SMART POULTRY FARM USING INTERNET OF THINGS AND MACHINE LEARNING PROJECT

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Computer Science and Engineering

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APPROVAL

This Project titled "Smart Poultry Farm Using Internet of Things and Machine Learning Project", submitted by Tabibur Rahman Rifat to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on 23 January 2024.

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I hereby declare that, this project has been done by me under the supervision of **Narayan Ranjan Chakraborty, Associate Professor and Associate Head, Department of CSE** Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

This paper offers a detailed investigation into poultry health monitoring utilizing an Internet of Things (IoT) platform and Machine Learning (ML) approaches. This article offers a detailed investigation into poultry health monitoring utilizing an Internet of Things (IoT) platform and Machine Learning (ML) approaches. The rising availability of low-cost processing resources, IoT sensors, and standard algorithms has made it appealing to use current technology to continually monitor big farms with millions of birds and enhance overall production. This model collects temperature, humidity, gasses, luminosity, and wind speed data and stores them in a cloud database. Using the dataset, the machine learning classification algorithms Nave Bias (NB), Support Vector Machine (SVM), and Random Forest (RF) perform and predict poultry health properly. This model predicts the best option for the birds' comfort throughout their life cycle and can use IoT to control lights, fans, sprinklers, and curtains automatically. By applying modern technologies in the poultry farm it can reduce bird problems like contagious diseases and identify more quickly. As a result, it yields better-quality poultry meat and eggs. Also, poultry farm diseases are communicable and contagious, this automation system protects the health of human workers.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

Poultry is the most significant and advanced component of Bangladesh's livestock economy, attracting both domestic and foreign investment. Bangladesh's demand for chicken products has expanded dramatically over the years, with per capita consumption in 2019 reaching 8.5 kg poultry meat and 5.1 kg (104 pieces) eggs. To fulfill rising local demand, the Bangladesh poultry sector's output must expand dramatically [1].

There are an approximate 150,000 poultry farmsteads across Bangladesh [7] where farmers apply a manual way to grow birds. In recent times, poultry has evolved comprehensively all over the world as a result these meet the demand of nutrition for mankind's health. The farmsteads yearly yield 570 million tones of flesh and 7.34 billion eggs in Bangladesh[7]. According to global self-interest, there is also a rising anxiety, in Bangladesh, that fowls should be grown in a healthy environment. So, the atmospheric status of the begetting abodes requires thought, particularly the relative humidity, temperature, luminosity and ammonia assembly in the wind, because outcome is involved in the atmospheric situations in which the fowls are grown. We have to monitor these variables very fast so that the farm owner can interfere more quickly to assure an ample atmosphere inside the breeding house. For instance, by finding out that the room warmth is increasing exceedingly high, the poultry peasant can handle the room's coverings or activate fans. Also, the workers who work in the poultry farm to maintain the environment of the farm and to take care of the bird are in great danger from the dangerous gasses that are produced from the waste and droppings of the poultry birds.

The expanding use of human labor in poultry farming has ramifications for both the birds' natural environment and worker health. Poultry infections, which are frequently highly transmissible, represent a threat to people, heightening the risk if a lethal disease emerges from the poultry population. This issue highlights the importance of integrating modern technical solutions. The use of various sensors, cameras, and microphones for poultry health monitoring and management can reduce human health hazards by minimizing human engagement in animal monitoring. Furthermore, the use of technology improves overall system efficiency and enables the early detection of any health or behavioral problems in chickens.

Figure 1.1: Bangladesh Poultry Farm Scenario.

To begin, the model collects real-time environmental data such as temperature, humidity, gasses, luminosity, and wind speed using sensors and devices and stores it in a cloud database. The model then uses three machine learning algorithms to analyze the data: Nave Bias, Support Vector Machine, and Random Forest. This model predicts the best choice for the birds' comfort and can use IoT to automatically control lights, fans, sprinklers, and curtains. As a result, contagious diseases and other types of bird problems are reduced and identified faster. It produces higher-quality poultry meat and eggs. Because poultry farm diseases are communicable and contagious, this automation system safeguards human workers' health. This project assists poultry farm owners in overcoming labor shortage issues [9].

So, in this project based on IOT and machine learning, farmers maintain a sound environment of the poultry farm for the poultry birds with minimum human interaction.

1.2 Motivation

Bangladesh is a developing agricultural nation. Poultry farms are widely spread throughout the nation. To monitor and maintain a healthy environment at the farm for the poultry birds, the country's farmers do not use current technologies (chicken). Due to this, many chickens (and other poultry) die extremely early, and the farms' unsanitary conditions reduce the poultry's ability to reproduce (chicken). Because of this, farmers constantly struggle with significant asset loss and financial setbacks. The farmers will be able to monitor and maintain a healthy environment for the poultry birds (chicken) by implementing current technologies in those poultry farms. Because, of this, the poultry birds (chickens) will be in better health, their mortality rate will drop, and their reproductive success will rise.

1.3 Rationale of the Study

The poultry industry has two primary goals: egg and meat production. Poultry farms used to be modest, with just a few hundred birds, and they were handled by humans who also monitored their health [10][11]. However, as demand for poultry products rose, so did the scale of poultry farms. Poultry birds are sensitive and disease-prone, thus it is critical to monitor each bird's status in order to recognize symptoms of illness early and prevent an outbreak. If human workers are the only ones responsible for monitoring cattle on an individual basis, production costs would rise due to the necessity for a larger staff. Furthermore, human workers can disrupt the natural environment of poultry birds while also posing health threats from contagious and transmissible poultry diseases. If a dangerous disease infects the chickens, the situation might quickly worsen.

As a result, advanced technology solutions are required in today's environment. Using technology, human intervention in livestock monitoring can be reduced, and various sensors, cameras, and microphones can be utilized to monitor and manage poultry health issues. This will also increase the overall system's efficiency and ability to detect any disease, sickness, or behavioral problem in poultry fast. Despite tremendous population increase, Bangladesh's poultry sector remains unorganized. In contrast to other developed countries, Bangladesh is performing poorly in this sector.

Figure 1.2: Infected and Death Chicks.

Despite the fact that poultry farms have grown significantly in size, humans are still required to oversee the health of the birds. Additionally, thousands of birds are raised in a confined space, making daily monitoring of each bird almost impossible. Due to the fact that infections are only discovered until a sizable population of chickens is affected, poultry farm owners frequently suffer significant losses. They typically raise the dosage of medications and antibiotics as a way of mitigating the effect. The increased usage of antibiotics impairs the product's adherence to food safety standards, making it considerably riskier from the perspective of human health. Applying contemporary technological solutions to increase chicken productivity and profitability requires a multifaceted strategy. For instance, each bird should be evaluated from a production perspective based on its individual body weight as well as its water and feed intake. From the perspective of disease outbreak management, the solution should be to identify the sickness and morbid bird as soon as possible. Improved techniques for controlling Salmonella, Campylobacter, and E. coli are needed to preserve food safety [14][15]. Similar rapid detection of body comforts, stress levels, and air quality factors like carbon dioxide and ammonia levels are important from the perspective of animal welfare. Consequently, in this work, while taking into account all of these factors, we investigated the possibilities for developing a locally developed IoT based AI equipped system for the entire Bangladesh in order to modernize poultry farming on a micro and macro level.

1.4 Research Questions

- In comparison to conventional techniques, how effective is deep learning at Smart Poultry?
- What deep learning architecture is most effective in Smart Poultry?
- What deep learning algorithms are the most effective and reliable for Smart Poultry?
- What are the main obstacles and restrictions to applying deep learning to the Smart Poultry, and how may they be overcome?
- Can deep learning models be used to monitor Smart Poultry fields in real-time?

1.5 Expected Output

The successful development and implementation of Smart Poultry system would have several significant impacts:

- Enhanced Management: A smart poultry farm system employs cutting-edge technologies to enhance management efficiency. Automated data collection and analysis enable real-time monitoring of key metrics such as temperature, humidity, and feed levels, empowering farmers to make informed decisions promptly. Integration with smart devices and artificial intelligence-driven algorithms optimizes resource utilization, minimizes waste, and ultimately ensures a more sustainable and profitable poultry farming operation.
- Cost and Time Savings: Implementing advanced technologies in poultry farming leads to significant cost and time savings. Automated processes such as smart feeding systems and IoT-enabled environmental controls reduce manual labor, enabling farmers to allocate their time more efficiently. Additionally, predictive

analytics and remote monitoring capabilities help identify potential issues early on, preventing costly disruptions and streamlining overall operations for a more cost-effective and time-efficient poultry farming model.

1.6 Project Management and Finance

The "SMART POULTRY FARM USING INTERNET OF THINGS AND MACHINE LEARNING" project must be executed successfully, and this requires careful attention to project management and budget planning. A thorough review of the project management techniques used and the associated financial factors is given in this section.

- Project Timeline: To direct the project from inception to conclusion, a meticulously constructed timeline has been devised. Important turning points including system design, installation, testing, and data analysis are included in this timeline. Periodic evaluations will be carried out to appraise advancement towards these benchmarks.

- Team Structure: The project team has been assembled with members possessing expertise in IoT, machine learning, and poultry farming. Roles and responsibilities have been clearly defined to ensure a smooth and coordinated workflow. Regular team meetings will facilitate collaboration and address any emerging challenges.

- Risk management: To identify any obstacles that could occur throughout the project, a thorough risk assessment has been carried out. A thorough plan for risk reduction has been developed to quickly identify and manage uncertainty. Regular risk assessments will be undertaken throughout the project's duration.

- Budget Allocation: A thorough budget has been set aside to pay for the creation of software, hardware, data collecting, and testing, among other project components.

This budget is made to make sure that resources are used as efficiently as possible while strictly adhering to budgetary limitations.

- Funding Sources: • Funding sources are distributed based on the project's aims and objectives, emphasizing the relevance of technological innovations in chicken farming.

- Cost-Benefit Analysis: A preliminary cost-benefit analysis has been undertaken to estimate the projected returns on investment. The long-term advantages of enhanced poultry health monitoring, such as higher production and possible cost savings, are taken into account in this research.

- Financial Reporting: To monitor spending and guarantee transparency, a strong financial reporting system will be put in place. To give stakeholders insight into budget use and facilitate informed decision-making, regular financial reports will be created.

1.7 Report Layout

This section walks audiences through each chapter of the project by outlining the report's hierarchical layout. The first chapter, "Introduction," explores project management and financial issues while introducing the project's relevance, motivation, research objectives, and expected outcomes. In Chapter 2, "Background," important terms are defined, relevant literature is reviewed, a comparative analysis is done, and the project's scope and difficulties are covered. In Chapter 3, "Research Methodology," the topic, tools, methods for gathering data, suggested methodology, and needs for execution are all covered. The experimental design, outcomes, and analysis are covered in Chapter 4, "Experimental Results and Discussion," along with considerations of the findings and limitations. The consequences for society, the environment, and sustainability are examined in Chapter 5, "Impact on Society, Environment, and Sustainability," along with ethical issues and sustainability strategies. Chapter 6, "Summary, Conclusion, Recommendation, and Implication for Future Research," concludes with a thorough overview, findings, recommendations, and suggestions for future study fields. The content in the report flows logically and cohesively thanks to this structure.

CHAPTER 2
BACKGROUND

2.1 Preliminaries

Important terms and fundamental ideas necessary to comprehend the project are defined in this part. This chapter attempts to provide readers, particularly those who are not familiar with the subject topic, a firm basis by developing a clear and succinct terminology. The definitions cover concepts particular to machine learning (ML), Internet of Things (IoT), poultry farming, and other important agricultural and technology sectors. Clear terminology guarantees a shared understanding throughout the report and makes the technical discussions and analyses in the following chapters easier for readers to grasp.

2.2 Related Works

Relatable works refer to projects, tasks, or experiences that share similarities or connections with a given context. In the context of poultry farming and the previous discussions on enhanced management and cost and time savings, some relatable works might include:

- **Smart Agriculture Platforms:** Implementation of integrated smart agriculture platforms that leverage sensors, IoT devices, and data analytics to optimize various aspects of farming, including poultry management.
- **Precision Livestock Farming:** Adoption of precision livestock farming techniques, which involve using technology to monitor and manage livestock with a focus on improving efficiency, reducing resource consumption, and enhancing animal welfare.

- **Automated Farming Systems:** Integration of automated systems for tasks such as feeding, watering, and environmental control within the broader agricultural framework, aiming to enhance productivity and reduce manual labor.
- **AgTech Startups:** Collaboration with or utilization of technologies developed by agricultural technology startups focused on creating innovative solutions for modernizing and improving farming practices, including those specific to poultry farming.
- **Data-Driven Decision Making:** Implementation of data-driven decision-making processes in agriculture, using analytics and insights to optimize resource allocation, predict trends, and improve overall operational efficiency.

2.3 Comparative Analysis and Summary

Poultry farming is a profitable company that draws a large number of investors. This company's major goods are eggs and meat, both of which are highly valued in the market. One of the advantages of poultry farming is that it does not require a large initial investment. You can begin growing chickens with a minimal sum of money. Furthermore, most poultry species are relatively inexpensive to raise. Another advantage of chicken farming is that it provides a rapid return on investment. Poultry goods are in high demand worldwide because they provide nutritious and fresh food. Consumers enjoy chicken goods because they are nutritious and fresh. Poultry farming generates money and employment prospects. Unemployed youth and educated adults can simply earn a lot of money by selling chicken at the market. This business is also appropriate for women and students. This chapter provides a detailed explanation of the goals, context, and motivation of our research endeavor, as well as a complete study of the problem. This chapter also discusses the general methodologies we employed for our research.

2.4 Scope of the Problem

During the past few years, the poultry sector has faced many difficulties. Lack of adequate knowledge has led to many problems. There is a lack of public awareness about poultry farms. If modern equipment is used in poultry farms, then the amount of damages can be reduced. Through this research we have tried to improve the health and nutrition of cattle and reduce the risk of death. Since Bangladesh is an agriculturally dependent country, if we can develop the poultry sector, our economic development will increase. Poultry farms in Bangladesh do not use modern technology which increases the mortality rate of cattle and reduces the nutritional value of meat. If the poultry farms of our country use Temperature Humidity Sensor Module (DHT22), Gas Sensor Module (MQ-5, MQ-135), LRD module they will be able to increase their production. If the price of these sensors can be reduced and people can be informed about how to use these sensors, what are the benefits of using them, then it will be possible to solve the problem of poultry farms. Building a smart poultry farm will not only meet the need for meat but also create employment.

2.5 Challenges

The Challenges of our project are as follows:

- Monitoring the environment of poultry farms using IOT.
- Monitoring the health of the poultry birds (chicken) in the farm.
- Maintaining a healthy environment for poultry birds (chicken) by analyzing sensor data stored in cloud databases using machine learning algorithms.
- Decreasing the death rate of the poultry bird by maintaining a healthy environment in the farm.
- Increasing the reproduction of the poultry birds (chicken) by ensuring a good health of the poultry birds of the farm.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Research Subject and Instrumentation

The “Internet of Things” refers to a network of physical objects that have the ability to communicate data. IoT devices are used by organizations to collect continuous and real-time data from sensors. This data can help them make better business decisions and improve customer satisfaction. Storing IoT data in the cloud has some advantages over storing it on-premises. However, there are also some challenges associated with storing IoT data on the cloud. The main challenge is security. IoT devices use Wi-Fi technology to transmit data through the cloud. However, the Internet of Things has some limitations that reduce its potential impact. If there are more WiFi-enabled devices or users accessing the internet, the network will become slower due to the division of the bandwidth among the clients. Therefore, the Internet of Things needs a faster and more reliable internet service to function properly [16].

3.2 Data Collection Procedure/Dataset Utilized

I used a dataset from the Poultry House Environmental Dataset for this project. They were used to train, test, and evaluate our model. The dataset is as follows:

Poultry House Environmental Dataset: I obtained this dataset by requesting it from Mr. Haikun Zheng, the authors of "Design and Implementation of Poultry Farming Information Management System Based on Cloud Database"[18]. There are ten columns and 2277 rows in this dataset. There are a total of seven sensore data points. Temperature, humidity, brightness, CO_2, CO, H_2S, and wind speed are among them.

	record_id	device_num	temperature	humidity	brightness	hydrogen_sulfide	Ammonia	win_speed	carbon_dioxide	record_time
0	2281	4	21.1	66.3	65	0	0	0	496	12/23/2020 19:10
1	2280	3	20.5	68.0	27	0	4	0	528	12/23/2020 19:10
2	2279	2	20.2	69.2	23	0	3	0	579	12/23/2020 19:10
3	2278	1	19.3	59.1	22	0	1	0	471	12/23/2020 19:10
4	2277	4	21.1	66.5	65	0	0	0	495	12/23/2020 19:09
...	...	...	...	...	...	...	...	...	...	...
62	2219	1	19.4	58.3	22	0	1	0	459	12/23/2020 18:56
63	2218	4	21.2	65.2	65	0	0	0	493	12/23/2020 18:55
64	2217	3	20.7	66.0	27	0	4	0	517	12/23/2020 18:55
65	2216	2	20.3	67.1	23	0	3	0	574	12/23/2020 18:55
66	2215	1	19.4	58.2	22	0	1	0	459	12/23/2020 18:55

Figure 3.1: Sample of Poultry House Environmental Dataset.

3.3 Statistical Analysis

Confusion Matrix

A confusion matrix is a table that displays the performance of a classification model (or "classifier") on a set of test data that contains known true values. A confusion matrix contains only two possible predicted classes: "true/yes" and "false/no". In our approach, we used the words Comfortable or Uncomfortable instead of Yes or No. In our approach, "comfortable" indicates that the environment is suitable for poultry life, whereas "uncomfortable" indicates that the environment is unsuited for poultry living. For this computation, we'll use the abbreviations TP (true positives), TN (true negatives), FP (false positives), and FN.

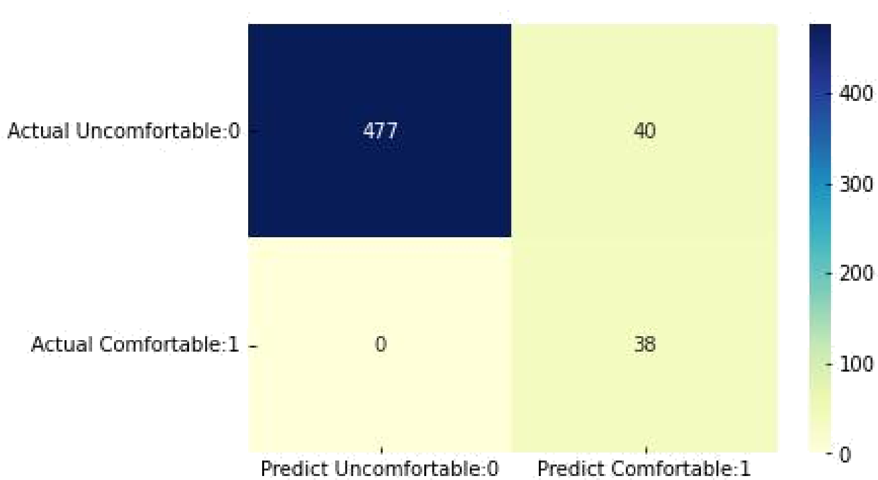

Figure 3.2: Naive Bias model confusion matrix evaluation.

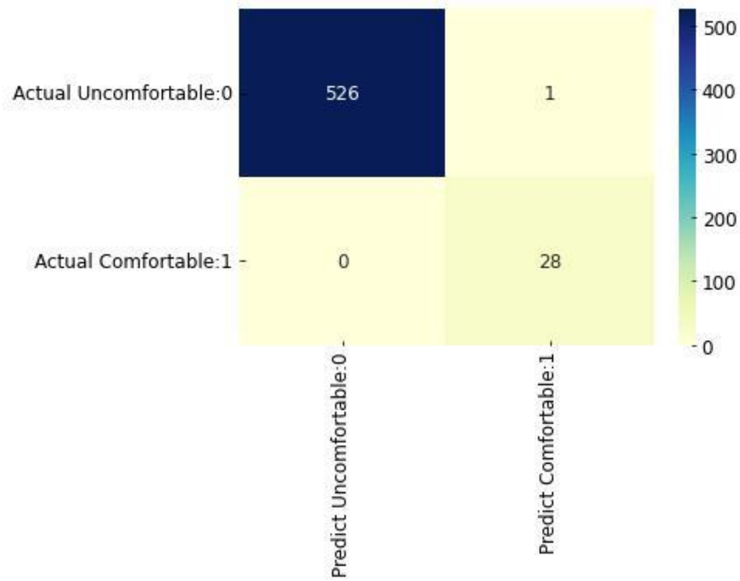

Figure 3.3: Support Vector Machine model confusion matrix evaluation.

3.4 Proposed Methodology/Applied Mechanism

There are four components within this section. With thorough explanations, the subsections are sequentially arranged from the model's input to output phase. Additionally, Figure 3.1 displays the architecture's overall workflow.

Data Pre-processing

Data cleaning, data labeling, data validation, and feature scaling or normalization are the four stages of the data pre-processing process. Below is a description of these four methods. Which is very important in this case due to its availability to the whole world. Simultaneously,

Data Cleaning: The environmental sensing dataset for chicken farms has a total of 10 columns and 2277 rows. There's a chance that some of the columns won't be tied to a specific result and can be safely ignored. So, from our dataset, we have removed the three columns "record id," "device num," and "record time." In order to create a more effective representation, the training data set's dimensions must be reduced using methods like principal component analysis.

Data Labeling: Algorithms for classifying data in machine learning are based on supervised learning techniques. It is necessary to create a labeled dataset from an unlabeled dataset for this reason. Our dataset was divided into the two classifications of true and false. Before training machine learning models, we first transform true to 1 and false to 0.

Data Validation: The dataset has been divided into two sets. The first batch represents 70% of the dataset and is used to train a machine learning model. The second set, which covers 30% of the dataset, is used to evaluate the final model's accuracy and dependability. This second step assists in identifying any issues with the assumptions made during data cleansing and feature engineering.

Feature Scaling or Normalization: Feature scaling is a strategy used to organize the data in a way that makes training data models and using them for conclusions more effective. Multiple variables frequently fluctuate at various scales, or one variable may change linearly while another changes exponentially. A meaningful relationship between variables can be more easily extracted by algorithms thanks to scaling, which helps to alter the data.

Gaussian Naive Bias Algorithm

Naive Bayes is a probabilistic classification technique based on the Bayes theorem and strong independence requirements. Independence in classification indicates that the existence of one value of a characteristic has no effect on the presence of another (unlike independence in probability theory). Naive refers to the concept that an object's features are independent of one another. NB classifiers are recognized to be relatively expressive, scalable, and fairly accurate in the context of machine learning, but their performance degrades rapidly as the training set grows. Several factors influence how well naive

Bayes classifiers function. One of the most essential features is that the categorization model's parameters do not need to be tuned.

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{P(A).P(B|B)}{P(B)} \text{------------------- (1)}$$

When working with continuous data, it is frequently assumed that the continuous values associated with each class have a normal (or Gaussian) distribution. The characteristics' probability is determined by-

$$P(x_i|y) = \frac{1}{\sqrt{2\pi\sigma_y^2}} exp(-\frac{(x_i - \mu_y)^2}{2\sigma_y^2}) \text{ ---------------- } (2)$$

Random Forest Algorithm

Random forest is a supervised learning approach that may be applied to both classification and regression issues. However, it is mostly utilized for categorization tasks. As the name implies, a random forest method generates numerous decision trees from data samples, collects predictions from each tree, and then votes to choose the best alternative. The ensemble technique, which outperforms a single decision tree, minimizes overfitting by averaging the findings.

$$f(x) = \omega^T * x + b \text{ ---------------------- } (3)$$

When we utilize the RF Algorithm to solve regression issues, we use the mean squared error (MSE) to determine how our data is distributed across nodes.

$$MSE = \frac{1}{N}\Sigma_{i=1}^{N}(f_i - y_i)^2 \text{ ---------------- } (4)$$

This algorithm determines the difference between each node and the actual predicted value, which aids in determining the appropriate split for our forest. Here is the value of the data point we are testing at a certain node, as returned by the decision tree. When we utilize Random Forests with classification data, we should be aware that we frequently employ the Gini index, which is the calculation used to determine how nodes divide in a decision tree.

$$Gini = 1 - \Sigma_{i=1}^{C} (P_i)^2 \text{ ------------------ } (5)$$

This formula employs class and probability to calculate the Gini of each split on a node, indicating which split is more likely to occur. The relative frequency of the class observed in the dataset is represented here.

$$Entropy = \Sigma_{i=1}^{C} - P_i * log_2(P_i) \text{ ----------- } (6)$$

3.5 Implementation Requirements

This section lists the fundamental elements and resources required for the suggested system to be implemented successfully. It describes the necessary hardware and software, including sensors for temperature, humidity, gasses, light, and wind speed, that are needed to implement the Internet of Things (IoT) infrastructure. Furthermore, the software prerequisites for putting machine learning techniques like Random Forest (RF), Nave Bias (NB), and Support Vector Machine (SVM) into practice are laid forth. The significance of cloud-based storage for gathered data is emphasized in this section, along with any particular platforms or technologies that are necessary for data processing and analysis. This chapter offers a road map for the parties engaged in establishing and managing the intelligent poultry monitoring system by outlining the prerequisites for its execution.

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Setup

The six sensors and devices of the internet of things for real-time data collecting architecture are the Arduino Uno, MQ135, LDR, DHT11, gas sensor, and anemometer. These six devices are described in more detail below.

- Arduino

  Arduino is an open-source platform for developing prototypes using user-friendly hardware and software. In this project, we utilized an Arduino UNO version. Arduino UNO is a microcontroller-based development board that employs an ATMEGA328P controller chip with a 5V operational voltage and a 10 MHz clock speed. Arduino UNO may be programmed using Arduino IDE since the ATmega328 includes a preloaded boot loader, eliminating the need for an additional hardware programmer. Here, each program is referred to as a sketch. [17].

- Temperature Humidity Sensor Module

  Animal well-being is directly influenced by environmental conditions, which can lead to some chronic outbreaks such as Bird Flu and Hand Foot and Mouth Disease. For this reason, we used DHT22 as a sensor to measure temperature (in both Fahrenheit and Celsius units) and humidity. The measurement unit will be shown in a digital signal form. [17].

- Presence of Toxic Gas

The health of the chickens is severely affected by ammonia in poultry houses. Ammonia is a gas that exists in the air of every poultry house. It is produced by the chemical breakdown of uric acid in droppings by some bacteria in the litter. It also harms the respiratory system, eyes and causes lesions in the cornea of the chickens. Therefore, the level of ammonia gas should be monitored in the farm. We used a MQ-5 gas sensor to detect the presence of ammonia gas. This sensor can sense the ammonia gas in the environment. [17].

- Anemometer

  The Adafruit anemometer can measure wind speeds of up to 70 m/s (156 mph), which should be sufficient for our location. The Adafruit Anemometer Sensor can be linked to an Arduino and an OLED display. The sensor will measure the wind speed in meters per second and display the result on an OLED screen.

In Fig. 4.1 I illustrated IoT system architecture. I take our poultry house environment detection sensors and devices. Then we connected them properly and simulated the system on Proteus software.

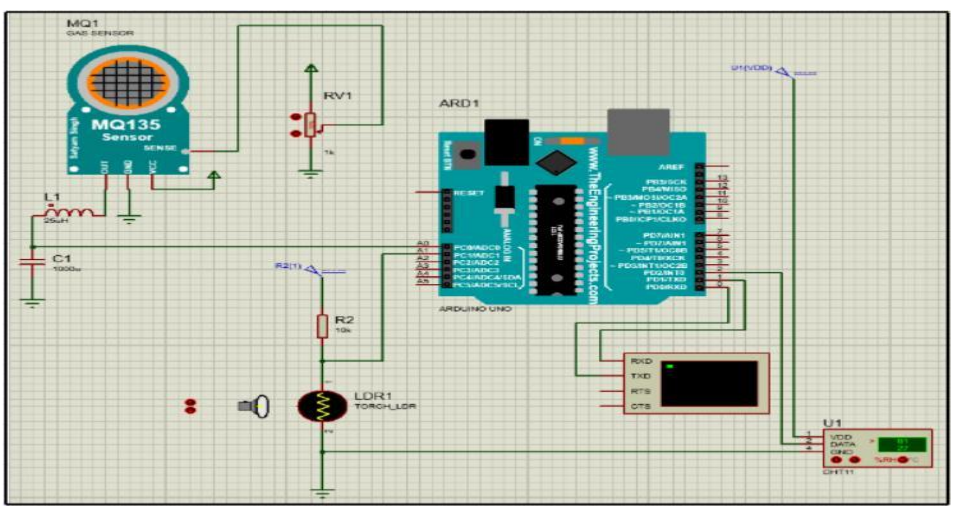

Figure 4.1: Full Diagram Design and Simulation of IoT.

4.2 Experimental Results & Analysis

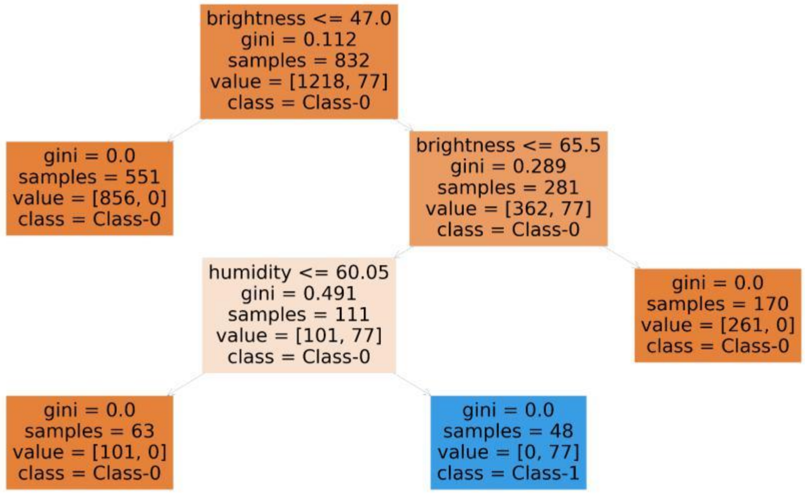

Figure 4.2: Training and evaluation of RF classifier applying 5 estimators.

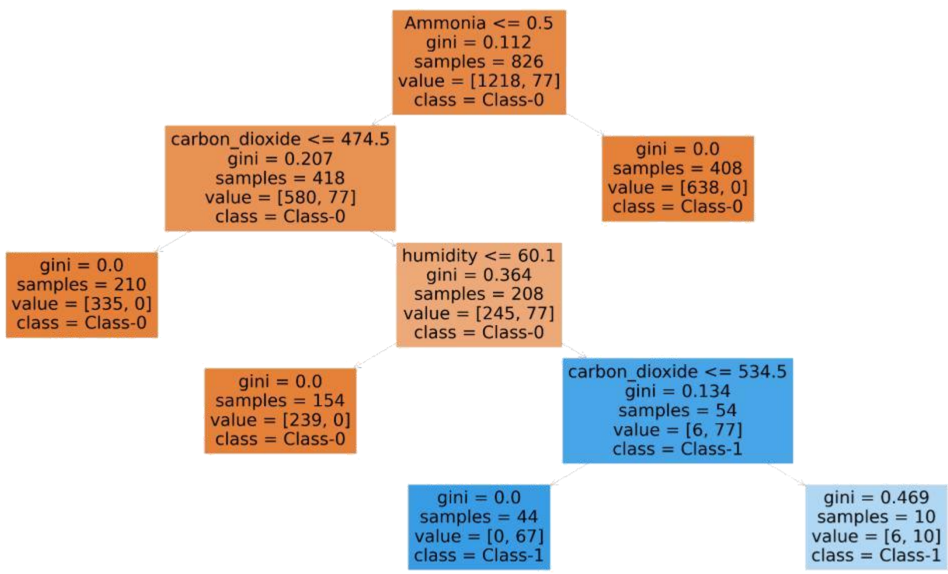

Figure 4.3: Training and evaluation of RF classifier applying 7 estimators.

Accuracy: Accuracy is a measure of how well a model predicts the correct outcomes. It is calculated by dividing the number of successful predictions by the total number of predictions. The formula of accuracy is:

$$Accuracy = \frac{(TP + TN)}{total} \text{ ----------------------- } (7)$$

Precision: Precision is a measure of how many of the predicted positive outcomes are actually positive. It is calculated by dividing the number of true positive samples by the number of samples that are predicted as positive. The formula of precision is:

$$Precision = \frac{TP}{(TP + FP)} \text{ --------------------- } (8)$$

Recall: Recall is a measure of how many of the actual positive outcomes are predicted as positive. Equation of recall is,

$$Recall = \frac{TP}{(TP + FN)} \text{ ---------------------- } (9)$$

F1-Score: F1-score is a measure of the balance between precision and recall. It is the weighted harmonic mean of precision and recall. The best possible F1-score is 1.0 and the worst is 0.0. F1-score is lower than accuracy measures because it incorporates both precision and recall in its computation. The weighted average of F1-score should be used to compare different classifier models, not global accuracy.

$$F1\ Score = \frac{2 \times Precision \times Recall}{Precision + Recall} = \frac{2 \times TP}{2 \times TP + FP + FN} \text{ ------ } (10)$$

ROC Curve:

The ROC curve (receiver operating characteristic curve) is a graph showing the performance of the classification model at all classification thresholds. This curve plots two parameters:

- True Positive Rate
- False Positive Rate.

True Positive Rate (TPR) True Positive Rate (TPR) is a synonym for the recall and is therefore defined as follows:

$$TPR = \frac{TP}{(TP + FN)} \text{------------------------} \quad (11)$$

False Positive Rate (FPR) False Positive Rate (FPR) is defined as follows:

$$FPR = \frac{TP}{(TP + TN)} \text{------------------------} \quad (12)$$

Figure- shows all the models' confusion matrix.

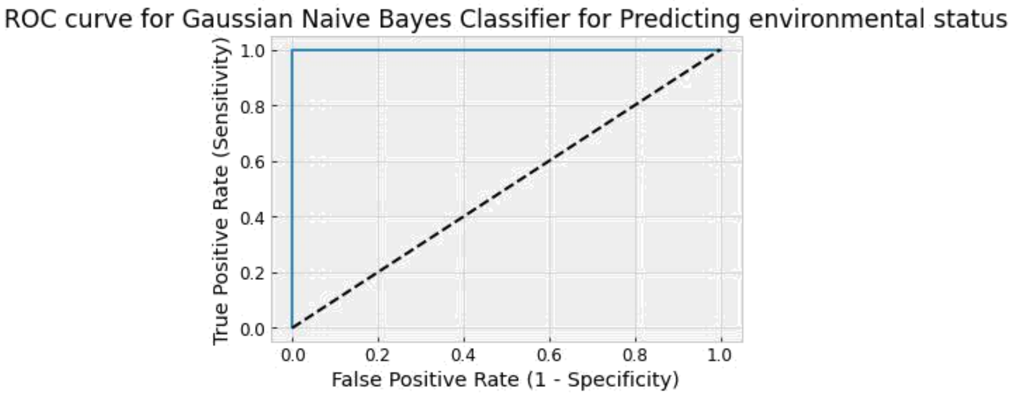

Figure 4.4: ROC curve of Naive Bias model.

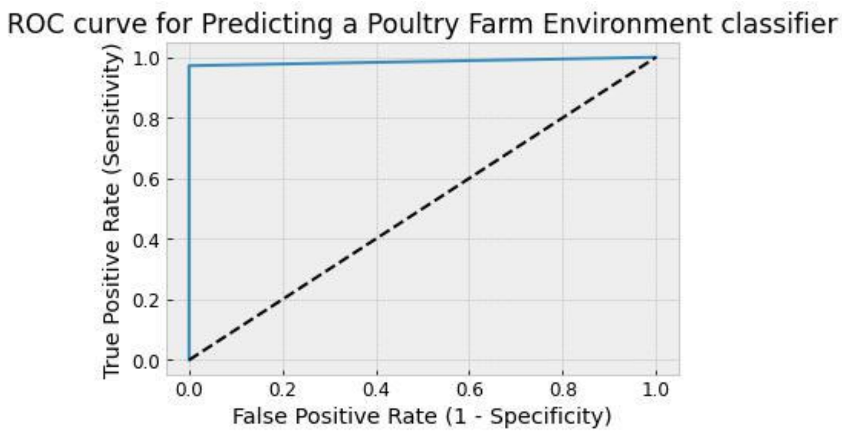

Figure 4.5: ROC curve of Support Vector Machine

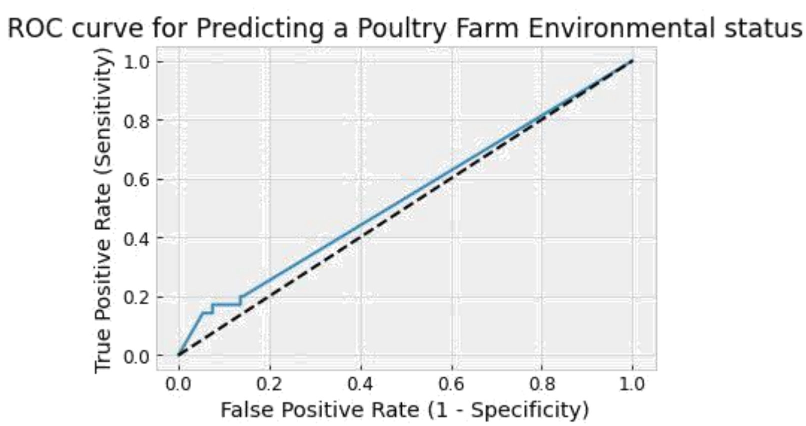

Figure 4.6: ROC curve of Random Forest model.

4.3 Discussion

The Results of all the models are given here. I give Accuracy, Precision and Recall to evaluate the model.

Table 4.1: Results of NB, SVM and RF models.

System Name	Accuracy	Precision	Recall	F1-Score
Naive Bias	93%	49%	100%	66%
Support Vector Machine	99%	96%	100%	98%
Random Forest	100%	100%	100%	100%

CHAPTER 5

IMPACT ON SOCIETY, ENVIRONMENT AND SUSTAINABILITY

5.1 Impact on Society

The main difficulty or challenge in raising chickens is simultaneously monitoring the environment around the farm and acting accordingly. Due to farmers' inability to adequately control the farm environment and a lack of environmental monitoring, the health of the poultry birds deteriorates, the production of meat and eggs declines, and the farms are forced to deal with

the effects. We can easily overcome the aforementioned difficulties by putting our research into practice on farms and employing machine learning algorithms to analyze sensor data. And as a result, the farmers will be able to see improved meat and egg output, which will enable them to grow economically. Other farmers will be inspired to use this concept on their farms to improve their economic position and quality of life as a result of seeing the farmers' economic prosperity. Therefore, this paper's work will have a hugely beneficial effect on society.

5.2 Impact on Environment

Implementing machine learning algorithms to analyze sensor data in poultry farming not only addresses the challenges of environmental monitoring but also has a profound impact on the overall environment. By efficiently managing the farm environment, the reduction in poultry bird health issues and increased meat and egg output directly contributes to sustainable agricultural practices. This optimized approach minimizes the need for excessive use of antibiotics or other interventions, thereby reducing the environmental impact of conventional farming practices. Moreover, as farms adopt these innovative techniques, there is a cascading effect on the broader agricultural community. The improved economic viability of individual farms leads to a shift towards more sustainable and technologically advanced practices across the industry. This collective transition positively influences the environmental footprint of poultry farming on a larger scale, contributing to a more ecologically balanced and resource-efficient agricultural sector.

5.3 Ethical Aspects

Implementing machine learning algorithms for environmental monitoring in poultry farming introduces several ethical considerations that need careful attention:

- Data Privacy and Security: The collection and analysis of sensor data, especially if it includes personal information about farmers or employees, raises concerns about data privacy. Ensuring robust data security measures and obtaining informed consent from stakeholders are crucial to uphold ethical standards.
- Animal Welfare: While the use of technology aims to improve overall poultry health, ethical considerations must be made to ensure that the welfare of the animals is prioritized. Continuous monitoring should be accompanied by humane treatment, and any potential negative impact on the well-being of the poultry must be carefully assessed.
- Technology Accessibility: The adoption of advanced technologies may inadvertently create disparities between farmers who can afford such innovations and those who cannot. Ethical practices involve ensuring that technology is accessible to a wide range of farmers, preventing the exacerbation of economic inequalities in the agricultural sector.
- Transparency and Accountability: Farmers, as well as the organizations implementing these technologies, must be transparent about the algorithms used, their decision-making processes, and the potential biases within the system. Accountability for any adverse consequences, whether related to data analysis or environmental impact, is crucial.
- Sustainable Practices: Ethical considerations extend to the broader environmental impact of implementing technology in farming. Ensuring that these innovations

contribute to sustainable practices, minimizing resource consumption and environmental harm, is essential for ethical agricultural development.

- Community Impact: The societal benefits envisioned should be shared equitably among the farming community. Ethical practices involve considering the broader community impact and ensuring that the adoption of technology doesn't lead to negative consequences for certain groups or regions.

5.4 Sustainability Plan

The sustainability plan takes long-term social, economic, and environmental factors into account. It outlines steps to minimize the use of resources, maximize energy efficiency, and lessen the environmental effect of chicken farming operations. The strategy also outlines procedures to guarantee the durability and flexibility of the technology used, taking changing standards and technical breakthroughs into account. Aspects of social sustainability include ethical treatment and health promotion for both human workers and poultry. In order to address economic sustainability, prospective advantages for poultry producers are evaluated together with long-term financial repercussions. The sustainability plan seeks to build a robust and long-lasting system that benefits the larger agricultural environment by combining these components.

CHAPTER 6

SUMMARY, CONCLUSION, RECOMMENDATION AND IMPLICATION FOR FUTURE RESEARCH

6.1 Summary of the Study

To address farmers' issues, we have provided a temporary attentive framework in this study. Our research in this publication will assist thousands of farms across the nation in increasing their production of meat and eggs. This work of ours demonstrates how we may resolve the issue of continuously monitoring and maintaining the environment of the poultry farm as well as the health of the poultry animals with a moderate amount of money and minimal effort. This further demonstrates how a few tiny sensors and a few machine-learning algorithms may greatly impact the chicken farming sector. In the future, we'll work to enhance our initiative so that it can help farmers with new challenges.

6.2 Conclusions

It summarizes the study findings and makes links between the performance of the deployed system and the original goals mentioned in the introduction. Based on the trial findings, conclusions are made on how well IoT and machine learning technologies monitor the health of chickens. Any findings that are not expected or that deviate from the predicted results are noted and examined. The section also addresses the study's wider ramifications, including possible effects on disease control, production levels, and chicken farming methods. The project's success is evaluated in the findings, which also provide insightful information for scholars, practitioners, and stakeholders interested in the nexus between technology and agriculture.

6.3 Implication for Further Study

This report is among the greatest initiatives that monitor and protect the environment using IoT and machine learning. Environment monitoring and control based on IoT and machine learning may be a major field of study. Additionally, the economy of developing countries like Bangladesh may benefit greatly from this sort of study and endeavor. We are certain that research and initiatives like IoT-enabled poultry farming will be widely recognized and accepted in the near future, especially considering the growing need for chicken meat and eggs in countries like Bangladesh.

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