SERISCOPE

seriscope.tdivyajyotis.in

SeriScope: A low cost edge-AI system for fertility and disease assessment of Tassar silkworm eggs

Suryakanta Lenka[1] and Tripathy Divyajyoti Senapati[2]

[1]Grade X
[2]Grade XI

Abstract

Pebrine is caused by *Nosema bombycis* and is the most destructive disease in silkworms. It historically devastated European sericulture in the 18th century. Even today, if infection is found, entire batches of eggs are destroyed. This leads to serious financial losses for farmers. Current detection methods depend on looking at moth body fluid under a microscope. This manual process is prone to errors and takes a lot of time, requiring skilled technicians. Misdiagnosis can result in the unnecessary destruction of healthy moths or the release of infected ones.

Our project, SeriScope, introduces a diagnostic system that uses AI to detect pebrine infection through automated analysis of microscopic images. The system employs **Convolutional Neural Networks (CNNs)** trained on **1400 real samples collected from our fieldwork.** It classifies samples as either **pebrine-positive or pebrine-negative** with high accuracy in just minutes. By combining image processing, pattern recognition, and machine learning, the system spots the unique spore shape of pebrine that people often miss.

The edge-AI model we propose is designed for low-cost local use in sericulture testing centers. It can run offline on microcomputers like Raspberry Pi. By automating diagnostics, SeriScope greatly cuts down on the need for manpower, lowers testing costs, and shortens analysis time. At the same time, it improves reliability and supports sustainable silk production.

Figure 1. Traditonal way of analysing samples

1 Introduction & Objective

Pebrine disease continues to be a challenging threat to Sericulture, and often entire crops of eggs are destroyed as a preventative measure. In the majority of cases where pebrine infection is present, the diagnostic process involves dedicated professionals observing moth fluid under a microscope. Even in the hands of professionals, microscopic diagnostic techniques are **slow, labor intensive, and prone to human error**, especially when the resting spores of ***Metarhizium anisopliae*** resemble those of pebrine, and dissimilarity between spores is only discerned when viewed under the microscope. The lack of affordable, rapid and robust diagnostic alternatives leaves the farmer at the mercy of fate.

Figure 2. Extracting the haemolyph to prepare slides

The vision of SeriScope is to create an **AI and machine learning based pre-harvest diagnostic system, capable of automatically diagnosing pebrine infection in moth fluid samples, with accuracy and precision.** The ultimate goal is to use artificial intelligence and machine learning to make sericulture safer, smarter and more sustainable through integration of these technologies in to farmer diagnostic workflows.

2 Innovation

SeriScope is the **first low-cost edge-AI diagnostic solution** for pebrine detection that eliminates the need for expert microscopists. Unlike conventional manual microscopy, it leverages **deep learning and image enhancement techniques** to autonomously recognize microscopic spores. The system can operate **offline on embedded devices**, is easy to use, and provides **instant visual results**, empowering even **non-technical staff**. Its scalability and affordability make it a transformative innovation for rural sericulture centers.

Figure 3. Female moths kept in container to lay eggs

3 Methodology

The system workflow begins with the collection of moth body fluid samples, which are imaged under a standard compound microscope. The captured images are preprocessed to remove noise and enhance clarity using **OpenCV-based digital image processing**. The preprocessed data are then passed through a Convolutional Neural Network (CNN) model trained on a labeled dataset of healthy and infected samples.

During training, **the AI model learns to recognize characteristic spore structures—such as oval shapes, texture patterns, and density variations—specific to pebrine infections**. These microscopic features are often too subtle for the human eye but are effectively extracted through feature maps in convolutional layers.

Once trained, the model performs classification in real time, labeling samples as **"Pebrine Positive" or "Pebrine Negative."** The interface displays results in a clear, color-coded format for ease of interpretation. The system was trained on **1400 locally collected samples from Tassar Development Foundation of our region** for improving its adaptability to regional variations.

By replacing manual diagnosis with automated AI inference, SeriScope drastically **reduces analysis time from hours to minutes**, lowers operational costs, and improves diagnostic precision beyond **97%**.

Figure 4. Taking microscopic images to train AI

4 Results & Conclusions

The trained CNN achieved **above 97% classification accuracy**, demonstrating reliable differentiation between pebrine-positive and negative samples. Testing revealed that SeriScope could analyze a sample in under two minutes, with minimal hardware requirements. Its integration capability allows installation in existing grainages or testing centers without major modifications.

This approach ensures disease-free egg distribution, reduces moth loss, and enhances farmer confidence. Compared to manual methods, SeriScope offers greater consistency, rapidity, and accessibility. By combining AI automation with simple microscopy, the system presents a **sustainable and scalable solution** for revitalizing sericulture diagnostics in rural India.

Figure 5. High manpower used in every stage

5 Future Improvements

Future versions of SeriScope aim to incorporate a more advanced, semi-automated workflow to increase speed, consistency, and throughput. In the planned system, **moths would first be loaded onto an ingress belt**, where an operator **pierces each moth and prepares the body-fluid smear.** The prepared slide is then placed back alongside the corresponding moth, which remains inside its individual box containing eggs, **ensuring correct traceability** for every sample.

From here, the sample travels on the conveyor to a microscopy station. **Instead of manually carrying slides, a downstream operator would simply place the incoming sample slide under the microscope,** trigger the imaging sequence, **and remove it once the check is complete.** The captured images would be analyzed instantly by the SeriScope AI model, allowing real-time feedback and rapid decision-making.

Once classification is complete, the system would perform automated sorting. A diverter mechanism would **shift pebrine-positive samples into one lane for isolation and safe disposal, while non-infected samples continue along a separate lane for further processing.** All used slides would be collected in a dedicated return lane for cleaning, UV sterilization, and reuse, ensuring sustainability and lowering consumable costs.

Additional modules such as **barcode-based sample tracking, automated slide feeding, and centralized data logging may also be integrated.** This planned cycle reduces unnecessary movement, standardizes handling, and introduces structured automation while keeping human intervention only where essential. It sets the foundation for future fully automatic systems with robotic slide placement, continuous unattended imaging, and end-to-end disease-free egg certification.

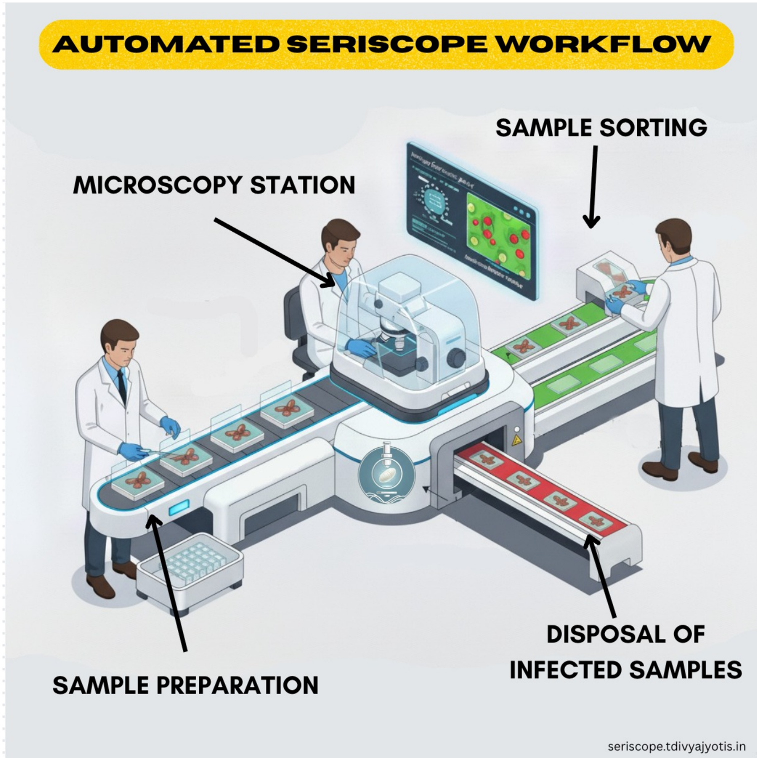

Figure 6. Next stage of our proposed solution

6 Acknowledgment & References

We sincerely thank the Tassar Development Foundation of our region, for assisting in sample collection and guidance. We also acknowledge insights from our mentor **Er. Tanmay Kumar Nayak** who inspired parts of our methodology and supported us.

1. **“Principles of Sericulture”** – Dr. K. N. Kabir & K. Sengupta
2. **“Silkworm Rearing and Disease Management”** – Dr. S. Krishnaswami
3. **“Textbook of Sericulture”** – C. S. Suresh Kumar
4. **Field data**: 600 silkworm samples (2024)
5. **Field data**: 850 silkworm samples (January 2025)