SMART POULTRY FARM IN SRI LANKA USING IOT – “Poultry HUB”

Madushan M.A.C   
Information TechnologyFaculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka  
madushanm.a.c@gmail.com

B.M.W.S Wijesekara  
Information TechnologyFaculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka  
wathsalas33.ws@gmail.com Ananda A.M.S.C Information TechnologyFaculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka  
supun.cxc@gmail.com

Mr. Kanishka Yapa  
Computer Systems Engineering Faculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka  
kanishka.y@sliit.lk Perera W.A.L.H.P.K  
Information TechnologyFaculty of Computing, Sri Lanka Institute of Information Technology, Malabe, Sri Lanka  
hashanikumari9@gmail.com

Ms. Pipuni Wijesiri Computer Systems Engineering Faculty of Computing, Sri Lanka  
Institute of Information Technology, Malabe, Sri Lanka  
pipuni.w@sliit.lk

*Abstract*—**Sri Lanka's poultry farming industry faces challenges such as disease outbreaks, low productivity and labor-intensive processes. To address these issues, this paper proposes the use of advanced technologies such as the Internet of Things (IoT), machine learning and computer vision to automate farming and egg collection processes and detect early signs of disease. The proposed system uses sensors to detect when hens lay eggs and conveyor belts to transport them to a collection point, reducing the time spent on egg collection and the need for manual labor. The system also uses machine learning algorithms to detect early signs of disease by collecting real-time data on chicken behavior. Furthermore, the paper suggests using automated hatching using computer vision and egg retrieval time prediction features to improve productivity and reduce economic losses to farmers. By predicting the optimal time for egg retrieval and using computer vision to monitor the incubation process, farmers can ensure high hatching rates and reduce the risk of hatching problems. The proposed non-interactive automated farming and egg collection system has the potential to revolutionize the poultry farming industry in Sri Lanka, improve efficiency, productivity and animal welfare, and reduce the risk of disease outbreaks and economic losses. Farmers can ensure a high calving rate and reduce the risk of calving problems. The proposed non-interactive automated farming and egg collection system has the potential to revolutionize the poultry farming industry in Sri Lanka, improve efficiency, productivity and animal welfare, and reduce the risk of disease outbreaks and economic losses. Farmers can ensure a high calving rate and reduce the risk of calving problems. The proposed non-interactive automated farming and egg collection system has the potential to revolutionize the poultry farming industry in Sri Lanka, improve efficiency, productivity and animal welfare, and reduce the risk of disease outbreaks and economic losses.**

Keywords—component, formatting, style, styling, insert (key words)

# INTRODUCTION

The poultry farming industry provides a significant portion of the world's food supply, particularly with the growing global population. However, the poultry farming industry in Sri Lanka is facing several challenges, including disease outbreaks, low productivity, and manual labor-intensive processes, which can lead to significant economic losses, reduced food security, and increased animal welfare concerns.

To address these challenges, the paper proposes the use of IoT-based technologies, machine learning, and computer vision to automate the farming and egg collection processes and detect early signs of diseases. By automating the egg collection process, the system reduces the need for manual labor, leading to increased efficiency and reduced risk of injury to the hens. Additionally, by using machine learning algorithms to detect early signs of diseases, farmers can take timely preventive measures to reduce the risk of disease outbreaks and minimize economic losses.

Conjointly Poultry ranches are defenseless to gatecrashers, which can cause critical harm and misfortunes. In this manner, it is fundamental to create compelling security frameworks that can identify and anticipate interlopers. In later years, picture preparing strategies have been broadly utilized for observation and security applications. In any case, visual examination alone may not be adequate to supply comprehensive bits of knowledge into the environment, question, or behavior being analyzed.

In this research, we propose a novel approach to intruder detection in poultry farms using audio-visual analysis. The combination of image and voice analysis can provide more accurate and reliable detection results compared to visual analysis alone. By analyzing both the visual and audio signals, we can identify the presence of intruders and distinguish them from other objects or animals that may trigger false alarms.

Moreover, it suggests that automatic hatching using computer vision and egg retrieval time prediction features of the system can help improve productivity and reduce economic losses for farmers. By predicting the optimal time for egg retrieval and using computer vision to monitor the incubation process, farmers can ensure a higher hatch rate and reduce the risk of issues arising during hatching.

The emphasizes the importance of IoT technology, machine learning, and image processing in poultry farming and highlights their ability to improve efficiency, productivity, and animal welfare while reducing the risk of disease outbreaks and economic losses. By automating processes and analyzing data in real-time, farmers can make informed decisions and optimize their operations, leading to increased productivity and reduced costs. Additionally, the early detection of diseases can prevent outbreaks and reduce the need for antibiotics or other treatments, improving animal welfare and reducing the risk of antibiotic resistance.

Overall, the proposed non-interactive automated farming and egg collection system has the potential to revolutionize the poultry farming industry in Sri Lanka. The system can improve efficiency, reduce costs, and improve animal welfare, leading to increased productivity and reduced economic losses. The introduction of the research paper sets the stage for the proposed solution and highlights the importance of technology in addressing the challenges facing the poultry farming industry in Sri Lanka.

# LITERATURE REVIEW

We have largely concentrated on related research projects in the same field in the literature review. Our research's major goal is to boost productivity by offering an automated solution to the poultry farm's problems. In the beginning, we used a variety of secondary sources to conduct some preliminary studies on this. This made it possible for us to be aware of the characteristics that were accessible, which assisted us in choosing our work's outlines.

For the literature survey we need to mainly focus on related research and functionalities in the same area. Our main objective was Design and develop an intelligent system to increase productivity and decrease market price and also prevent egg shortage in Sri lanka, in order to do this poultry farm safety is very important.  As a beginner point we did some similar research using external sources .This analysis under the wild life intruder detection using only acoustic sensors.this is by Technical University of Cluj-Napoca, Faculty of Electronics, Telecommunications and Information Technology, Signal Processing Group, Str. Baritiu 26-28, RO-400027, Cluj-Napoca, Romania. They have developed systems to protect related to large wildlife regions such as forests, lakes,and other natural reservations. They take only the sounds and sensors, the sound by who, like humans, engines, birds and animals. They utilized this with low complexity and standard audio classification methods [1]. Another research was "Intruder Detection in Poultry Farms using Computer Vision Techniques" by Arun et al. (2018). This paper proposes a computer vision-based approach for intruder detection in poultry farms that uses background subtraction and object detection algorithms. The approach is shown to achieve high accuracy in detecting intruders while minimizing false alarms this basically is related to our research. What is done is they are taking two dimensional data for the detection voice plus video, and preprocessing data and getting real time output. They are using Yolo, we are expecting to use what giving most accurate framework and algorithm like SSD, R-CNN, CNN.

Dina Machuve and Ezinne Nwankwo are developing a Deep Convolutional Neural Network (CNN) model to detect poultry diseases by classifying healthy and unhealthy feces. The goal is to test the early detection of poultry diseases using deep learning techniques. Unhealthy stool patterns can be symptoms of coccidiosis, salmonella, and Newcastle disease. They used a total of 1,255 laboratory-labeled stool and feces samples, as well as 6,812 photographs of chicken feces, for polymerase chain reaction diagnosis and laboratory-labeled stool interpretation. They trained basic CNN models such as VGG16, InceptionV3, MobileNetV2, and Exception models using labeled farm and laboratory fecal images [3]. The aim of this research is Early Disease Detection using Machine Learning to detect diseases in laying hens. There are several steps to obtain quick solutions.

Poultry farming is an essential part of the agriculture industry and a major source of food for humans worldwide. The productivity of poultry farms is dependent on various factors, including the control conditions and the prediction of product outcomes. In recent years, there has been a growing interest in developing new algorithms to improve the productivity of poultry farms.One of the critical factors that affect the productivity of poultry farms is the control conditions. The control conditions in poultry farming include the temperature, humidity, lighting, and ventilation of the poultry house. These factors are crucial for the health and well-being of the birds, and they can significantly impact the productivity of the farm. Therefore, it is essential to maintain optimal control conditions to ensure maximum productivity.

In recent years, researchers have been using advanced technologies and algorithms to predict the product outcomes in poultry farming. The prediction of product outcomes is essential for the farmers to make informed decisions about the management and breeding of the birds. By predicting the product outcomes, farmers can identify the most productive birds and improve the overall productivity of the farm.

One of the advanced technologies used in predicting the product outcomes in poultry farming is the use of artificial intelligence (AI) and machine learning algorithms. AI algorithms can analyze large volumes of data collected from sensors and other monitoring devices in the poultry house. This data can include the feed consumption, and environmental conditions, among other factors.

The use of AI algorithms has been shown to improve the accuracy of predicting the product outcomes in poultry farming. For example, a study conducted by Miao et al. (2021) used a deep neural network algorithm to predict the weight of broiler chickens. The algorithm achieved an accuracy of 93.14%, which is higher than traditional statistical models.

Another study by Liu et al. (2020) used a machine learning algorithm to predict the egg production of laying hens. The algorithm achieved an accuracy of 95%, which is higher than traditional statistical models.

In conclusion, the control conditions and the prediction of product outcomes are critical factors that affect the productivity of poultry farms. Advanced technologies, such as AI and machine learning algorithms, can significantly improve the accuracy of predicting product outcomes in poultry farming. These technologies have the potential to revolutionize the poultry farming industry and increase productivity in a sustainable way.

Poultry farming is a sector that has been around since ancient times. In the past, these poultry farms were controlled by humans and nowadays, with the advancement of technology, the daily activities of the poultry farm are being automated. When the tasks of the chicken farm are done by humans, it requires a lot of labor cost and time. Therefore, investigations are being done since the past to solve this problem. (Smart Poultry Robot) The robot can also pick up and sort eggs without damaging them. An egg feature extraction method with automatic thresholding is employed to detect both white and brown eggs, and a behavior-based navigation method is applied to allow the robot to reach the eggs while avoiding obstacles. The robot can move towards the position of each egg via visual tracking. Once the egg is within the collection area of the robot, it is gathered, sorted and stored in the tank inside the robot. Experiments are carried out in an outdoor field of size 5 m×5 m under different climatic conditions, and the results showed that 5 m under different climatic conditions, and the results showed that the average egg recognition rate is between 94.7% and 97.6%.The robot can also Experiments have shown that this robot can retrieve at least four eggs. The probability of collecting more than four eggs is only 34%. The disadvantage of this robot is that when it is used continuously, its efficiency decreases and the chances of damaging the eggs increase. Also, as the farm area increases, it can be seen that it takes more time to collect eggs. The figure below shows the time taken to collect eggs as the area of the farm increases .The modern egg collection systems supplied by TEXHA will make poultry farming operations more efficient and profitable egg collection system operates on the level-by-level basis. The crosswise conveyor adjusted for specific battery level actuates the respective lengthwise belts, so the egg is transported to the conveyor. Then the egg moves along the inclined conveyor portion and arrives at the stacking table. When out of operation, the crosswise conveyor rests at the upper level in order to avoid interference with the personnel activities. The lengthwise belts may operate at different speed rates. The speed rate is selected by the poultry farm personnel depending on the egg-laying performance of the flock and

The crosswise conveyor utilization level. In order to prevent egg contamination during handling at the egg collection belt, the equipment incorporates a dedicated lengthwise belt cleaning brush with the waste container. The lift-based egg collection system may be integrated into the general egg-handling system of the poultry farm. This device consists of a helical spring. When rolling this spring over the floor, contact with an egg will open the spring and let the egg in. Collect-ed eggs can be unloaded to the side of the device, facilitated by the rotary movement of the spring. Design parameters were optimized.

# RESEARCH OBJECTIVES

Main objective of the poultry hub is to Develop and Design an intelligent System to increase and protect Egg productivity and minimize loss of egg and Prevention of egg shortage in Sri Lanka.

The Sub Objectives are as follows:

A. Identify and prevent intruders;

The poultry Hub system can identify whether the unauthorized animals are there or not there is any kind of harmful animal related to the poultry farm will be detected and prevented according to suitable manner.. in order to do this we are taking sample animal data.

B. Develop a model to detect early signs of diseases in egg-laying hens.

The objective of this research is to develop a machine learning model that can accurately detect early signs of diseases in egg-laying hens. The model should be able to identify the patterns and changes in the hens' behavior, egg-laying, and physiological characteristics that may indicate the onset of a disease.

C. Prediction and condition control required to maintain high egg production

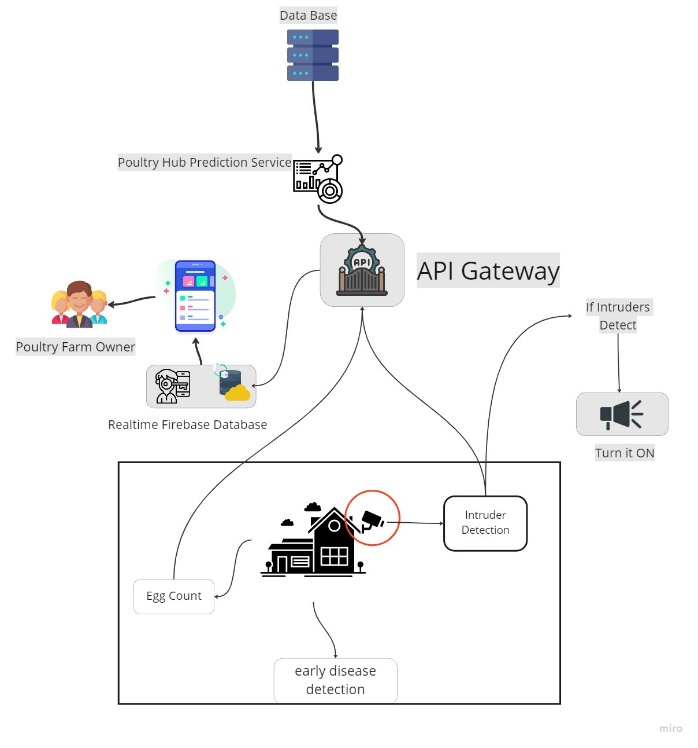
Developing a System to predict the product outcome and control conditions in the poultry farm to increase productivity by designing a new algorithm, and it’s going to be used to get the most accurate Date​.

D. Smart egg collecting and counting system using internet of things

The main object of this system is to facilitate the daily activities of the farm owner. This system automatically collects and counts the eggs and facilitates tracking the number of counted eggs through a mobile app. In addition, farmers can control the system remotely

# METHODOLOGY

Overall research contains a mobile application, and hardware device. Mobile applications support both android and iOS. Users can monitor poultry farm conditions in real time. The system has four services which are intruders identification and prevention system These are the services we are providing with our System. This system we are going to develop separately according to the microservice Architecture and in addition we are including more features for the mobile application like a Report Generation, if the situation happening wrong way some helps and suggestions service , managing log book for by counting day data details, and also the hardware devices connect with the mobile application an effective way then farm owner can get real time data within minimum delay. And these devices are used for various important tasks like identifying egg count, poultry farm environment.



Main objective of the poultry hub is to Develop and Design an intelligent System to increase and protect Egg productivity and minimize loss of egg and Prevention of egg shortage in Sri Lanka.

There is four component for a Poultry Hub System as follow:

1. Intruder Detection and prevention System to Ensure Safety of poultry Farm

To Detect intruders, such as Unauthorized animals related to Poultry farming the System is using data set web scraping plus own real captured images for a related farmhouse. And we are trained on that data set to achieve more comprehensive Accuracy for the identification. The data set includes only the unauthorized animals which are trying to harm poultry birds.

The main objective for this (a) is collecting video data and audio data from cameras and microphone sensors installed from the poultry farm, and we are taking that information and data then preprocessing and analyzing. After that this data to extract relevant features and evaluate the performance.

While System taking images sometimes it may take useless images and compare with the data set and it will take more time to identify and then the alarm system will be turned on like similar intruder objects but not a real one. To reduce these matters, we have to do data analysis. It is essential to do because when it is done we are able to reduce our dataset with useless data, then it performs fast and also it is a direct reason to increase accuracy of the model. For the data standardization we need to use Standard Scaler and manage.

When it comes to the classification the large data sets of label images are using Convolutional Neural Networks (CNNs) or R-CNN. This is an extension of CNN, or else we can get YOLO to real time object detection to detect and classify or else SSD - This is another real-time object detection system that uses a single deep neural network to detect and classify objects in an image at multiple scales and we are planning to take hi accuracy to object detection. For the deploy model we are using frameworks like TensorFlow and pytorch which are tested object detection models.

1. Early Disease Detection using Machine Learning

Early detection of diseases in laying hens is crucial to enable farmers to take appropriate measures to prevent the spread of the disease and minimize its impact on the health and welfare of the birds. This can help reduce mortality rates and prevent the spread of infectious diseases to other birds in the flock.

To achieve early disease detection, data can be collected from various sources, such as animal health records, production data on behavior, laying and physiological characteristics of laying hens, and several machine learning algorithms can be used, including logistic regression, decision trees, support vector machines, and neural networks.

1. Prediction and condition control required to maintain high egg production

Developing a system to predict the product outcome and control conditions in a poultry farm requires a structured methodology that encompasses the following steps:

**Define the problem**: The first step is to identify the problem that needs to be solved. In this case, the problem is to increase productivity in the poultry farm by predicting the product outcome and controlling the conditions.

**Gather data**: Data will be collected from the poultry farm using sensors to monitor the temperature, humidity, feed consumption, and other relevant parameters.

**Preprocess data**: Once the data is collected, it needs to be cleaned, filtered, and transformed into a usable format. This step involves removing any irrelevant or erroneous data and converting it into a suitable format for analysis.

**Feature engineering**: Feature engineering involves selecting the most relevant variables from the collected data that have the highest correlation with productivity. These variables could include temperature, humidity, feed consumption, lighting conditions, and other factors.

**Develop a predictive model**: The next step is to develop a predictive model that uses the selected variables to predict the product outcome and control conditions. This can be achieved using machine learning algorithms such as linear regression, decision trees, or neural networks.

**Train the model**: The predictive model needs to be trained using the historical data collected from the poultry farm. The model will learn from this data and identify patterns that can be used to make predictions.

**Evaluate the model**: The model needs to be evaluated using a test dataset to ensure that it is accurate and robust. This step involves comparing the predicted values to the actual values and calculating metrics such as mean squared error or R-squared.

**Implement the model**: Once the model is validated, it can be deployed in the poultry farm to make predictions and control conditions. The model will continuously collect data from the sensors and adjust the conditions to maintain high productivity. If the production goes low, the system will trigger an alert to change conditions to increase the production.

**Monitor and maintain the system**: Finally, the system needs to be monitored and maintained to ensure that it is functioning correctly. Regular checks need to be performed on the sensors and other hardware components to ensure that they are working correctly. Additionally, the model needs to be updated regularly to ensure that it is up-to-date with the latest data and changes in conditions.

Overall, the steps to developing this system are to identify the parameters that affect poultry productivity, install sensors to collect real-time data, store the data in a database, use data analytics and machine learning techniques to build a predictive model, integrate the model into the control system, and continuously monitor and collect new data to improve the system.

1. Automatic egg collection and counting system

The first step in developing the egg collecting and egg counting (IOT) device was to design the device.  The device is designed using a node MCU and two proximity sensors TCRC 1000 and IR sensor and a servo motor.  We have used a proximity sensor to detect the presence of eggs in the egg collection box.  Then the node MCU sent the data to the cloud client using Wi-fi module.  A conveyer belt was used to carry the eggs to the egg collection bin. A gear motor was used to operate this belt.  Eggs traveling along the belt are counted by a proximity sensor and sent to the mobile app.  The egg storage tank has the ability to store only Hike eggs at the same time.  After six eggs are added to the bowl, the conveyor belt will stop automatically.  A cloud server was developed to receive the data obtained by the sensor.  The cloud server receives the data from the system and stores it in a database.  A mobile application was developed to display the egg collection and counting data obtained by the device.  Mobile app developed using flutter.  In addition, the mobile application allows the farm owner to remotely control the egg collection and counting system and at the end of the day, the farm owner is able to know the total number of eggs collected.

# RESULTS AND DISCUSSION

Poultry farming is one of the most crucial sectors in the agriculture industry that contributes significantly to food security worldwide. However, there are several difficulties faced by poultry farmers that hinder the productivity and profitability of their farms. Some of these challenges include unauthorized animal intrusion, inaccurate data collection, and early detection of diseases in egg-laying hens. In this research, we propose an automatic solution to these challenges using image processing, machine learning, and the internet of things technology.

Unauthorized animal identification by image processing: Unauthorized animal intrusion into poultry farms is a significant challenge faced by poultry farmers. The animals not only disrupt the birds' feeding and resting patterns but also introduce diseases that can wipe out entire flocks. In this research, we propose an image processing solution that can detect and identify any unauthorized animal intrusions into the farm. The solution uses a camera system that captures images of any animal that tries to enter the farm, and then an algorithm is used to analyze the images and identify the intruder. Once the animal is identified, the system can trigger an alarm or activate deterrent devices to prevent the animal from entering the farm.

Developing a system to predict the product outcome and control conditions: Product outcome prediction and control conditions are crucial in poultry farming as they determine the productivity and profitability of the farm. In this research, we propose an algorithm that can predict the product outcome and control conditions in the poultry farm. The algorithm uses a combination of data from IoT sensors, weather forecast data, and historical data to predict the outcome of the products and control the conditions in the farm. The system can adjust the temperature, humidity, and ventilation in the farm to ensure optimal conditions for the birds' health and productivity. The algorithm can also predict the egg-laying patterns of the birds and trigger alerts when there are changes in the patterns.

 Automated and accurate product outcome and egg counting: Egg collecting, and counting is a critical aspect of poultry farming as it determines the productivity and profitability of the farm. With advancements in technology, an IoT device has been developed to automate this process, making it more efficient and reliable. The IoT egg-collecting device is equipped with sensors that can detect the presence of eggs and collect them automatically. The eggs are then safely stored in a designated compartment, eliminating the need for manual collection, which can be tedious and time-consuming. The device also has a counting feature that accurately tallies the number of eggs collected, making it easier for farmers to monitor egg production and adjust their operations accordingly. This information can be accessed remotely, providing real-time updates and insights into the productivity of the farm. The IoT egg-collecting device is an innovative solution that streamlines egg collection and counting, enhancing the efficiency and productivity of poultry farming. By reducing manual labor and increasing accuracy, farmers can focus on other critical aspects of their operations, leading to improved profitability and sustainability.

Machine learning model for early detection of diseases in egg-laying hens: Disease outbreaks in poultry farms can have devastating effects on the birds' health and productivity. Early detection of diseases is crucial in preventing disease outbreaks and reducing losses in the farm. In this research, we propose a machine learning model that can detect early signs of diseases in egg-laying hens. The model uses a combination of data from IoT sensors, image processing, and physiological characteristics to identify patterns and changes in the hens' behavior and egg-laying patterns that may indicate the onset of a disease. The system can trigger alerts to the farmer when there are anomalies in the hens' behavior or egg production, allowing prompt action to be taken to prevent the spread of the disease.

Conclusion: In conclusion, this research proposes an automatic solution to the challenges faced by poultry farmers using image processing, machine learning, and IoT technology. The proposed solutions can improve productivity, reduce losses, and enhance profitability in the poultry farm. The system can detect and identify unauthorized animal intrusions, predict product outcome, control conditions, automate data collection, and detect early signs of diseases in egg-laying hens. The proposed solutions can help poultry farmers streamline their daily tasks and optimize their operations, leading to increased productivity and profitability.

# CONCLUSION AND FUTURE RESEARCH

Finally, the IoT egg counting and collection devices developed by Smart Poultry Farm Research successfully present accurate and real-time data on egg production. Also, this has created a machine learning algorithm that predicts future egg production by analyzing past data. In addition, an image processing technology and diagnostic tool has been developed to detect poultry diseases and stray animals on the farm. Machine learning programs provide predictions of future egg output, enabling farmers to plan proactively. The use of smart poultry farming systems has shown encouraging results in increasing production, reducing labor costs and increasing overall farm efficiency. With accurate data on egg production from egg counting and egg counting equipment, farmers can allocate resources to each production and achieve more productive production. In addition, the machine learning program's intruder detection method helps keep predators out of the poultry farm. And the chance of loss of livestock is also reduced. Future research could focus on a number of issues, including:

1. Integration of more sensors and IoT devices: The smart farm system can be enhanced by incorporating more sensors and IoT devices such as temperature sensors, humidity sensors and air quality sensors to better understand the external and internal environment of the chickens. Producers are able to make and improve their quality of life.

2. Creating more sophisticated machine learning algorithms: The machine learning algorithms developed in this study can provide insights into future egg production, while examining data from multiple sensors to create more sophisticated algorithms to make more accurate predictions.

3. Designing more sophisticated image processing methods: In order to more accurately diagnose and treat poultry diseases, the image processing method developed in this study can be improved by integrating more sophisticated algorithms such as deep learning.

##### References

[1] Audio Analysis for Intruder Detection in Wildlife Reserves" by Loh et al. (2017). This paper presents an audio analysis approach for intruder detection in wildlife reserves that combines acoustic and visual features using machine learning algorithms. The approach is shown to outperform unimodal approaches in detecting intruders.

[2] Intruder Detection in Poultry Farms using Computer Vision Techniques" by Arun et al. (2018). This paper proposes a computer vision-based approach for intruder detection in poultry farms that uses background subtraction and object detection algorithms. The approach is shown to achieve high accuracy in detecting intruders while minimizing false alarms.

[3] Dina Machuve1, Ezinne Nwankwo, Neema Mduma and Jimmy Mbelwa, Poultry diseases diagnostics models using deep learning,

<https://www.frontiersin.org/articles/10.3389/frai.2022.733345/full>

[4] Yangyang Guo ,Samuel E. Aggrey ,Peng Wang ,Adelumola Oladeinde, andLilong Chai , Monitoring Behaviors of Broiler Chickens at Different Ages with Deep Learning <https://www.mdpi.com/2076-2615/12/23/3390>

[5] Circulation, and More. [online] WebMD. Available at: https://www.webmd.com/heart/anatomypicture-of-blood#1 [Accessed 20 Feb. 2020].

[6] .P. Jacob, H. W. (2019). How Long Do Chickens Lay Eggs? Goals for Laying Hens . actors Affecting

Egg Production in Backyard Chicken Flocks, <http://edis.ifas.ufl.edu/ps029>.

[7] Development and Performance of a Mechanical Egg Collection System Versus the Hand-Operated

Dutch Nest. (2015, Oct-Dec ). p.

https://www.scielo.br/j/rbca/a/jbrfyjGxLy84T7wvtXBw9rq/?lang=en.

Chung-Liang Chang, B.-X. X. (November 2020). Visual Guidance and Egg Collection Scheme for a

Smart Poultry Robot for Free-Range Farms.

[8].https://www.researchgate.net/publication/347798002\_Visual\_Guidance\_and\_Egg\_Collection\_Scheme