the proposed monitoring system.

2.2 System Design

The proposed system was designed to monitor the temperature and humidity conditions inside a chicken coop using Internet of Things (IoT) technology. The system consists of a DHT22 sensor, a NodeMCU ESP8266 microcontroller, an LCD 16×2 I2C display, RGB LEDs, a buzzer, the Blynk platform, and Google Spreadsheet. The DHT22 sensor continuously measures temperature and humidity, while the NodeMCU processes the sensor readings and transmits the data via a Wi-Fi connection.
The measured data are displayed locally on the LCD and simultaneously sent to the Blynk platform for real-time monitoring. In addition, the monitoring data are automatically stored in a Google Spreadsheet, which serves as the primary dataset for implementing the Random Forest algorithm. The system also provides visual and audible notifications through RGB LEDs and a buzzer whenever the measured temperature or humidity exceeds the predefined threshold values. The overall architecture of the proposed monitoring system is illustrated in **Fig. 2.**

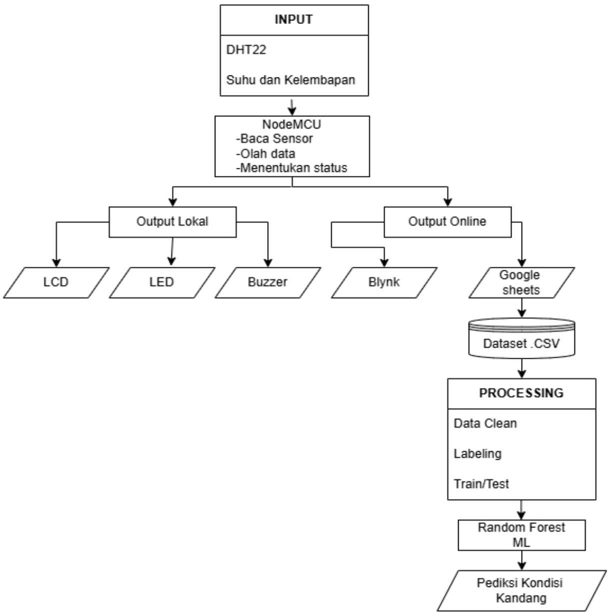

Fig. 2. Block diagram of the proposed IoT-based temperature and humidity monitoring system.

Table 1. Hardware Components of the Proposed System

NO	Component	Function
1	NodeMCU ESP8266	Main controller and Wi-Fi communication
2	DHT22	Temperature and humidity sensor
3	LCD 16×2 I2C	Displays monitoring data
4	RGB LED	Visual status indicator
5	Buzzer	Audible warning indicator
6	Blynk	Real-time monitoring platform
7	Google Spreadsheet	Data storage

As shown in **Fig. 2**, the DHT22 sensor measures the temperature and humidity inside the chicken coop. The collected data are processed by the NodeMCU ESP8266 and displayed on the LCD module. The NodeMCU also transmits the monitoring data through a Wi-Fi connection to the Blynk platform for real-time monitoring and stores the data in a Google Spreadsheet. In addition, RGB LEDs and a buzzer provide visual and audible alerts whenever the measured temperature or humidity exceeds the predefined threshold values.

The operational workflow of the proposed system begins with the DHT22 sensor measuring the temperature and humidity inside the chicken coop. The NodeMCU ESP8266 processes the acquired data and determines the environmental status based on predefined threshold values. The processed data are displayed on the LCD, transmitted to the Blynk platform for remote monitoring, and stored in a Google Spreadsheet for further analysis. The workflow of the developed system is presented in **Fig. 3**.

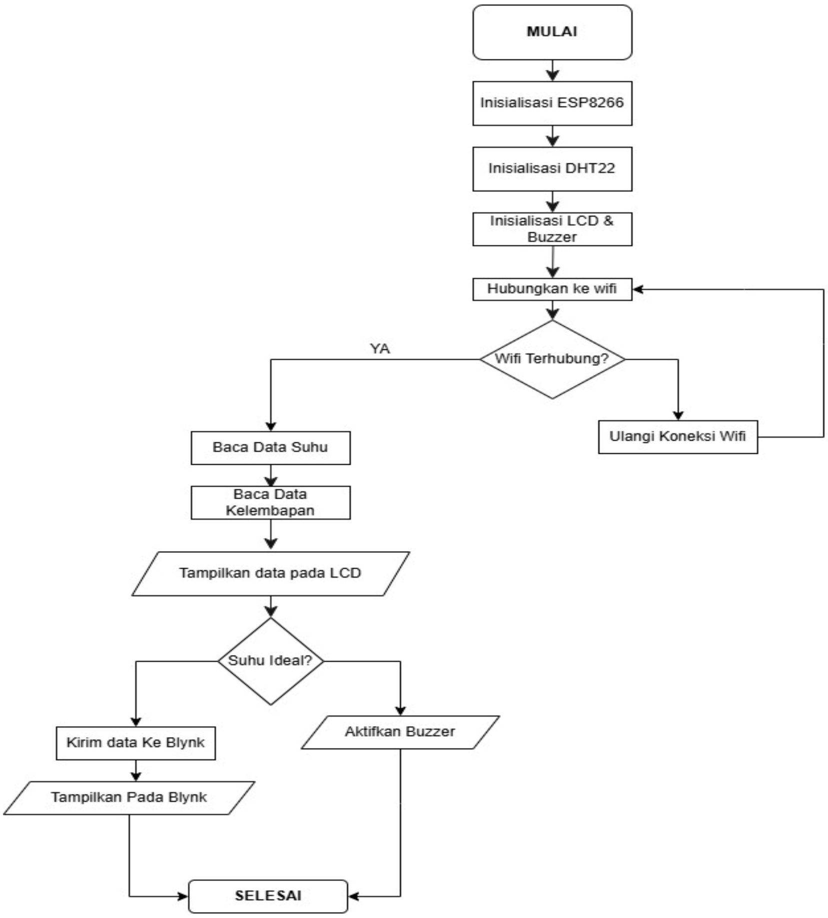

Fig. 3. Workflow of the proposed monitoring system.

As illustrated in **Fig. 3**, the monitoring process begins with the initialisation of the NodeMCU ESP8266 and the DHT22 sensor. The system continuously reads temperature and humidity data, determines the environmental status based on predefined threshold values, displays the information on the LCD, and sends the monitoring data to the Blynk platform and Google Spreadsheet. If the measured values exceed the specified thresholds, the RGB LEDs and buzzer are activated as warning indicators. This process is repeated continuously to provide real-time environmental monitoring.

2.3 Data Collection and Machine Learning Process

The temperature and humidity data were collected automatically using the developed IoT monitoring system. The DHT22 sensor measured the environmental conditions inside the chicken coop, while the NodeMCU ESP8266 transmitted the collected data to Google Spreadsheet through an internet connection. The recorded data included temperature, humidity, date, and time information, which were used as the primary dataset for this study. A total of 7,737 data records were collected during the observation period.

Before implementing the machine learning model, the collected dataset underwent a preprocessing stage to improve data quality and prepare the data for analysis. This process included data cleaning, labelling based on predefined temperature and humidity thresholds, determining the input and output variables, and dividing the dataset into training and testing sets. Temperature and humidity were used as the input variables, while the output variables consisted of sensor status labels and chicken coop condition labels.

The Random Forest algorithm was then implemented to classify the environmental conditions of the chicken coop. The dataset was divided into 80% training data and 20% testing data using the stratified sampling method to preserve the class distribution. The trained model was evaluated using several performance metrics, including Accuracy, Precision, Recall, F1-score, Confusion Matrix, and Feature Importance, to determine its effectiveness in classifying chicken coop conditions.

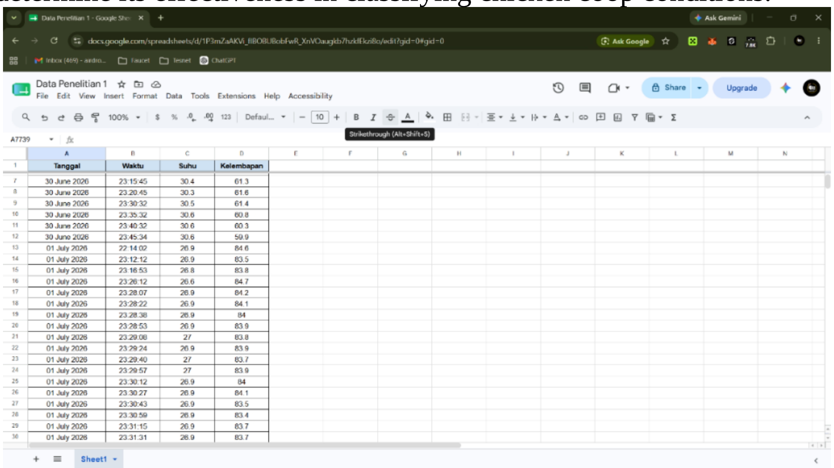

Fig. 4 Temperature and humidity dataset collected using Google Spreadsheet.

The monitoring data collected by the proposed IoT system were automatically stored in Google Spreadsheet through an internet connection. Each record contains the date, time, temperature, and humidity values measured by the DHT22 sensor. This storage mechanism enables continuous and organised data collection while facilitating real-time monitoring and subsequent data analysis. A total of 7,737 records were collected during the observation period and used as the primary dataset in this study. Before implementing the Random Forest algorithm, the dataset was further processed through data preprocessing, including data cleaning, labelling, feature selection, and dataset splitting.

Table 2. Temperature and Humidity Classification Thresholds

Parameter	Condition	Range
Temperature	Cold	< 25°C
Temperature	Normal	25–35°C
Temperature	Hot	> 35°C
Humidity	Dry	< 50%
Humidity	Normla	50–85%
Humidity	Humid	> 85%

After the dataset had been collected, a preprocessing stage was performed to prepare the data for machine learning. This process included data cleaning, assigning labels based on predefined temperature and humidity threshold values, and organising the dataset into a structured format suitable for analysis. The preprocessing and labelling results are presented in **Fig. 5.**

```
#menampilkan 10 sampel data
data[['Suhu', 'Kelembapan', 'Label', 'Kondisi_Kandang']].sample(10)
```

	Suhu	Kelembapan	Label	Kondisi_Kandang
5521	28.9	74.4	NORMAL	IDEAL
3956	28.8	73.2	NORMAL	IDEAL
6487	31.0	67.9	NORMAL	IDEAL
6105	30.7	68.1	NORMAL	IDEAL
3644	28.9	73.3	NORMAL	IDEAL
6864	31.2	68.5	NORMAL	IDEAL
6156	31.0	64.8	NORMAL	IDEAL
5150	27.9	71.6	NORMAL	IDEAL
3124	29.6	74.9	NORMAL	IDEAL
5003	27.2	72.3	NORMAL	IDEAL

Fig. 5 Dataset After Preprocessing and Labelling

As shown in **Fig. 5**, the original dataset was transformed into a structured dataset by adding several classification labels. The temperature and humidity measurements were assigned corresponding status labels according to predefined threshold values, while an additional chicken coop condition label was generated to represent the overall environmental condition. The resulting labelled dataset was then used as the basis for selecting the input and output variables before proceeding to the dataset splitting and Random Forest model implementation.

After completing the preprocessing stage, the labelled dataset was divided into training and testing sets before the Random Forest model was developed. The dataset was split using the train_test_split() function from the Scikit-learn library with an 80:20 ratio. In addition, stratified sampling was applied to preserve the distribution of each class in both the training and testing datasets. The dataset splitting process is illustrated in **Fig. 6**.

```
from sklearn.model_selection import train_test_split

X_train_label, X_test_label, y_train_label, y_test_label = train_test_split(
    X,
    y_label,
    test_size=0.2,
    random_state=42,
    stratify=y_label
)
```

```
X_train_kandang, X_test_kandang, y_train_kandang, y_test_kandang = train_test_split(
    X,
    y_kandang,
    test_size=0.2,
    random_state=42,
    stratify=y_kandang
)
```

```
#Menampilkan Jumlah data Training dan data testing
print("Jumlah Data Training :", X_train.shape[0])
print("Jumlah Data Testing  :", X_test.shape[0])
```

```
Jumlah Data Training : 6189
Jumlah Data Testing  : 1548
```

Fig. 6. Dataset splitting using the train_test_split() function

As shown in **Fig. 6**, the dataset was successfully divided into training and testing subsets before model development. The training dataset was used to train the Random Forest classifier to recognise patterns in the temperature and humidity data, whereas the testing dataset was reserved to evaluate the model's classification performance. This data partitioning strategy helps reduce overfitting and provides a more reliable assessment of the model's ability to classify unseen data.

Table 3. Dataset Distribution

Dataset	Number of Records	Percentage
Training Dataset	6,189	80%
Testing Dataset	1,548	20%
Total Dataset	7,737	100%

Table 2 summarises the distribution of the dataset used in this study. A total of 7,737 records were collected, of which 6,189 records (80%) were allocated for model training, and 1,548 records (20%) were reserved for model testing. This partitioning ratio is widely adopted in machine learning applications to ensure that sufficient data are available for training while maintaining an independent dataset for evaluating model performance.

3. Result & Discussion

This section presents the implementation and evaluation results of the proposed Internet of Things (IoT)-based temperature and humidity monitoring system for chicken coops. The discussion covers the performance of the developed monitoring system, including real-time data acquisition, visualisation through the Blynk platform, and automatic data storage in Google Spreadsheet. Furthermore, the collected dataset was used to develop a Random Forest classification model to determine chicken coop conditions. The performance of the proposed model was evaluated using standard classification metrics, including accuracy, precision, recall, F1-score, confusion matrix, and feature importance analysis.

3.1 IoT-Based Monitoring System Implementation

The proposed Internet of Things (IoT)-based monitoring system was successfully developed to monitor the temperature and humidity conditions inside a chicken coop in real time. The system integrates the DHT22 sensor, NodeMCU ESP8266 microcontroller, LCD 16×2 I2C display, RGB LEDs, buzzer, Blynk platform, and Google Spreadsheet into a single monitoring platform. The developed prototype continuously measures environmental conditions and transmits the collected data through a wireless internet connection for remote monitoring and data storage.
The physical implementation of the proposed monitoring system is presented in **Fig. 7.**

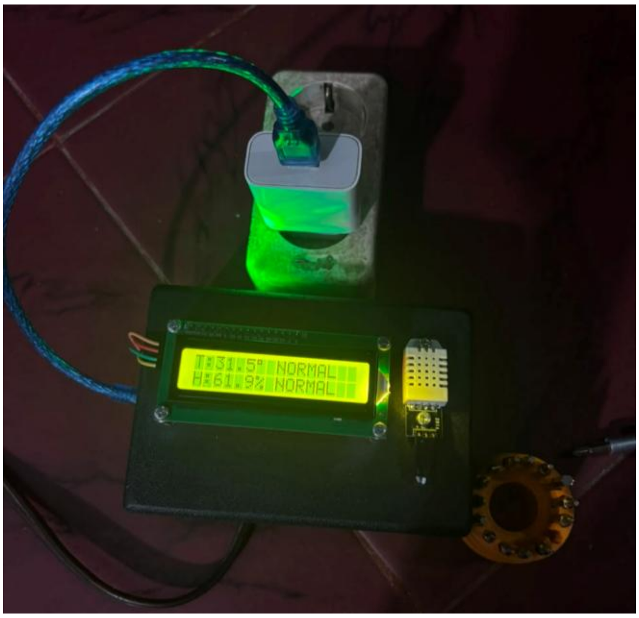

Fig. 7. Implementation of the proposed IoT-based temperature and humidity monitoring system.

As shown in **Fig. 7**, the developed prototype integrates all hardware components into a compact monitoring device. The DHT22 sensor continuously measures the temperature and humidity inside the chicken coop, while the NodeMCU ESP8266 processes the acquired data and transmits the information through a Wi-Fi connection. The measured values are displayed locally on the LCD module and simultaneously sent to the Blynk platform and Google Spreadsheet for real-time monitoring and data storage.

3.2 Real-Time Monitoring Results

The developed IoT-based monitoring system successfully performed real-time monitoring of temperature and humidity inside the chicken coop. The NodeMCU ESP8266 continuously transmitted environmental data collected by the DHT22 sensor through a Wi-Fi connection. The measured values were displayed on the Blynk platform, allowing users to remotely observe the environmental conditions using a smartphone or other internet-connected devices.

The real-time monitoring interface is presented in **Fig. 8.**

Fig. 8. Real-time monitoring interface using the Blynk platform.

As shown in Fig. 8, the Blynk platform displays the temperature and humidity values received from the NodeMCU ESP8266 in real time. This enables users to monitor the environmental conditions of the chicken coop remotely without requiring direct observation at the monitoring location. The continuous synchronisation between the IoT device and the Blynk platform demonstrates the reliability of the proposed system for real-time environmental monitoring.

3.3 Random Forest Classification Results

The Random Forest algorithm was implemented to classify the environmental conditions of the chicken coop based on the collected temperature and humidity data. The model was trained using the training dataset and evaluated using the testing dataset generated during the data splitting stage. The classification process was performed using the Scikit-learn library in Google Colab, enabling efficient model training and prediction.

To evaluate the classification performance of the proposed model, a confusion matrix was generated using the testing dataset. The confusion matrix summarises the comparison between the actual class labels and the predicted class labels produced by the Random Forest classifier. The evaluation result is presented in **Fig. 9**.

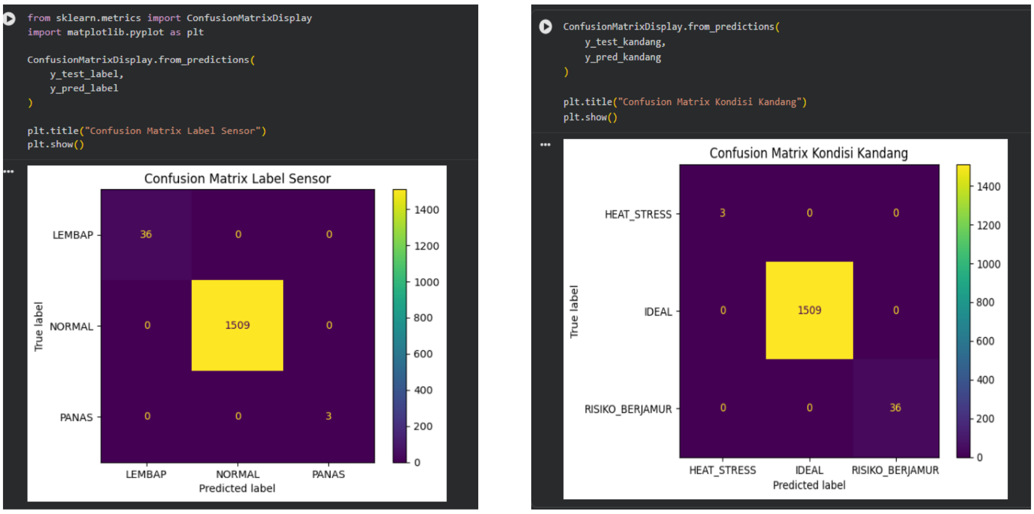

Fig. 9 Confusion Matrix

As illustrated in Fig. 9, the Random Forest classifier achieved excellent classification performance by correctly identifying the majority of the testing samples. The confusion matrix indicates that the predicted labels closely matched the actual labels, demonstrating the proposed model's ability to accurately classify chicken coop environmental conditions based on temperature and humidity measurements. The high number of correctly classified samples also suggests that the preprocessing and labelling stages successfully prepared the dataset for machine learning.

To further evaluate the classification performance, several evaluation metrics were calculated, including accuracy, precision, recall, and F1-score. These metrics provide a comprehensive assessment of the model's ability to classify the environmental conditions of the chicken coop.

```
print(classification_report(y_test_label, y_pred_label))

              precision    recall  f1-score   support

      LEMBAP       1.00      1.00      1.00        36
      NORMAL       1.00      1.00      1.00      1509
       PANAS       1.00      1.00      1.00         3

    accuracy                           1.00      1548
   macro avg       1.00      1.00      1.00      1548
weighted avg       1.00      1.00      1.00      1548

print(classification_report(y_test_kandang, y_pred_kandang))

                 precision    recall  f1-score   support

    HEAT_STRESS       1.00      1.00      1.00         3
          IDEAL       1.00      1.00      1.00      1509
RISIKO_BERJAMUR       1.00      1.00      1.00        36

       accuracy                           1.00      1548
      macro avg       1.00      1.00      1.00      1548
   weighted avg       1.00      1.00      1.00      1548
```

Fig.10 Performance Evaluation of the Random Forest Model

As presented in **Fig 10**, the Random Forest model achieved high performance across all evaluation metrics. The obtained accuracy indicates the overall proportion of correctly classified samples, while precision and recall demonstrate the model's effectiveness in identifying each class without producing excessive false predictions. Furthermore, the F1-score confirms a balanced performance between precision and recall, indicating that the proposed classification model is reliable for monitoring the environmental conditions of the chicken coop.

3.4 Feature Importance Analysis

To further understand each input variable's contribution to the classification process, a feature importance analysis was conducted using the trained Random Forest model. Feature importance measures the relative influence of each feature in constructing the decision trees and determining the final classification results. This analysis helps identify which environmental parameter has the greatest impact on predicting chicken coop conditions.

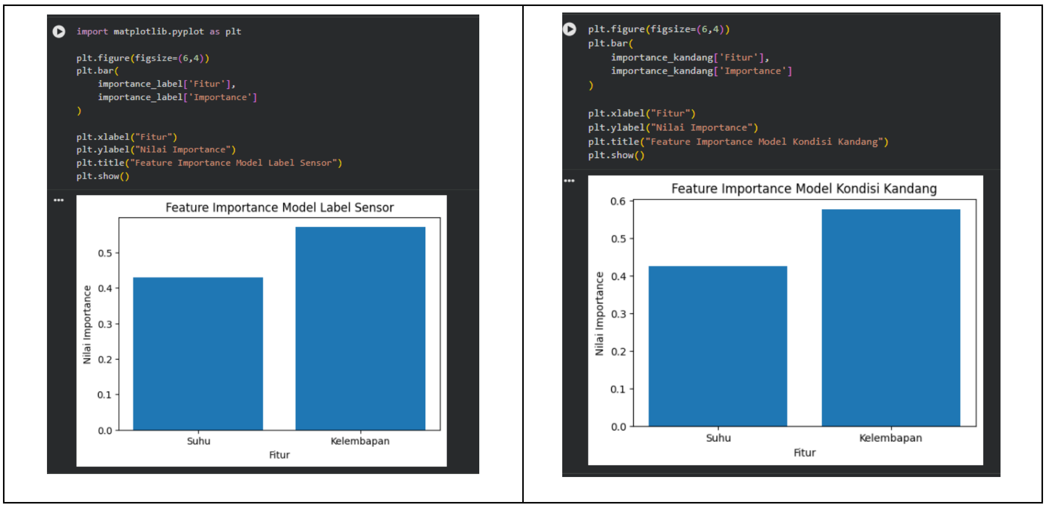

Fig.11 Feature importance obtained from the Random Forest model.

As shown in **Fig. 11**, both temperature and humidity contributed to the classification of chicken coop conditions. However, one feature exhibited a higher importance value, indicating that it had a greater influence on the decision-making process of the Random Forest classifier. This result demonstrates that the model automatically identifies the most informative feature based on the collected monitoring data without requiring manual weighting.

The feature importance analysis also confirms that the proposed IoT monitoring system provides sufficient information for machine learning-based classification. By utilising both temperature and humidity measurements simultaneously, the Random Forest model was able to accurately recognise environmental conditions and support decision-making for chicken coop monitoring. Therefore, the combination of IoT technology and machine learning offers an effective solution for real-time environmental monitoring and classification.

4. Conclusion

This study successfully developed an Internet of Things (IoT)-based temperature and humidity monitoring system for chicken coops using the NodeMCU ESP8266 and DHT22 sensor. The proposed system monitored environmental conditions in real time, displayed the measured data through an LCD and the Blynk platform, and automatically stored the monitoring data in a Google Spreadsheet for further analysis. In addition, RGB LEDs and a buzzer provided immediate visual and audible notifications whenever abnormal environmental conditions were detected.

The collected monitoring data were successfully processed using the Random Forest algorithm to classify the environmental conditions of the chicken coop. The experimental results demonstrated that the proposed model achieved excellent classification performance, indicating that the combination of IoT technology and machine learning can effectively support intelligent environmental monitoring. Therefore, the developed system has the potential to assist poultry farmers in maintaining optimal chicken coop conditions, improving monitoring efficiency, and supporting better decision-making for poultry management.

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