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A Novel Approach For Silkworm Disease Detection And Classification By Using CNN And Image Processing Techniques

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ABSTRACT

Silkworms, scientifically known as Bombyx mori, are integral to the silk industry, which has substantial economic and cultural significance in various regions worldwide. However, silkworms are susceptible to several diseases that can severely impact their health and productivity, leading to significant economic losses. Common silkworm diseases include Flacherie, Grasserie & Muscardine, each caused by different pathogens such as bacteria, viruses, and fungi. Effective identification & timely behaviour of these ailments are crucial to maintaining the health of silkworm populations and ensuring consistent silk production. For this we propose an automated system for the identification of silkworm diseases and providing treatment recommendations using CNN and image processing. Leveraging deep learning techniques, the system is considered to accurately classify images of silkworms into categories of health status, including specific diseases such as Flacherie, Grasserie, Muscardine, and a healthy state. Experimental results analysis demonstrates 99% of accuracy using proposed model. This approach signifies a step forward in agricultural technology, demonstrating the potential of AI in solving practical problems in sericulture.

Keywords*: *Silkworm diseases, Classification, Image Processing, Sericulture, Grasserie, Muscardine, Flacherie.

I. INTRODUCTION

Silk is highly required after intended its dye affinity, light weight, and durability, earning it the title 'Queen of Textiles.' Beyond silk production, sericulture offers numerous by- products, making it a profitable industry and a significant source of rural employment, particularly in countries like India. India, the second-largest silk producer after China, generates around 8.25 million jobs and produces approximately 8200 metric tons of raw silk annually, with Karnataka leading in production. Mulberry is the most widely cultivated silk type in India, with each cocoon producing 300-900 meters of raw silk [1]. Farmers face significant production losses, around 30-40%, due to worm infestations, making disease identification crucial. Maintaining ideal climatic conditions for healthy silkworms is essential. The sericulture industry aims to improve yield & quality due toward high mandate intended silk. Several factors, including conservational situations& human negligence, contribute to worm sickness [2].

Sericulture involves raising silkworms to produce cocoons, which are the raw material for silk. Mulberry leaves, collected outdoors, are fed to silkworms raised indoors, making them susceptible to pathogens. Silkworm diseases, caused by fungi, viruses, bacteria, and protozoa, result in significant crop losses, with common diseases like Flacherie, Muscardine, and Grasserie reducing productivity and causing substantial economic impact. Disease outbreaks can cause losses exceeding 20% of annual production, sometimes reaching 50%. Despite advances in agricultural technology, silkworm disease diagnosis remains underutilized, highlighting essential intended early recognition systems to prevent financial losses [3]. Sericulture involves the large-scale rearing of silkworms for silk production, which began in China. India is a major silk producer and the only country to produce all types of commercial silk, contributing about 5% to its GDP. Sericulture is mainly practiced in West Bengal, Karnataka, Assam, and Andhra Pradesh. Different silkworms produce various silk qualities: Tasar (low quality, copper brown, used in furnishings), Muga (moderate quality, light yellow, used in sarees and chadars), Mulberry (high quality, creamy white, widely reared), and Eri (moderate quality, creamy white, less lustrous) [4]. China leads the world in silk production with Guangxi at the forefront domestically, producing the most silkworm cocoons for over a decade. The health of silkworms is crucial for silk quality, and Guangxi's industry currently lacks AI technology for disease identification.

The process of sericulture, or silk farming, involves the rearing of silkworms to produce silk. Silkworms are highly sensitive creatures that thrive under specific conditions, and their health is paramount to ensuring a successful silk harvest. However, these valuable insects are susceptible to a range of diseases that can devastate populations and significantly reduce silk yield[14]. Silkworm diseases, including Flacherie, Grasserie, and Muscardine, present a major challenge to sericulture. Flacherie is typically caused by bacterial or viral infections and can lead to high mortality rates if not managed properly. Grasserie, caused through BmNPV, results in swollen and fragile larvae, while Muscardine is a fungal disease categorized through occurrence of white fungal spores on the larvae's body, caused primarily by Beauveria bassiana. These ailments not only distress health & productivity of silkworms but also lead to significant economic losses for silk farmers. Traditionally, the identification and management of silkworm diseases have relied on manual inspection and expert knowledge. This method, while effective, is labor-intensive, time-consuming, and prone to human error. With the advent of technology, around stands growing interest in developing computerized systems that canister accurately diagnose silkworm diseases & suggest appropriate treatments, thereby enhancing efficiency and accuracy in sericulture.

Silkworm farming, or sericulture, involves the cultivation of silkworms to produce silk. It instigates through hatching silkworm eggs into caterpillars, which remain before fed mulberry leaves pending, they rotation silk cocoons. The cocoons are harvested, and the silk threads are carefully extracted and spun into silk fabric. This progression necessitates vigilant organization of temperature, humidity, and hygiene to ensure high-quality silk production.

This study presents an automated system for the identification of silkworm diseases and the provision of treatment recommendations using Convolutional Neural Networks (CNN). CNNs, a class of deep learning algorithms, have demonstrated remarkable success in image classification tasks owing toward their capacity to automatically learn & extract structures from images.

Remainder of the paper is structured as: Section 2 summarizes about some of the existing work carried out by various researchers. Section 3 provides proposed system; section 4 discusses results achieved by proposed method. Lastly section 5 discusses conclusion and future enhancement.

II. LITERATURE SURVEY

In order to recognize silkworm disease accurately, in this article we have studied and analyzed the research of various researchers on different agricultural fields.

The study in [5] explores an image recognition algorithm for silkworm diseases, leveraging the DenseNet model and attention modules to improve accuracy. By enhancing the automatic recognition system for silkworm diseases, this research aims toward afford noteworthy methodological sustenance intended precise disease diagnosis & the advancement of AI in Guangxi's sericulture industry.

Kiratiratanapruk, K., et al. [6] explored partitioning a dataset into clusters to minimize distance between data points and cluster centers. It utilizes color space transformation and image segmentation as preprocessing methods, coupled with K-means clustering for classification.

Kiratiratanapruk, K., et al. [7] addressed segmentation using centroid revealing in low divergence images, involving data on three types of egg colors (one normal and two abnormal). The preprocessing techniques include image segmentation and centroid detection, with classification achieved using a Pulse-Coupled Neural Network algorithm.

Zhou, S., et al. [8] proposed using a dataset of silkworms and applies robotic manipulation and microinjection processes for data preprocessing, through image processing procedures intended classification.

Thomas, S., et al. [9] explored two hybrid silkworm cocoon varieties (FC1 and FC2) for classification. It involves segmentation, skewness correction, feature extraction, & classification using CNN to achieve high accuracy.

Nishali M Suvarna et al. [10] proposed the dataset entails of 1000 silkworm images in with 800 images for training & 200 silkworm images for Testing, Our Dataset contains two categories: Diseased and non diseased and also considered sequential model method and CNN algorithms which can be castoff to catalogue diseased and un diseased silkworm and improved accuracy.

Research gap analysis:

From the discussion made on existing research on classification of healthy & diseased silkworms using collaborative learning & CNN. Fallowing observations draws the benefits as well limitations given below.

Table1:Research gap analysis

No	Author	Algorithm used	Merits	Gaps
1	Kantip Kiratiratana pruk et al.	K-means clustering algorithm. Simplest unsupervised learning algorithms	The results obtained are accurate, faster and reliable with accuracy of 0.97 for healthy and 0.99 for diseased Grasserie silkworm	nstead of considering color images of egg able to take the life cycle of egg.
2	S Singla et al.	Deep learning algorithm and CNN	It is operated to detect disease with accuracy.	Accuracy need to be improve
3	Kantip Kiratiratana pruk et al.	ulse-coupled neural network (pcnn)	Image analysis process, allowing for rapid data processing and decision-making. provides an information of worm egg development, health.	bject in low contrast image, however, errors and limitation of the technique will be improved for our future work. Able to improve accuracy
4	S M Nagashetti et al.	Deep neural networks, mage classification,	Early and accurate disease detection Continuous monitoring of silkworm health, allowing for	Present model is restricted to identify grasserie diseases which can be further Developed it to identify
5	S Thomas et al.	Cnn	The sericulture industry is an inevitable field that contributes to the cultural and economical Progress of country. Works efficiently and effectively	The proposed model intended classification of pupa based on gender was designed using lda + adaboost with logistic regression as the weak learner in addition need to improve accuracy
6	Ajey kalgi et al.	Cnn	Protected from being infected.	Need to find accuracy.
7	P. S. Shilpashree et al.	Random forest (rf) Light gradient boosting machine (lgbm) and Convolutional neural network (cnn)	Detection of diseased silkworm so that appropriate action is taken to avoid financial loss.	The counting of healty eggs in calculation to enhanceexactness.
8	Yu zhen et al.	Cnn	Good recognition rate of silkworm disease image Recognition.	Need to improve recognition rate by Using other algorithms.

To overcome the draw backs of existing system we propose a CNN model that effectively classifies the silkworm disease, its causes and recommending treatments. For this we have created an intuitive Flask-based web application.

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III. PROPOSED SYSTEM

Proposed system uses CNN model intended for detecting & treating silkworm diseases. Unlike SVM, CNN inevitably citation features from raw picture element data without needing manual setup. They're great at classifying images and can learn detailed patterns in silkworm images, which improves how accurately diseases are detected. This technique uses assignment learning from pre-trained models to speed up training and make the system work better with silkworm- specific data.

3.1 System Architecture

The system architecture begins with the input of silkworm images, which undergo preprocessing to standardize their format and enhance clarity. Feature extraction then utilizes Convolutional Neural Networks (CNNs) to automatically identify intricate patterns and disease-specific appearances after images. These mined features remain decisive intended accurate classification into categories such as Flacherie, Grasserie, Muscardine, or Healthy.

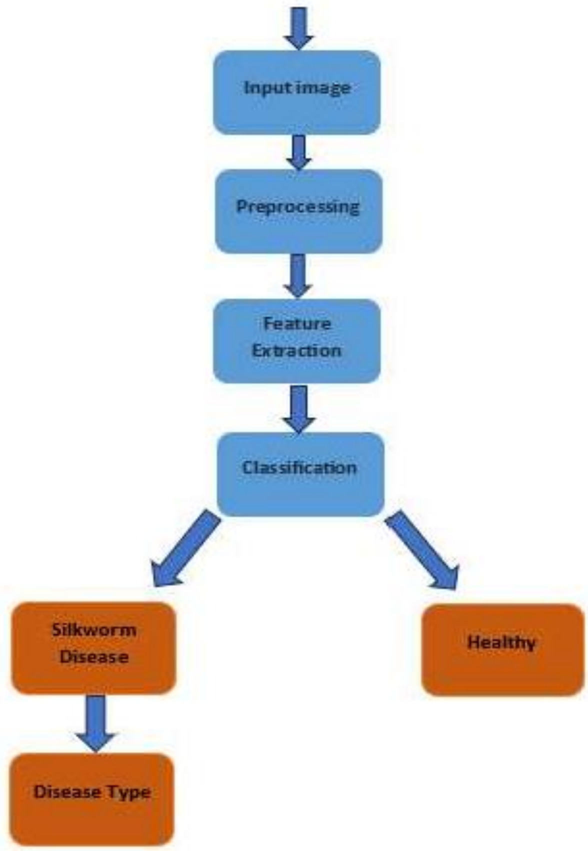

Figure 1: System Architecture of Silkworm Disease Detection

Each classification is accompanied by detailed disease type identification, providing specific treatment recommendations based on predefined cause and treatment dictionaries. This structured approach ensures efficient disease detection and management in sericulture, leveraging advanced image processing and machine learning techniques to support silk farmers in maintaining healthy silkworm populations.

3.2 Methodology

The model follows a structured methodology involving the following steps:

1) **Data Collection and Preprocessing**: High-quality images of silkworms showing various disease symptoms are collected. This can be done in controlled environments using digital cameras or microscopes. Each image is labeled with the correct disease classification by experts in silkworm pathology. This labeled

dataset is crucial intended exercise administered ML models. Performances such as contrast adjustment, noise reduction, & normalization remain pragmatic toward improve image quality.

2) Feature Extraction and Selection: Appropriate optical aspects are dragged from preprocessed silkworm images. These features capture distinct characteristics that differentiate one disease from another. Feature assortment methods are pragmatic toward identify the most informative attributes, reducing complexity and enhancing model performance.

3) CNN Model Development: The CNN algorithm is chosen for its ability to handle complex classification tasks and mitigate overfitting. dataset is divided obsessed by training, authentication, & testing sets. algorithm is trained scheduled training set, iteratively constructing decision trees and aggregating their outputs to form a robust ensemble model.

4) Model Evaluation and Tuning: Trained model's presentation evaluated using the validation set. Metrics like accurateness, precision, recall classification abilities. Hyperparameter tuning is performed to optimize model performance, preventing overfitting and enhancing generalization.

5) Web Application Development: A user-friendly web application is developed using the Flask framework. The application allows users to upload silkworm images for identification. The uploaded image is processed by the trained CNN model to classify the diseases.

6) Testing and Deployment: The complete system, comprising the CNN model and the web application, is rigorously tested using an independent dataset of silkworm images.

IV. RESULTS AND DISCUSSIONS

Through leveraging authority of CNNs, proposed system provides reliable & efficient tool intended silkworm disease management. The proposed system operates by capturing images of silkworms and analyzing them to detect occurrence of diseases. The CNN model is accomplished on comprehensive dataset of labeled silkworm images, empowering it to acquire complex patterns & features associated with each disease.

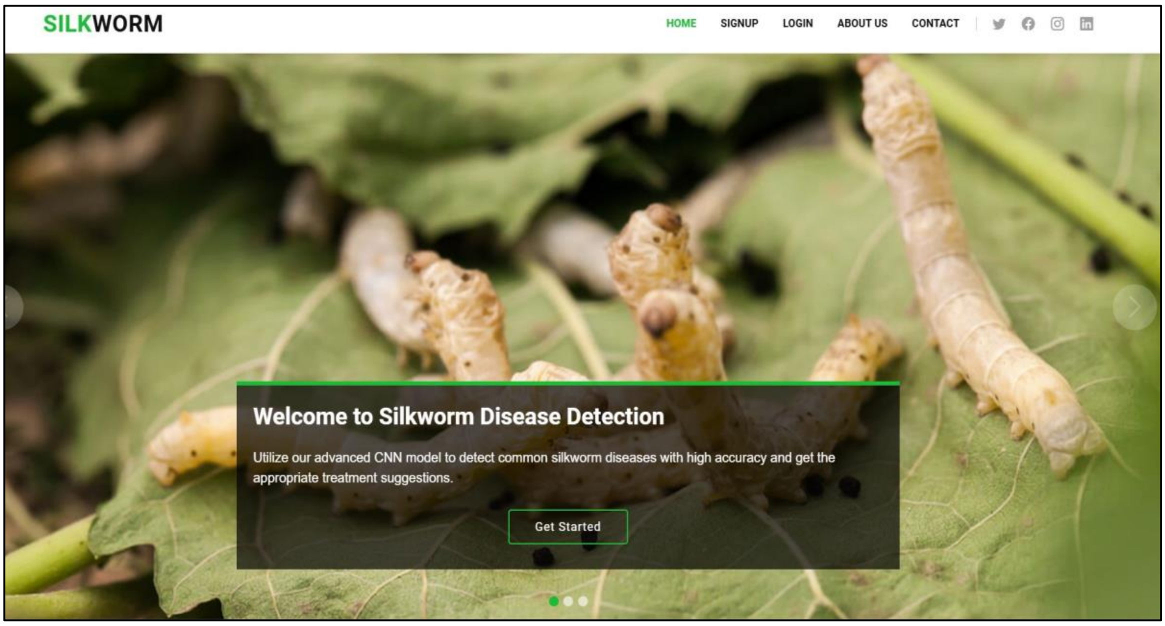

Figure 2: home page

This home page provides navigation in the site and overview of the website which contains all tags such as sign up, login, about us and contact.

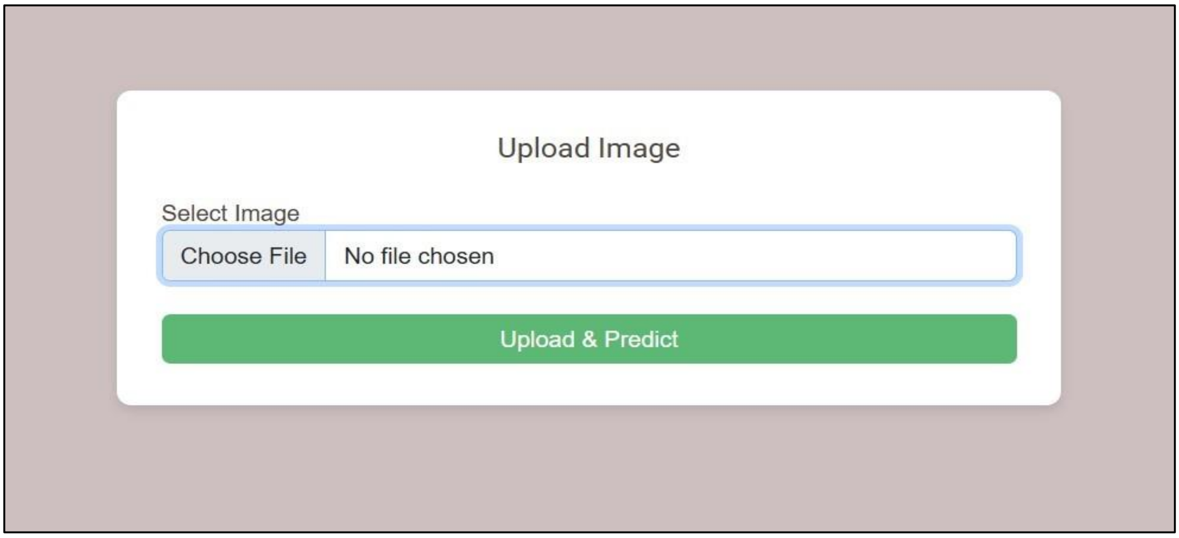

Figure 3: upload image

In figure 3, we need to choose a file and upload the image of silkworm then that will predict the disease, accuracy, causes and treatment.

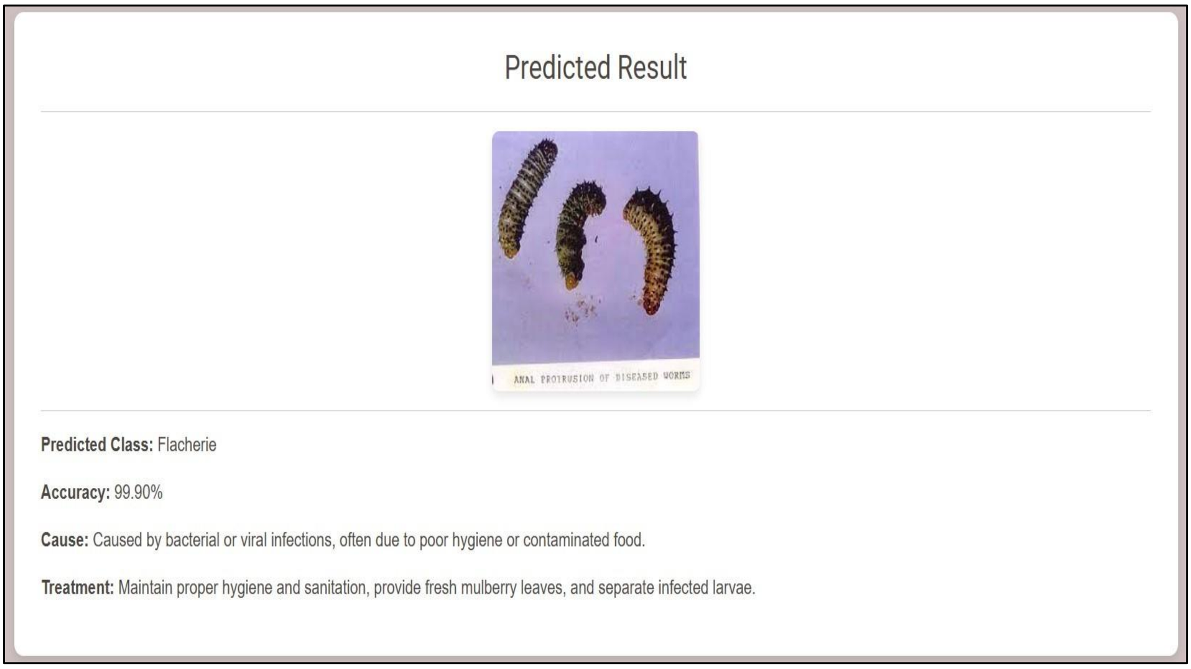

Figure 4: predicted class of flacherie

After uploading the image, the predicated result will show the predicated class as Flacherie, its accuracy, causes and treatment for silkworm disease.

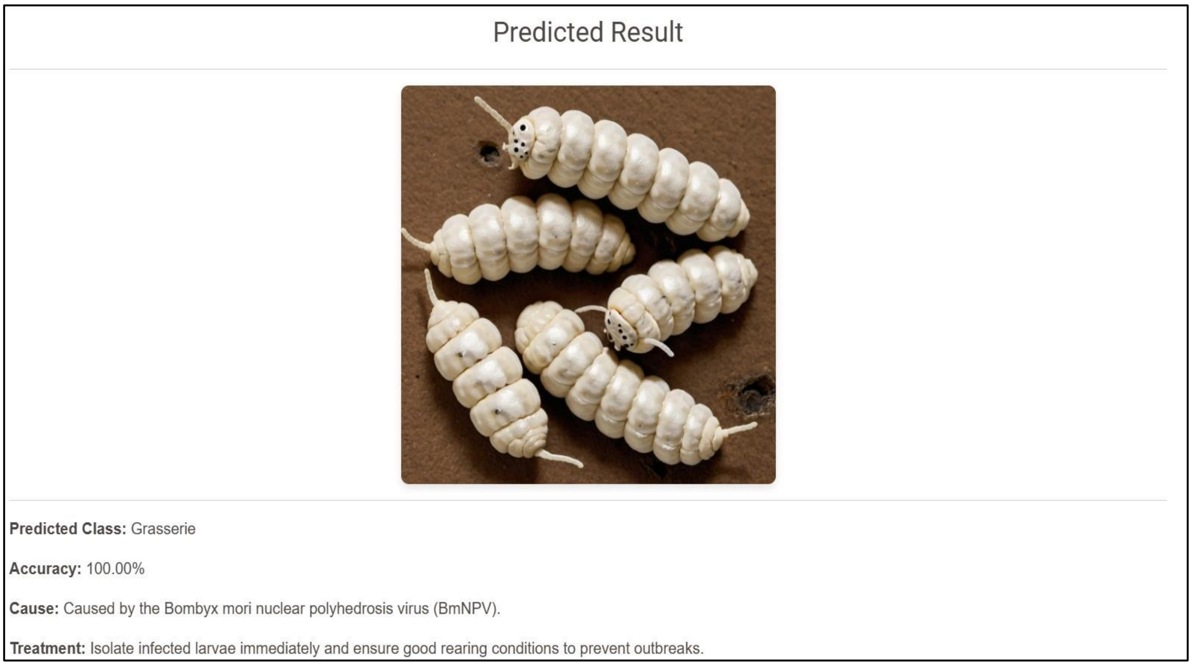

Figure 5: predicted class of Grasserie

After uploading the image, in fig.5 the predicated result will show the predicated class as Grasserie, its accuracy, causes and treatment for the predicted silkworm disease.

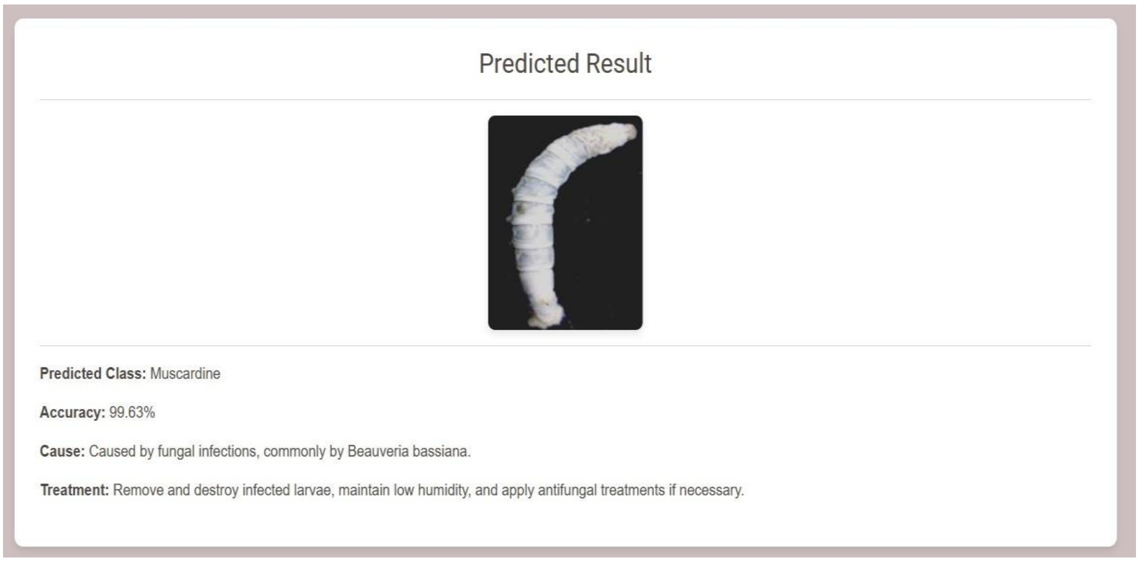

Figure 6: predicted class of Muscardine

After uploading the image, the predicated result in fig. 6 will show the predicated class as Muscardine and its accuracy, causes and treatment for predicted silkworm disease.

From the above results it is clear that once trained, the CNN model can classify new images into categories of health status, including Flacherie, Grasserie, Muscardine, and a healthy state. System not solitary identifies disease then also delivers thorough statistics cause & appropriate treatment methods. For example, if the system detects Flacherie, it highlights bacterial or viral infections as the cause and suggests maintaining proper hygiene and sanitation, providing fresh mulberry leaves, and separating infected larvae as treatment measures. In the case of Grasserie, the system identifies BmNPV as cause & advises immediate isolation of infected larvae and ensuring good rearing conditions. For Muscardine, caused by Beauveria bassiana, the system recommends removing and destroying infected larvae, maintaining low humidity, and applying antifungal treatments if necessary.

V. CONCLUSION

In the silk industry the economic loss is happening throughout the world because of different disease that effects the health and productivity of silkworm. The different disease are caused by bacteria, fungi and virus. Project has successfully developed an innovative system for silkworm disease detection and treatment recommendations using Convolutional Neural Networks (CNNs). By leveraging CNNs, the system automates feature extraction from silkworm images, significantly improving disease detection with 99% accuracy. Through extensive testing and validation, the system reliably classifies silkworm images into categories such as Flacherie, Grasserie, Muscardine, or Healthy, providing tailored treatment recommendations based on disease type.

As a future enhancement, several avenues can optimize the model's performance and usability such as expanding the dataset to include a broader range of silkworm images encompassing diverse environmental conditions and disease severities could enhance the model's robustness and generalization capabilities. Additionally, integrating real-time disease monitoring capabilities into the system would enable continuous surveillance of silkworm health. Enhanced user interfaces and mobile applications could further improve accessibility, enabling silk farmers to monitor and manage silkworm health remotely. Exploring advanced AI techniques such as reinforcement learning for dynamic disease management strategies and predictive analytics could provide proactive insights into disease patterns and treatment effectiveness.

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