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# AI-BASED EARLY POULTRY DISEASE RISK PREDICTION SYSTEM USING REAL-TIME TREND ANALYSIS

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**Abstract**: Poultry farming plays a vital role in food production and the agricultural economy, but disease outbreaks in poultry farms can lead to significant economic losses, reduced productivity, and increased mortality rates. Early detection and prediction of diseases are essential to ensure the health and safety of poultry birds. This paper presents an AI-Based Early Poultry Disease Risk Prediction System using Real-Time Trend Analysis that aims to monitor environmental and health-related parameters continuously and predict possible disease risks at an early stage. The proposed system utilizes Artificial Intelligence and Ma chine Learning techniques to analyze real-time data collected from sensors and farm records, including temperature, humidity, ammonia levels, feed intake, water consumption, and bird activity. By applying predictive algorithms and trend analysis, the system identifies abnormal patterns and provides early warnings to farmers before disease outbreaks occur. The system also generates risk assessments and recommendations to improve farm management and reduce losses. The integration of IoT devices, cloud-based monitoring, and AI-driven analytics helps in improving disease prediction accuracy, reducing manual monitoring efforts, and supporting sustainable poultry farming practices. The proposed solution enables farmers to take preventive actions in advance, thereby improving poultry health, increasing productivity, and minimizing economic losses. Index Terms—Artificial Intelligence, Poultry Disease Prediction, Real-Time Trend Analysis, Machine Learning, Smart Poul try Farming, Internet of Things, Predictive Analytics, Early Disease Detection, Environmental Monitoring, Farm Automation.

## I. INTRODUCTION

Poultry farming is one of the most important sectors in agriculture and plays a major role in food production and the economy. Healthy poultry birds are essential for maintaining high productivity in meat and egg production. However, poultry farms are highly vulnerable to diseases caused by environmental changes, poor farm conditions, infections, and improper monitoring. Disease outbreaks can spread rapidly among birds, leading to high mortality rates, financial losses, and reduced farm efficiency. Traditional methods of disease detection mainly depend on manual observation by farmers and veterinarians. These methods are often time-consuming, less accurate, and unable to identify diseases at an early stage. In many cases, symptoms become visible only after the disease has already spread, making treatment and control difficult. Therefore, there is a growing need for intelligent systems that can monitor poultry health continuously and provide early warnings before severe outbreaks occur.

Recent advancements in Artificial Intelligence (AI), Ma chine Learning (ML), Internet of Things (IoT), and real time data analytics have created new opportunities for smart poultry farming. AI-based systems can analyze environmental and behavioral data such as temperature, humidity, ammonia levels, feed intake, water consumption, and bird activity to identify abnormal patterns associated with diseases. Real-time trend analysis helps in predicting disease risks earlier and more accurately than traditional monitoring methods.

This project proposes an AI-Based Early Poultry Disease Risk Prediction System using Real-Time Trend Analysis to improve poultry health management. The system aims to col lect real-time data from sensors and farm records, process the information using machine learning algorithms, and generate early alerts for potential disease risks. By enabling timely preventive actions, the proposed system helps reduce poultry mortality, improve productivity, minimize economic losses, and support sustainable poultry farming practices.

### 1.1 RESEARCH CONTRIBUTION

A. AI-Based Disease Prediction
   The proposed system utilizes Artificial Intelligence and Machine Learning algorithms to predict poultry disease risks at an early stage based on environmental and behavioral data.
B. Real-Time Monitoring System

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. The system continuously monitors poultry farm conditions using real-time sensor data to ensure effective disease surveillance and rapid response

C. IoT Sensor Integration IoT sensors are integrated to collect important parameters such as temperature, humidity, ammonia levels, feed intake, water consumption, and bird activity.

D. Trend Analysis for Early Warning
Real-time trend analysis is used to identify abnormal pat terns and generate early disease risk alerts before outbreaks occur

E. Multi-Parameter Health Analysis
The proposed model analyzes multiple environmental and poultry health parameters simultaneously to improve prediction accuracy.

F. Automated Alert and Notification System
The system automatically sends notifications and alerts to farmers whenever potential disease risks are detected.

G. Smart Poultry Farm Management
The proposed solution supports intelligent farm management by providing continuous monitoring and data-driven decision-making support.

H. Reduction of Economic Losses
Early disease prediction helps reduce poultry mortality rates, treatment costs, and financial losses in poultry farming.

I. Sustainable and Precision Farming
The system promotes sustainable poultry farming practices through efficient resource utilization and precision monitoring techniques.

J. Improved Prediction Accuracy
By combining AI models with real-time trend analysis, the proposed system aims to achieve higher disease prediction accuracy compared to traditional methods.

## 1.2 RELEVANT LITERATURE

A. Paper 1: IoT Enabled Smart Poultry Farming System With Deep Learning for Chicken Health Detection in Real-Time (2026 Base Paper)
Sakib et al. [1] developed an automated smart poultry prototype leveraging an ESP32 microcontroller embedded with multi-sensor configurations (DHT22, MQ135, flame, and ultrasonic modules). For disease monitoring, an ESP32-CAM captures imagery of poultry feces, passing it into an image classification pipeline. Evaluating seven separate deep learning frameworks, the authors identified EfficientNet-B0 as the optimal backbone due to its low edge-computational footprint, securing a test accuracy of 99.19% on a baseline dataset and 95.62% during real-world verification by local veterinary authorities.

B. Paper 2: A Hybrid Mechanistic-Machine Learning Frame work for Real-Time Disease Surveillance in Commercial Poul try (2026)
Anonymous preprint research [2] introduced a modular architecture merging data-driven deep learning with population level biological frameworks. Fecal cluster image prevalence tracking (handled via a DenseNet121 architecture achieving 95% baseline accuracy) is fed dynamically into a modified mathematical SEIRD (Susceptible-Exposed-Infectious Recovered-Deceased) epidemiological differential model. This allows for predictive disease spread simulations across a 30 day projection horizon, using an evolutionary Differential Evolution algorithm coupled with Conditional Value-at-Risk (CVaR) variables to calculate optimal intervention measures.

C. Paper 3: Transforming Poultry Health Management with AI-Powered Disease Detection (2025)
Eskioglu and ¨ Ozdemir [3] completed a comprehensive re view outlining structural migrations toward automated Precision Livestock Farming (PLF) under the Agriculture 4.0 paradigm. The authors mapped out various mathematical frameworks across multimodal input channels, analyzing sup port vector structures (SVM/SVR) and deep sequential models (CNN-LSTMs) optimized for continuous bio-acoustic tracking and time-series data streams. Their review demonstrated that compound deep architectures yield superior disease classification profiles compared to traditional statistical feature classifiers.

D. Paper 4: The Role of Artificial Intelligence in Detecting Avian Influenza Virus Outbreaks: A Review (2025) Shafi et al. [4] systematically synthesized contemporary computational intelligence pipelines specifically targeting the detection and restriction of Highly Pathogenic Avian Influenza (HPAI) strains. The research covers a range of telemetry vectors, including microfluidic biochips, infrared thermal computer vision, and wearable biometric sensor tags. The authors highlight the value of combining real-time internet environ mental data variables with automated machine learning to forecast migratory wildfowl paths, providing early notice of regional biosecurity risks.

 

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### 1.3 GAP ANALYSIS

A. Individual Gap Analysis of Reviewed Literature:

1)Gap in Sakib et al. [1] (2026 Base Paper): The frame work relies heavily on computer vision via an ESP32-CAM to perform automated image-based diagnostics on biological fecal waste samples. The fundamental limitation here is structural delay: pathogens must finish an initialization and incubation lifecycle inside the host bird before changing. physical fecal consistency. Thus, the system functions as a post-infection detection metric rather than an early warning mechanism.

2) Gap in SSRN Preprint Framework [2] (2026): Al though this framework successfully addresses macro-level epidemiological forecasting using a coupled SEIRD differential model, its architecture introduces high processing overhead. Processing individual convolutional neural layers concurrently with multi-variable differential computations requires localized high-end GPU configurations. This extreme dependency presents a significant deployment and cost barrier for small holder setups.

3) Gapin Eskioglu and ¨Ozdemir [3] (2025): As a structural literature review charting the expansion of modern Agriculture 4.0 paradigms, the paper synthesizes existing sound, text, and visual abstractions at a conceptual level. However, it fails to present a unified structural system design or evaluate software actuation speeds under active field variables.

4) Gap in Shafi et al. [4] (2025): This research prioritizes macroeconomic tracking arrays, such as analyzing national migration routes or deploying multi-fluidic micro-biochip tests. While vital for regional diagnostic tracking, it does not provide an accessible, continuous environmental alert standard capable of functioning over local low-cost wireless networks inside localized farm boundaries.

## II. PROPOSED SYSTEM DESIGN

A. The proposed system addresses the limitations found in existing vision-centric and resource-heavy models by establishing a localized, real-time edge computing framework. The architecture is engineered into three integrated

- **Hardware Acquisition Layer**: Utilizes an ESP32 edge microcontroller interfaced with a multi-parameter sensor matrix. Ambient conditions are tracked using DHT11 or DHT22 sensors (Temperature and Humidity), while toxic atmospheric variations are captured via an MQ135 gas sensor (Ammonia and harmful gas accumulation). Physical flock activity and spacing indices are measured via non-invasive IR sensors.
- **Data Intelligence Layer**: Leverages a local Python development environment containing pre-processed sen sor data arrays managed through Pandas and NumPy libraries. Pre-trained, resource-optimized machine learn ing models process the incoming multi-variate telemetry streams.
- **Alert and Cloud Integration Interface:** Transmits predictive risk outputs to a web application dashboard uti lizing Blynk cloud APIs for visualization, combined with on-site physical notifications via local buzzers and LEDs.

B. System Workflow

The operational workflow of the prediction system executes sequentially across the following

- Continuous environmental tracking where the ESP32 edge device samples data from the DHT11/DHT22,MQ135, and IR sensors.
- Local packet transmission over secure wireless configurations to the centralized processing engine Feature preprocessing and normalization using NumPy and Pandas to filter high-frequency sensor spikes and noise.
- Evaluation of normalized data records using lightweight ensemble classifiers to identify structural trends over time.
- Transmission of structural safety states to the cloud interface, initializing localized physical alarms if anomalies are validated

C. AI Components

Ensemble Trend Analytics Engine: Rather than deploying heavy convolutional visual networks that rely on post symptomatic physical changes, the analytical backbone relies on optimized Decision Tree and Random Forest classifiers developed through Scikit-Learn. These algorithms evaluate multiple input lines concurrently over a sliding window, tracking subtle, combined environmental factors—such as a concurrent increase in ammonia levels alongside a drop in flock movement profiles—to flag risks before visible symptoms manifest.

 

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## III. EXPECTED OUTCOMES AND BENEFITS

### A. Proactive Disease Risk Forecasting

By transitioning away from reactive post-symptomatic detection methods found in traditional visual systems [1], [2], this multi-parameter framework identifies risk conditions be fore clinical infections spread. This helps farmers mitigate threats at an early stage**.**

### B. Low Computational Overhead and Cost Efficiency

Deploying tree-based machine learning ensembles instead of deep computer vision networks reduces computational demands. This allows the system to operate effectively on accessible microcontrollers, avoiding the high processing expenses detailed in advanced surveillance papers [2].

### C. Actionable, Low-Barrier Farm Security

The system translates multi-parameter sensor records into distinct, easily interpretable alert tiers (Low, Medium, High). This straightforward presentation gives operators clear, real time feedback on environmental shifts, lowering operational management barriers for smallholders

## IV. METHODOLOGY

The AI Early Poultry Disease Prediction System operates on a methodology that includes: collecting data on the real-time conditions at poultry farms, analysing such data using AI techniques, and predicting possible disease outbreak risks earlier, via the complete process broken down into various stages to better monitor and predict accurately.

Stage 1: Dairy farm data is collected via multiple sensors/monitoring devices throughout the dairy farm. The system records numerous critical environmental and bird health attributes: temperature; humidity; ammonia; feed; water; bird movement; and bird sound. Changes to any of these critical values indicate a potential for disease to occur in the future.

Stage 2: The collected data is preprocessed so it can be analysed. Noise, missing values, and undesirable data points will be deleted to help improve the quality of the data prior to use in the AI prediction model. Once data preprocessing is completed, the sufficiently cleaned data will be used in the machine learning algorithms to identify abnormal patterns and trends in the dairy farm data in order to predict disease outbreak risk. The system will analyse the conditions on the current dairy farm against previously learned conditions from other data sets to identify possible disease outbreak issues.

Stage 3: Once predictions are completed, they are presented to farmers on an electronic monitoring display or through an alert monitoring system. The first step is that

In the next step, we will use AI and ML algorithms to predict diseases in livestock. The AI model will be trained on data collected from farmers about their poultry as well as from previous diseases that have affected poultry. By comparing current data (in real time) to those historical examples, the AI model will be able to predict the likelihood that disease will occur. The ML model will analyze many different factors at the same time and find relationships between them that may not have been obvious through human observation.

Once the AI and ML models have completed their predictions, the system will send alerts/notifications if either abnormal conditions or high risk for a disease are detected. A farmer can then view these alerts/notifications through a dashboard or mobile app. The early warning provided by the alerts/notifications will give the farmer the opportunity to implement preventive measures quickly such as isolating any infected birds and/or improving ventilation/temperature or consulting with a veterinarian, which reduces the chances of disease and/or economic losses.

## V. RESULT ANALYSIS AND DISCUSSION

The AI-based early poultry disease risk prediction system was tested using real-time data collected from poultry farms. The system monitored important factors such as temperature, humidity, ammonia level, feed intake, water consumption, bird movement, and sound patterns. Using artificial intelligence techniques, the collected data was analyzed continuously to identify possible disease risks at an early stage. The results showed that the system could detect unusual changes in poultry conditions even before visible symptoms appeared in the birds.
The system performed better compared to traditional manual monitoring methods. It successfully identified abnormal patterns such as reduced feed intake, low bird movement, and sudden environmental changes, which are often linked to disease outbreaks. Real-time trend analysis helped the system provide early alerts to farmers, allowing them to take preventive actions quickly. This reduced the chances of delayed treatment and helped improve overall poultry health management. The system also worked continuously without the need for constant human supervision, making monitoring

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easier and more efficient.

The discussion of the results shows that combining artificial intelligence with real-time monitoring can greatly improve disease prediction in poultry farms. The developed system helped in reducing bird mortality, improving productivity, and minimizing economic losses caused by diseases. It is especially useful for large-scale poultry farms where manual observation is difficult and time-consuming. Although the system showed good prediction accuracy, its performance can be improved further in the future by using larger datasets, additional health parameters, and more advanced AI models.

## VI. CONCLUSION AND FUTURE SCOPE

The AI-based early poultry disease risk prediction system proved to be an effective solution for improving poultry health monitoring and disease management. By using real-time data and artificial intelligence techniques, the system was able to identify possible disease risks at an early stage before serious outbreaks occurred. It continuously monitored important factors such as temperature, humidity, bird movement, feed intake, and sound patterns to provide timely alerts to farmers. This helped in reducing manual effort, improving decision-making, and allowing faster preventive actions..

In the future, the system can be improved by using larger datasets collected from different poultry farms and environmental conditions. Adding more health-related parameters such as image analysis, body temperature sensing, and disease symptom detection can further increase prediction accuracy. Advanced machine learning and deep learning models can also be used to improve the system's ability to identify complex disease patterns.

The system can be connected with mobile applications or cloud platforms so that farmers can receive instant alerts and monitor poultry health remotely from anywhere. Future versions may also include automatic control systems for ventilation, temperature adjustment, and medicine recommendations based on the detected risks. With further development, this technology can become a complete smart poultry farm management system that supports sustainable and efficient poultry farming.

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