IOT AND DATA SCIENCE BASED LOW-COST SMART POULTRY FARMING

BY

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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 "**IoT And Data Science Based Low-Cost Smart Poultry Farming.**", submitted by **Md. Anowar Hossen Faysal, Md. Rasel Ahmed** and **Md. Masudur Rahaman** 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 2 January, 2022.

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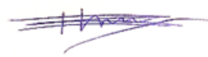

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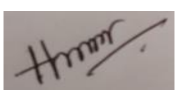

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We hereby declare that, this project has been done by us under the supervision of **Dr. Fizar Ahmed, Assistant Professor, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Environmental maintenance of the poultry house is essential for maintaining the excellent health of the poultry as the rate of egg production is disrupted due to illness. Our main objective is to find real-time environmental impact using IoT and machine learning to ensure optimal egg production in the poultry industry, an unimaginable change for the poultry industry. Environmental data such as Temperature, Humidity, Ammonia, Light Intensity, Noise which affect the egg production, have been measured through low-cost IoT devices. The collected data has been kept on the online server. Through our website and Android app, we will send messages to poultry farmers by combining the collected environmental data with standard data to be aware of the status of their poultry farms. The server analyzes the stored data using machine learning algorithms on how to maximize egg production based on poultry farm environment conditions. As a result, the poultry industry can be transformed into a profitable industry with unimaginable changes.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

Introduction

1.1 Introduction

As part of the evaluation of egg production, we have reviewed the current knowledge about the environmental impact of the egg production system. We monitored about 3,500 broiler chickens of one poultry farm in the Dhamrai area of Dhaka district of Bangladesh through our IoT device for eleven months. We know that there are many types of poultry in Bangladesh, but due to different kinds of obligations, the poultry industry may not be as profitable as expected. In the absence of proper environment monitoring, we have noticed that poultry farm chickens are easily infected with multiple diseases that hinder their growth and die in most cases. So, we want to transform egg production in this poultry industry into a profitable poultry industry using IoT and machine learning. We also know that eggs play an essential role in boosting immunity. Eggs also contain zinc, vitamin D and help reduce heart disease. Eggs also contain choline, which helps maintain eye health and weight control. So, eggs are an essential part of our lives. Egg eating increases day by day as it is a portion of excellent and delicious food. Eggs are now used in many dishes[1] such as Egg Masala, Egg and Garlic Fried Rice, Egg Biryani, Tomato Egg Curry, Egg Paratha, and Egg Keema Pulao. More than 200 eggs are eaten daily in developed countries, but 104 eggs are eaten in Bangladesh. In Bangladesh, 96 eggs are eaten less because egg production is not like in developed countries. As the price of eggs is lower than other nutritious foods, eggs play an important role in meeting the nutritional needs of developing countries.

In the rainy season, the humidity increases so much that the poultry egg production rate decreases, and the mortality rate increases. Low environmental temperature increases feed intake and reduce body weight grain and feed efficiency. At high temperatures, chickens consume more water than feed. The reduced water intake is primarily behind the decrease in egg production. Ammonia gas is harmful to poultry broilers, and high ammonia levels kill the chicken. Light intensities have adverse effects on egg production. As the light intensity decreases, so egg production is also reduced. As the light intensity increases, so egg production is also increased. Noise levels above the 85-decibel level reduce feed intake by 15 to 25 percent. High noise has adverse effects on egg production. Poultry farm environmental temperature, humidity, ammonia, light intensity, sound can be monitored using IoT technology. Maximum production is obtained when a certain amount of temperature, humidity, ammonia, light intensity and sound information are available. Machine learning algorithms will determine that a certain level and maximum egg production will be readily available in an environment at that particular level.

1.2 Motivation

Bangladesh has many types of poultry industry, but the poultry industry is not able to benefit as expected due to various kinds of obligations. We have noticed that many chickens die due to a lack of proper poultry environment monitoring, and the rate of laying eggs decreases due to easily infected diseases. As a result, poultry egg production is not available as expected. This is why we want to transform this poultry industry into a profitable poultry industry using the Internet of Things and machine learning.

1.3 Research Question

1. What are the effects of environmental parameters on poultry farms?
2. How to visualize environment data?
3. How will the system affect the poultry industry?
4. Which Machine learning method is better for your system?
5. How to get optimum egg production?
6. What is the main reason this system is applicable?
6. What is Future Work?

1.4 Expected Outcome

Poultry environment data such as Temperature, Humidity, Ammonia, Light Intensity, Noise can be monitored through the website and Android apps, and production data will be input. They can store data on the online server. Find the optimum egg production by analyzing the collected data with a machine learning algorithm.

CHAPTER 2

Process Model

2.1 Description

Figure 1 shows our proposed model. This model highlights our work overview. The primary tool of our work is our IoT device. The model shows IoT our device being used inside a poultry farm. The IoT device collects the environmental data of the poultry farm and transmits the collected data to the data server via the Internet. Data servers transmit data over the Internet to mobile apps and websites. Users can become aware of the poultry farm environment through mobile apps and websites. As a result, by comparing the standard value, appropriate action can be taken if there is any problem in the environment.

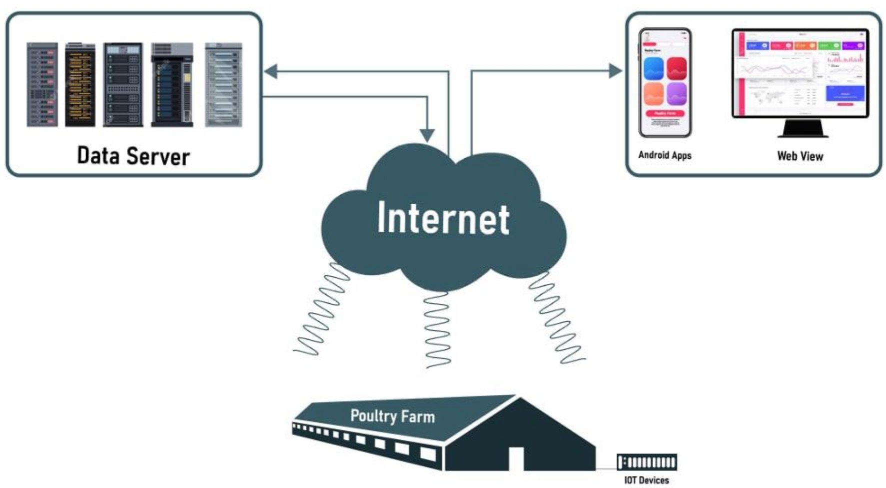

Figure 1: Process model of IoT

CHAPTER 3

Research Material and Method

3.1 IoT-Based Device

The following is a part-by-part description of how data was collected from poultry farms by combining an IoT device.

3.1.1 System Diagram

As shown in Figure 2, Our system collects data from the poultry environment through various sensors such as ammonia sensor, temperature and humidity sensor, light intensity sensor, noise sensor. We have used SD cards to save data. When there is no interconnection, the data will send from the SD card of the server after the internet connection. We have also used the RTC module through which we do real-time maintenance. Data was transferred to the server via the Internet via a microcontroller. We visualized the data through the website and the Android app.

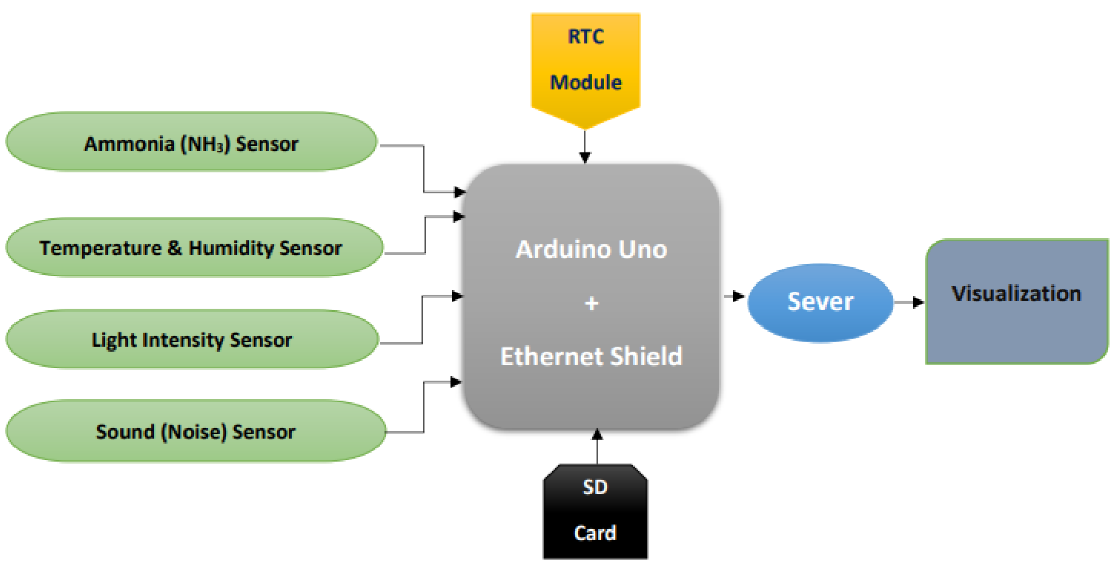

Figure 2: System Diagram

3.1.3 Algorithm & Flowchart

Algorithm:

Step 1: Start

Step 2: Read Temperature, Humidity, Noise, Ammonia, and Light Intensity data from the poultry environment by the sensor.

Step 3: Data capture and process by Arduino Uno.

Step 4. Check the internet: If available, go to Step 5; if not available, go to Step 6.

Step 5: Ethernet Shield sends data to the server from Arduino directly and goes to Step 7.

Step 6: Temporarily store data in an SD card. When the internet is available, data is sent to the server via the Ethernet shield.

Step 7: Check server data for matching with a standard chart of data.

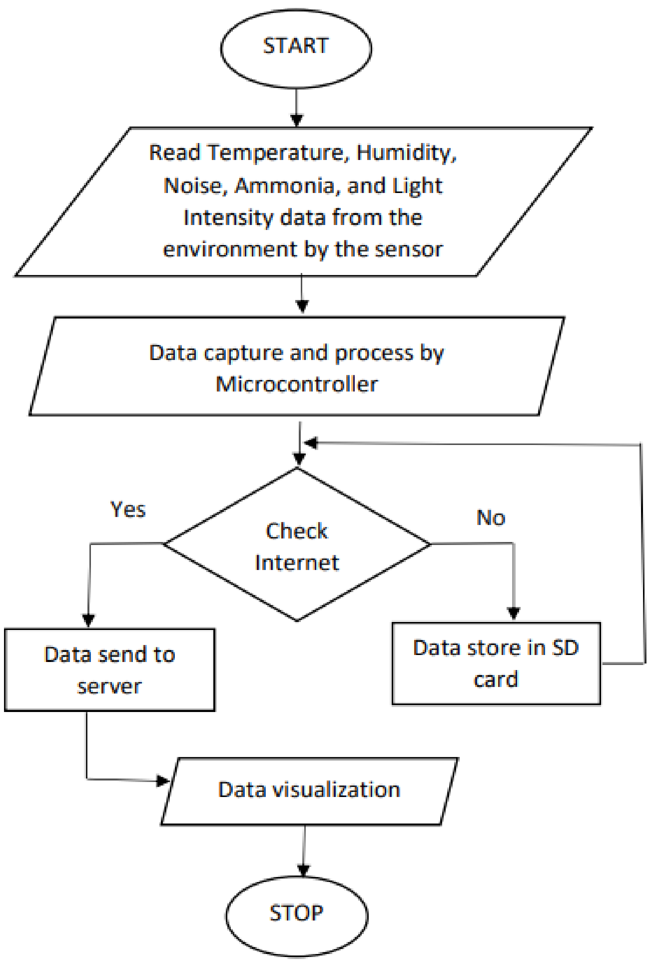

Figure 3: Flowchart of the IoT system

3.1.3 Hardware Component

Figure 4 shows the hardware design. It shows genuine pictures of what devices are used in our system. The Hardware system used some sensors to sense the poultry environment. MQ-135 sensors measure the Ammonia gas of the poultry environment, ambient poultry temperature and humidity determination through DHT-22, LDR for Light intensity detection, and Sound module for noise detection. We used Arduino Uno and Ethernet Shield as microcontrollers. We have used Arduino Uno for data processing and Ethernet Shield for data transfer to the server, and an SD card used for data storage. A real-time clock module is used to get real-time data.

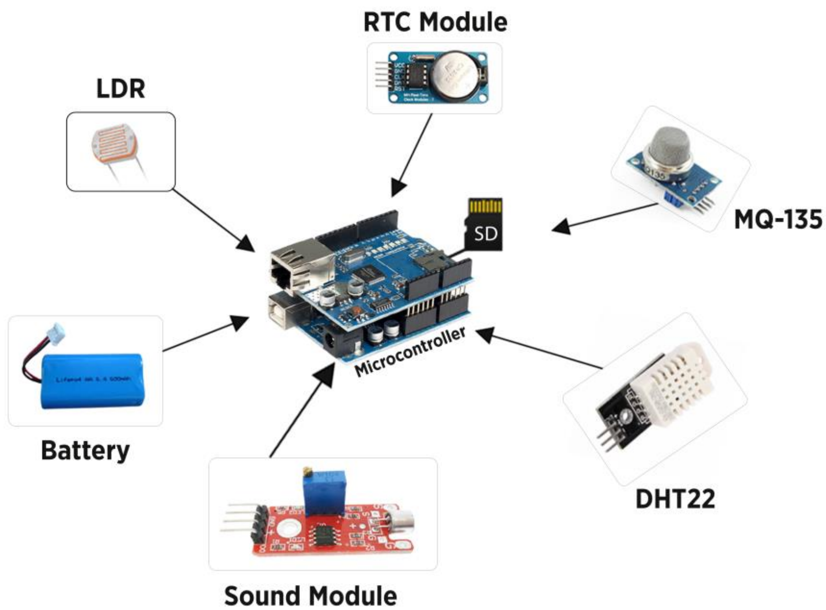

Figure 4: Hardware Component

3.1.4 Software Component

Figure 5 and 6 shows the Software design—the PHP framework we used for Websites and the React Native framework for Android applications. The MySQL database is used on the server because it is easy to implement. Data in JSON format from the server comes through API in the Website and Android Apps, And the data has visualized website and android Apps. Users can be aware of the poultry farm environment through Android apps and websites and take action accordingly.

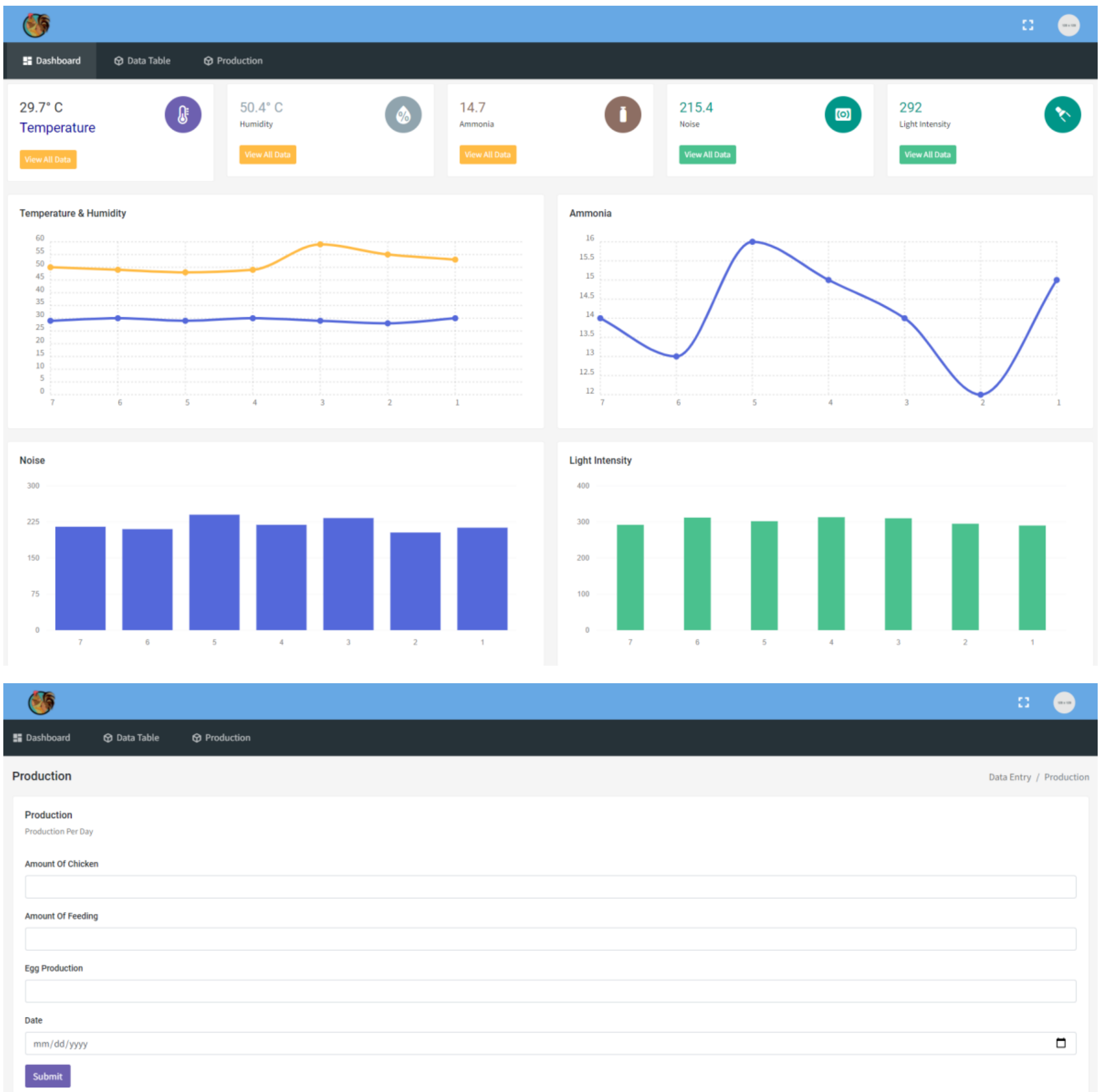

Figure 5: Website

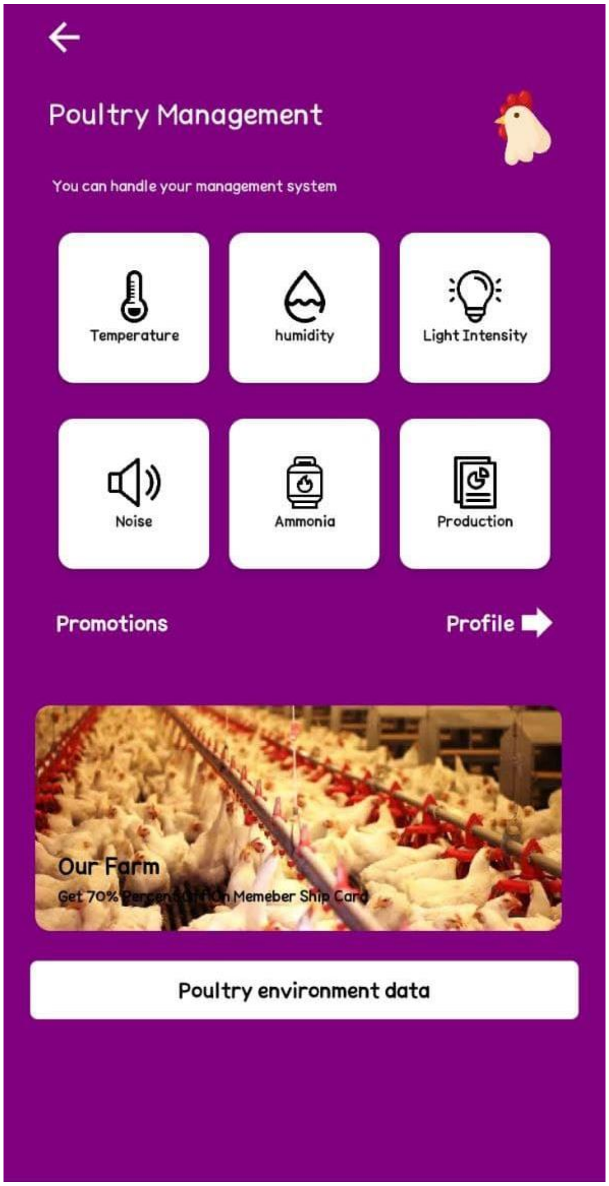

Figure 6: Android Apps

3.2 Machine Learning Models

An outline of how our model works is shown in Figure 7. The model first collects poultry data and then divides the data into two parts. One is the training data set, and the other is the testing data set. The training data set is used directly by machine learning algorithms. The data from the algorithm is sent to the testing data set for evaluation. Evaluation reveals how the accuracy of this model comes from. Predictable egg production will be available as the output if the input data is given in the ML model.

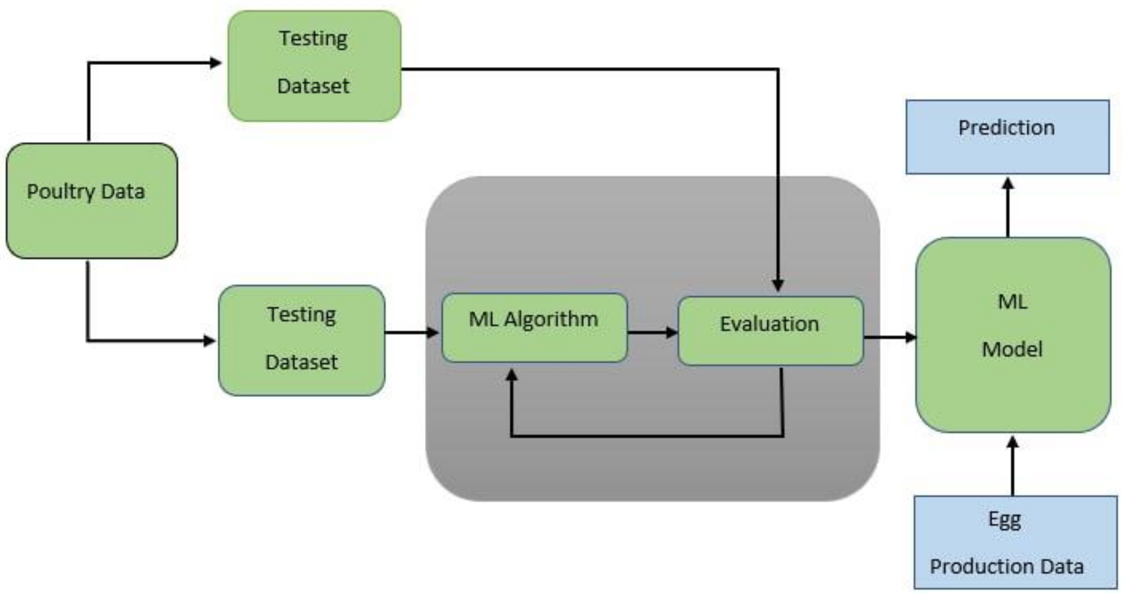

Figure 7: ML Model

3.2.1 Data Collection

In this research paper, 3,500 broiler chickens of one poultry farm have been used for data collection. Poultry farms are located in the Dhamrai area of Dhaka district in Bangladesh. About eleven months of poultry farm data have been collected through IoT devices, Websites, or Android apps. Temperature, humidity, ammonia, light intensity, and noise data have been collected through the poultry farm shed IoT devices. Amount of Chicken, Amount of Feeding, and Egg Production data has been collected manually using the Website or Android apps. The data is taken daily, and the data is stored on an online server to be accessed from anywhere. About 350 input and output variables data have been collected from poultry farms in eleven months, and sample data is shown in Table 1.

The input variables for data analysis are Amount of Chicken, Amount of Feeding, Temperature, Humidity, Ammonia, Light Intensity, Noise, and output variables are Egg Production. The output variable, egg production, will be predicted by training the data using machine learning algorithms. The machine learning that will be used is described in the model description.

Table 1: Poultry Environment Data

Amount_of_chicken	Amount_of_Feeding	Ammonia	Temperature	Humidity	Light_Intensity	Noise	Total_egg_production
2728	170	14.4	29.3	51.7	364	214	2115
2728	175	17.6	29.3	52.3	369	235	1958
2728	175	15.0	29.3	52.5	373	237	1990
2728	170	15.0	29.3	49.7	372	240	2015
2728	170	15.9	29.2	51.4	381	237	2112
...	...	...	...	...	...	...	...
2735	180	14.4	29.0	49.5	341	224	2065
2735	185	14.9	29.5	50.7	317	202	2202
2735	180	16.0	29.5	49.3	346	197	1972
2732	195	13.4	30.0	51.7	325	183	2120
2732	175	14.2	30.0	49.6	319	219	1804

3.2.2 Model Description

A. Multiple Linear Regression (MLR):

Multiple linear regression[2] is a model that measures the relationship between a dependent variable and two or more independent variables using a direct line. Multiple regression analysis aims to use independent variables whose values are known to predict single dependent values. The weights of each prediction, the consequences indicate their relative contribution to the overall forecast.

$$\mathbf{Y= a+b_1X_1+b_2X_3+\ldots+b_nX_n}$$

Here Y is the dependent variable, and $X_1, \ldots, X_n$ is the n independent variable. When calculating weights, a, $b_1, \ldots, b_n$, regression analysis maximises the dependent variable from a set of independent variables.

B. K-Nearest Neighbors (KNN)[3]**:**

The KNN algorithm is a supervised ML algorithm used for classification and regression prediction problems. However, it is used chiefly for the classification of predictive issues in the industry.

C. Naive Bayes(NB)[4]**:**

The Naive Bayesian algorithm is based on Bayes' theorem with the independence hypotheses between predictors. A Naive Bayesian model is simple to build, with no complicated iterative parameter estimation, making it individually valuable for enormous datasets. Notwithstanding its simplicity, the Naive Bayesian algorithm often does surprisingly great and is broadly used because it often betters more sophisticated algorithm methods.

$P(c \mid y) = (P(y \mid c)\, P(c))/(P(y))$

$P(c \mid Y) = P(y_1 \mid c) \times P(y_2 \mid c) \times \ldots \times P(y_n \mid c) \times P(c)$

$P(c \mid Y)$ is the posterior probability of target class given predictor.

$P(c)$ is the prior probability of class.

$P(y \mid c)$ is the likelihood which is the probability of predictor given class.

$P(y)$ is the prior probability of predictor.

D. XGBoost (XGB)[5]**:**

XGBoost is a decision-tree-based Machine Learning algorithm that does a gradient-advancing framework. Artificial neural networks tend to better all other algorithms or frameworks in prediction problems involving unstructured data (images, text, etc.). However, when it arrives in small-to-medium tabular data, decision tree-based algorithms are regarded best-in-class.

E. Random Forest[6]**:**

Random Forest is a combined learning method for classification, regression, and other tasks that make many decision trees during training. Random Forest is a supervised learning algorithm. Forest decision making is a combination of trees, usually trained in bagging methods. The general idea of the bagging method is that the combination of model learning improves the overall result.

CHAPTER 4

Experimental Results

4.1 Test Data and Graph

Table 2 shows the testing data based on which the output prediction graphs of the five algorithms are shown, which indicate Figures 8,9,10,11 & 12. Figures 8,9,10,11 & 12 are presented sequentially in the form of Multi Linear Regression, K-nearest Neighbors, Naive Bayes, XGBoost, and Random Forest Algorithm. Each graph is different from each according to predictions. The graphs show the testing data along the horizontal and the output results along the vertical. Egg production rate varies through the highest and lowest conditions of the line graph. Indicates the maximum production rate at the highest points of the line graph and the minimum production rate at the lowest points.

Table 2: Testing Data

Amount_of_chicken	Amount_of_Feeding	Ammonia	Temperature	Humidity	Light_Intensity	Noise
2645	175	14.2	29.0	51.5	348	216
2732	185	16.4	30.5	52.9	352	226
2730	175	13.1	32.0	50.8	328	214
2646	180	15.0	29.0	51.0	337	212
2735	180	14.4	29.0	49.5	341	224
2736	180	13.5	30.0	50.2	313	215
2721	170	16.0	29.2	51.7	239	108
2744	180	16.2	30.0	48.8	354	201
2712	180	17.1	29.1	50.0	316	195
2640	185	14.2	29.0	50.5	343	216

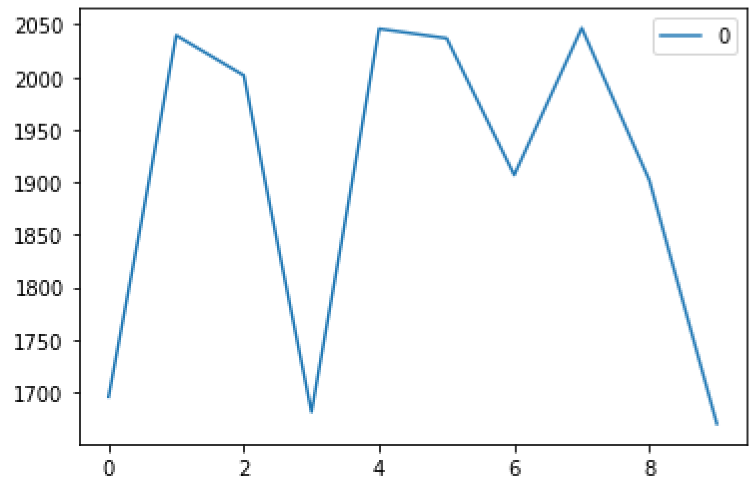

Figure 8: Multi Linear Regression Prediction Graph

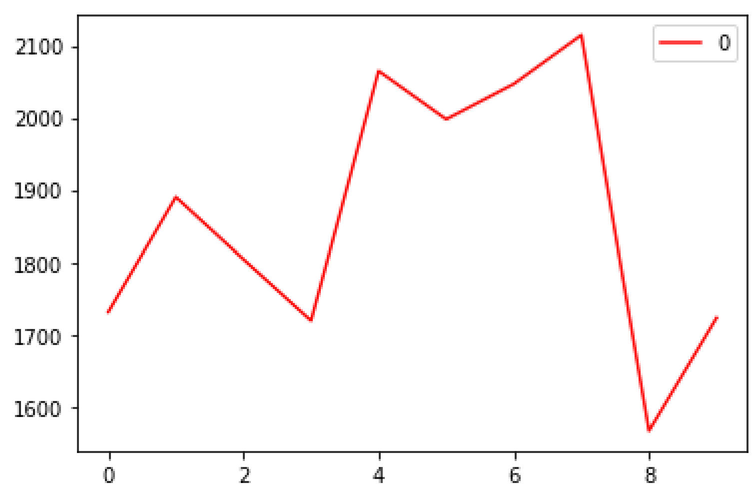

Figure 9: K-nearest Neighbors Prediction Graph

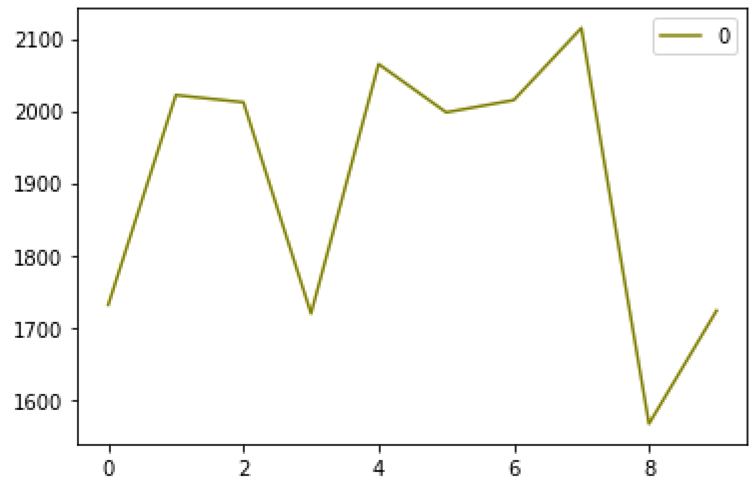

Figure 10: Naive Bayes Prediction Graph

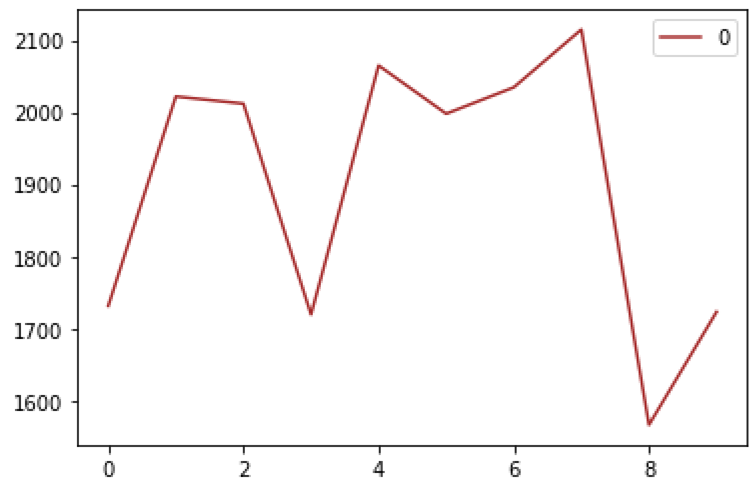

Figure 11: XGBoost Prediction Graph

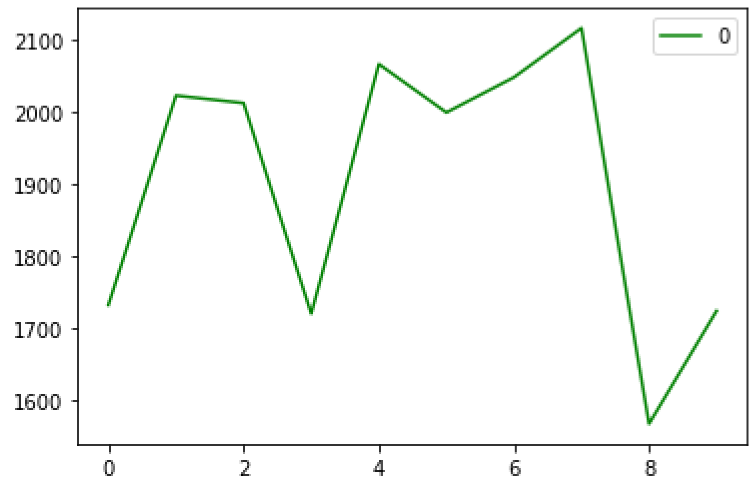

Figure 12: Random Forest Prediction Graph

4.2 Comparing Model Accuracy:

Table 3 shows the accurate measurements of the machine learning algorithms we have used and the results that can be used to compare the maximum accuracy. From the table, we can see that the accuracy of Naive Bayes, XGBoost and Random Forest algorithms is much better than the Multiple Linear Regression and KNN algorithms. The maximum accuracy rate is 95.98% using Random Forest algorithms

Table 3: Model Accuracy

Models	**Accuracy (%)**
Multiple Linear Regression	66.61
KNN	64.94
Naive Bayes	91.93
XGBoost	95.90
Random Forest	95.98

4.3 Correlation Matrix[7]:

A correlation matrix is a square that shows the correlation coefficients between variables—each of the same variables acts presented in the rows and columns. A correlation matrix is applied to summarize data, input more advanced analysis, and diagnose cutting-edge research. The five algorithms in Figure 13 are created by correlation matrix relative to each other in Multiple Linear Regression (MLR), KNN, Naive Bayes (NB), XGBoost (XGB), and Random Forest (RF). Figure 13 shows that XGBoost and Random Forest algorithms have a perfect relationship, and the relationship value is 1. Everyone has the slightest connection with Multiple Linear Regression.

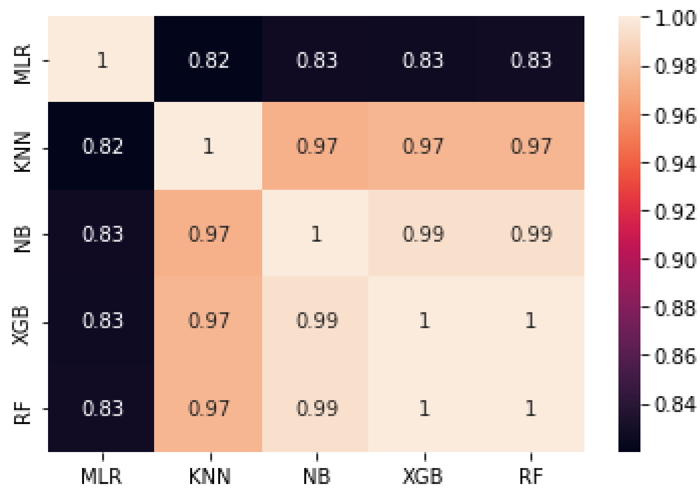

Figure 13: Correlation Matrix

4.4 Standard Environment Parameter:

The environmental standards of poultry farms are shown in Table 4. In line with these standard values, we will send messages to poultry farmers through our website and Android app so that they can be aware of the status of their poultry farms and take immediate action.

Table 4: Standard Environment Parameter

Ammonia	0-25 ppm	Good production [8]
Temperature	11-26 degree Celsius	Good production [9]
Humidity	60% - 80%	Good production [8]
Noise	55dBA - 63dBA	Good production [10]
Light-Intensity	400 – 500 lux	Good Production [11]

CHAPTER 5

Conclusion and Future Work

5.1 Conclusion

This study shows how egg production can be increased in the poultry industry using IoT and machine learning techniques. Poultry farm environmental data is collected and stored on data servers using IoT devices. Instant messages are transmitted via the website and Android apps to poultry farmers by matching stored data in the server with poultry environment data standard data. Five algorithms of machine learning algorithms have been used for data analysis, each of which differs from the other, and the highest accuracy comes from a random forest whose accuracy is 95.96. The best poultry farm egg production can be achieved very quickly if the poultry environment is controlled based on the results obtained through data analysis.

5.2 Future Work

Our future task is to automatically maintain the Poultry Environment using IoT and Computer Vision Technology, based on the results obtained by data analysis.

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