DESIGN OF INTELLIGENT SERICULTURE MANAGEMENT SYSTEM BASED ON AI

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ABSTRACT:

Sericulture is a vital agro-based industry that requires precise monitoring and management to ensure high-quality silk production. Traditional methods face challenges such as disease outbreaks, inefficient environmental control and suboptimal resource utilization. This paper proposes an AI-driven intelligent sericulture management system that integrates machine learning, IoT and computer vision to enhance efficiency and productivity. AI-based image recognition is employed for real-time detection of silkworm diseases, reducing losses and improving silk quality. IoT-enabled sensors continuously monitor environmental parameters such as temperature, humidity and air quality, ensuring optimal growth conditions. A cloud-based decision support system processes collected data and provides actionable insights for effective decision-making. The system enables early disease detection, automated environmental regulation, and resource optimization, leading to improved production outcomes. Experimental results demonstrate significant improvements in disease detection accuracy, environmental stability and operational efficiency. This intelligent sericulture management system offers a scalable, cost-effective and sustainable approach to modern silk farming.

KEYWORDS: Sericulture, Artificial Intelligence, IoT, Machine Learning, Computer Vision, Precision Agriculture, Smart Farming, Silkworm Health Monitoring

I. INTRODUCTION

Sericulture, the practice of cultivating silkworms for silk production, is a significant agro-based industry that supports rural livelihoods and contributes to the textile sector. The quality and quantity of silk depend on various factors, including environmental conditions, disease prevention, and proper nutrition. Traditional sericulture management relies heavily on manual labor and experience-based decision-making, which often leads to inefficiencies, high production costs and increased vulnerability to diseases. One of the major challenges in sericulture is early disease detection, as silkworms are highly sensitive to infections and environmental fluctuations. Diseases such as flacherie, grasserie and muscardine can cause significant losses if not identified and controlled in time.

Additionally, maintaining optimal temperature, humidity and air quality is crucial for silkworm growth, yet manual monitoring of these parameters is prone to errors and inconsistencies. To address these challenges, the integration of Artificial Intelligence (AI), Internet of Things (IoT) and computer vision offers a revolutionary approach to sericulture management. AI-driven systems can enhance decision-making by automating disease detection through image recognition and deep learning models. IoT-enabled sensors can monitor environmental conditions in real time, ensuring a stable and optimal habitat for silkworms. The collected data can be processed using cloud-based analytics, providing farmers with actionable insights and recommendations.

This intelligent sericulture management system aims to improve productivity, minimize losses and optimize resource utilization. By leveraging AI and IoT, farmers can make informed decisions, automate routine processes and achieve higher silk yields with improved quality. Furthermore, the

system promotes sustainability by reducing dependence on chemical treatments and minimizing wastage. In this paper, we explore the design and implementation of an AI-powered sericulture management system, detailing its components, functionalities and potential benefits. This study highlights how smart sericulture can transform traditional farming practices into a technology-driven, efficient and sustainable model for silk production.

II. MATERIALS AND METHODS:

1. Existing method

Traditional sericulture management relies on manual monitoring and experience-based decision-making, which is time-consuming and prone to errors. Farmers inspect silkworms visually for signs of disease, but early detection is difficult, leading to potential losses. Environmental conditions such as temperature, humidity, and air quality are measured using basic instruments, requiring frequent human intervention. To prevent diseases, farmers often rely on chemical treatments and antibiotics, which can affect silk quality and sustainability. Record-keeping is typically done manually, making it challenging to track silkworm health trends over time. Additionally, data on environmental factors and silkworm growth is not systematically analyzed, limiting the ability to make data-driven decisions.

Some recent advancements include semi-automated sensor-based monitoring for environmental control, but these systems often lack integration with AI for predictive analysis. Mobile applications provide basic advisory services, but they depend on manual data entry and lack real-time processing capabilities. Machine learning and computer vision applications are still in early experimental stages, with limited deployment in real-world sericulture farms. Overall, existing methods are labor-intensive, less accurate, and reactive rather than proactive, highlighting the need for an AI-driven intelligent sericulture management system that automates monitoring, analysis, and decision-making for improved efficiency and sustainability.

2. Proposed System

The proposed intelligent sericulture management system integrates Artificial Intelligence (AI), Internet of Things (IoT), and computer vision to enhance silk production efficiency. It automates disease detection using AI-based image recognition, enabling early identification of infections like flacherie and muscardine. IoT sensors continuously monitor environmental parameters such as temperature, humidity, and air quality, ensuring optimal conditions for silkworm growth. A cloud-based decision support system collects and analyzes real-time data, providing farmers with actionable insights and recommendations. Machine learning models process historical and real-time data to predict disease outbreaks and optimize resource utilization. Automated alerts notify farmers of unfavorable conditions, reducing manual intervention and improving response times. The system also includes a mobile and web-based dashboard for remote monitoring and control, making sericulture management more accessible and efficient. By integrating AI and IoT, the proposed system minimizes losses, enhances silk quality, and promotes sustainable farming practices. This approach transforms traditional sericulture into a data-driven, intelligent, and automated process, ensuring higher productivity and profitability.

3. Methodology

The methodology for designing an intelligent sericulture management system based on artificial intelligence (AI) comprises four essential components: data collection and IoT integration, AI-based disease detection and analysis, a cloud-based decision support system, and a user-friendly interface with automation. Each component plays a significant role in enhancing the efficiency, accuracy and reliability of sericulture practices, ultimately leading to improved silk production and disease management.

i. Data Collection and IoT Integration

Effective monitoring of environmental conditions and silkworm health is fundamental to an intelligent sericulture management system. Internet of Things (IoT) sensors are strategically deployed within the rearing environment to continuously track vital parameters such as temperature, humidity, CO_2 levels, and light intensity, all of which significantly impact silkworm growth and disease susceptibility. Additionally, high-resolution cameras capture real-time images of silkworms, facilitating visual analysis of their health and development. The collected data is transmitted securely to a cloud-based database, where it is stored and processed for further analysis. By leveraging IoT and cloud computing, this system ensures a seamless and automated approach to data acquisition, reducing manual effort while enhancing monitoring precision.

ii. AI-Based Disease Detection and Analysis

Disease management is a critical aspect of sericulture, as infections such as flacherie, muscardine and grasserie can severely impact silk yield and quality. To address this challenge, AI-powered machine learning and computer vision algorithms are employed to analyze silkworm images and identify disease symptoms at an early stage. The AI models are trained using comprehensive datasets containing images of both healthy and diseased silkworms, enabling them to recognize visual patterns associated with infections. With continuous learning and model updates, the system improves its detection accuracy over time, adapting to emerging disease variations. Early diagnosis allows farmers to implement timely interventions, reducing losses and ensuring better silkworm health.

iii. Cloud-Based Decision Support System

A cloud-integrated decision support system processes real-time and historical data using AI-driven analytics. This component plays a crucial role in providing predictive insights and actionable recommendations. Advanced algorithms analyze environmental conditions, silkworm behavior and disease trends to predict potential disease outbreaks before they occur. Farmers receive automated suggestions on necessary preventive measures, such as adjusting temperature and humidity levels or administering appropriate treatments. The cloud infrastructure ensures that all computations and analyses are performed efficiently, making the system accessible and scalable for sericulture farms of varying sizes. By integrating predictive modeling with real-time monitoring, this system enhances decision-making, minimizes risks and optimizes the overall productivity of sericulture operations.

iv. User Interface and Automation

A user-friendly interface serves as the bridge between farmers and the intelligent sericulture system, providing an intuitive and accessible platform for monitoring and control. This component includes both mobile and web-based dashboards, enabling farmers to access real-time data, disease alerts and environmental conditions from anywhere. Automated notifications inform users of potential threats, allowing for immediate intervention. Furthermore, smart control mechanisms are integrated into the system to autonomously regulate environmental conditions. For instance, if the temperature exceeds optimal limits, the system can automatically activate cooling mechanisms or ventilation controls. By

reducing the need for constant manual supervision, automation enhances operational efficiency, ensures optimal conditions for silkworm rearing, and ultimately contributes to higher silk production yields.

4. Proposed Flow Diagram

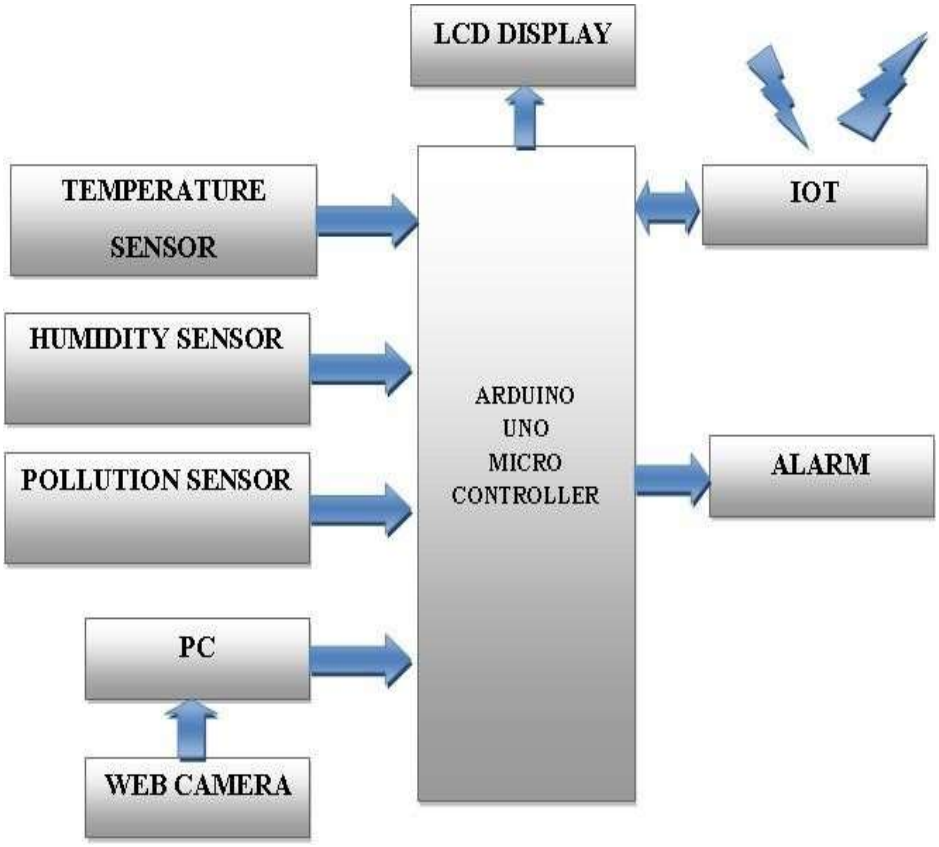

Figure 2.1 Flow diagram

III. SIMULATION OUTPUT

The simulation setup for the intelligent sericulture management system based on AI focuses on modeling and validating the system in a controlled virtual environment. AI algorithms, such as machine learning models (e.g., Decision Trees, Neural Networks, and Support Vector Machines), are developed and tested using synthetic and historical sericulture data. Parameters like temperature, humidity, light intensity, silkworm growth stages and disease patterns are simulated using software tools such as MATLAB, Python (TensorFlow, Keras), and IoT simulators like Simulink. These tools allow the testing of AI predictions for optimal environmental conditions, disease detection and resource allocation. The simulation enables the identification of potential challenges in real-world applications, providing a robust framework for validating the accuracy.

The experimental setup involves deploying the AI based system in a real sericulture environment to monitor its performance under practical conditions. A controlled farm is equipped with hardware components such as environmental sensors (for temperature, humidity and CO_2 levels), soil moisture sensors and cameras for image-based silkworm and mulberry crop health monitoring. IoT

devices are employed to collect real-time data, which is processed by AI algorithms deployed on cloud-based or edge computing systems. Actuators, such as automated fans, heaters and irrigation systems, respond dynamically to AI recommendations, ensuring optimal rearing conditions. The system's effectiveness is evaluated by comparing its predictions and decisions against expert assessments, measuring improvements in silkworm yield, disease prevention and resource optimization.

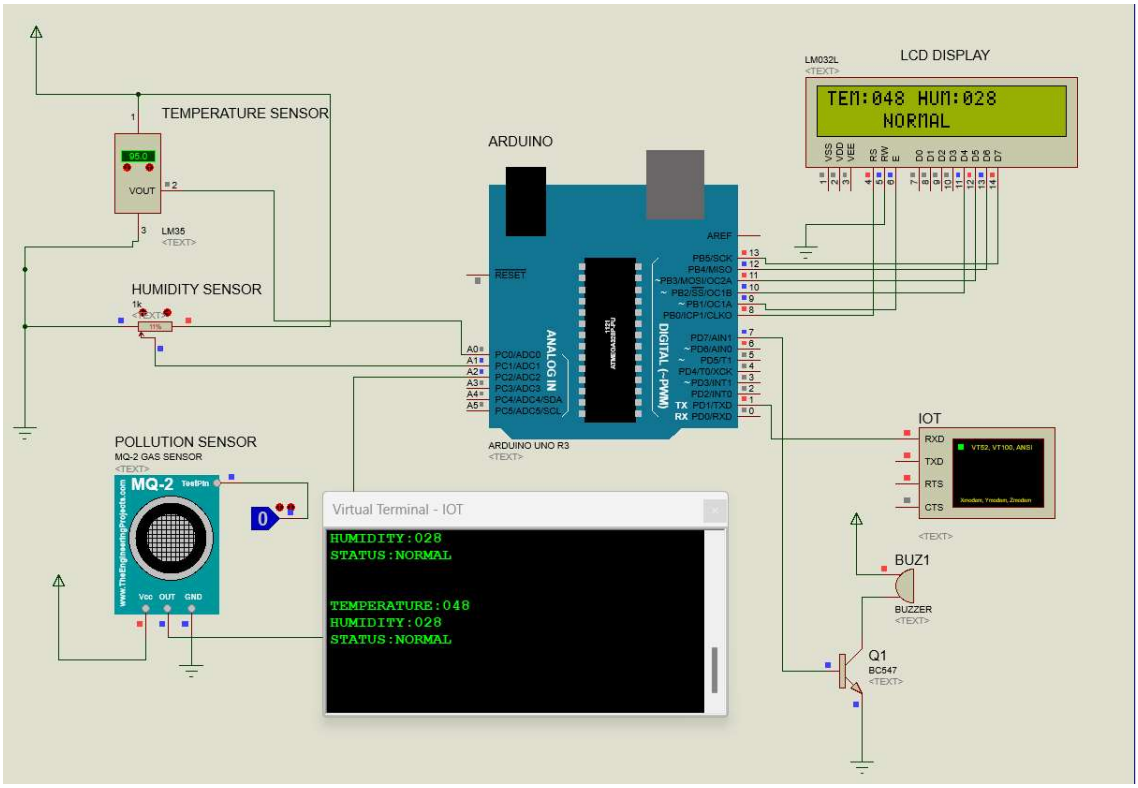

Figure 3.1 Simulation output

IV. RESULT AND DISCUSSION

The AI-powered sericulture management system plays a crucial role in continuously monitoring and optimizing the rearing environment for silkworms. By leveraging IoT sensors and intelligent algorithms, the system tracks essential environmental parameters such as temperature, humidity, CO_2 levels, and light intensity. Based on the collected data, AI-driven automation ensures that these conditions remain within optimal ranges, fostering healthy silkworm growth and improving silk production efficiency. By maintaining an ideal rearing environment, the system helps maximize silk yields, minimize waste, and significantly reduce the need for manual intervention, thereby lowering labor costs and improving overall farm productivity. Early warnings enable farmers to take timely preventive measures, reducing the spread of diseases and improving silkworm survival rates. This proactive approach not only enhances the overall health of silkworms but also ensures superior silk quality, leading to increased profitability for farmers. As AI continues to evolve, its role in sericulture will expand further, integrating predictive analytics, precision farming techniques, and automated decision-making to create a more sustainable and efficient silk production industry.

V. CONCLUSION

It demonstrates significant potential to modernize and enhance silk farming practices. By integrating advanced technologies such as machine learning, IoT and data analytics, the system optimizes key parameters like temperature, humidity, and silkworm health, ensuring ideal rearing conditions. AI-driven tools enable real-time monitoring, early detection of diseases and accurate predictions, thereby reducing risks and improving productivity. The use of automated decision-making processes helps farmers make informed choices regarding resource allocation, crop management and harvesting schedules. Simulation and experimental validation confirm the system's reliability, accuracy and practical effectiveness in improving silk yield and quality. Furthermore, the system promotes sustainable farming by minimizing resource wastage and labor requirements. It bridges the technological gap in traditional sericulture, empowering farmers with precision and efficiency. The intelligent management system not only enhances profitability but also ensures consistent production, meeting growing demands for silk. Overall, AI-based solutions have the potential to transform sericulture into a modern, data-driven, and sustainable agricultural practice.

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