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Image Processing Based Automated Sericulture Monitoring System Using IOT

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ABSTRACT: India is the second largest country as a manufacturer of silk. Sericulture plays a vital role in the economic, social, political and cultural aspects in India. Silk is the queen of textiles because of its smoothness, magnificence, gracefulness, flexible properties and many more. In each stage of the healthy silkworm, the salient challenge is humidity and temperature, particularly at the stage of the larva. During the rearing of silkworms, the major cause of failure is due to bactericide or infection in them. This project presents a modern approach to keep track of the silkworms during its process of rearing. The image processing technique helps to recognize the infection and health conditions at different stages of the silkworms. The temperature and humidity sensors check environment inside the room of silkworm rearing. This minimizes the manual intervention of the farmer. The process of irrigation is automated using soil moisture sensor and sufficient amount of light is provided with the aid of LDR sensor.

KEYWORDS: Silkworm, Sericulture, Arduino Mega, Image Processing, VGG19.

I. INTRODUCTION

Sericulture is the science that deals with the production of silk by rearing of silkworm. Producing silk is a lengthy and complex process. The root of sericulture in India is economic, social, political and cultural. The silkworm ingests the mulberry leaves during the period of larva and it produces the luxuriant or lush silk thread in the formation of cocoon. Cocoon mass, shell mass and shell ratio can be affected by the seasonal environmental conditions. So the maintenance of temperature and humidity for the sustainable production of cocoon has to be done. As mulberry plantation is the only food for the silkworms, it requires regular irrigation which is both time consuming and requires the presence of farmers in land. Due to the absence of automation in sericulture process, the rearing of silkworm is highly affected. Therefore, this project extends a thought of development in the field of sericulture in order to enhance the silkworm rising subjectively and quality wise.

The mulberry silkworm (Bombyx Mori L.) is a standout amongst the most vital trained creepy crawlies which create silk string by expending mulberry leaves as casing. The silkworm's versatility to change in ecological elements broadly contrasts from different creepy crawlies. Since silkworm is very not the same as different creepy crawlies, it is exceptionally delicate to changes in condition and can't get by under extensive variety of varieties.

Effect of environmental parameters

The part of temperature, relative humidity, air dissemination and light that would influence the embryonic advancement of silkworm can be comprehended as takes after:

i. **Temperature**: The temperature assumes a lively part on larval advancement at various instars and has an immediate relationship with the silkworm development. The encompassing temperature required for raising silkworms of various early in stars are depicted in Table 1

Table 1: Ambient temperature requirements of silkworm during different stages.

Stages	Incubation	1st	2nd	3rd	4th
Temp(°C)	25	28	27	26	25

The extensive variety of fluctuations in temperature is hurtful to the improvement of silkworm. Ascend in temperature quickens the different physiological capacities and with a fall in temperature, the physiological exercises get hindered. The ideal temperature for sound development of silkworms is in the vicinity of 20°C and 28°C and the attractive temperature for most extreme profitability ranges from 23°C to 28°C. Temperature over 30°C straightforwardly influences the soundness of the worm. The temperature underneath 20°C decelerates the physiological exercises, particularly in early instars, the worms turn out to be excessively feeble and helpless, susceptible to various diseases.

ii. **Relative Humidity**: Humidity likewise assumes an imperative part in silkworm raising both specifically and by implication. The impact of dampness makes sense of the attractive development of the silkworms, generation of good-quality cocoons and straightforwardly impacts physiological exercises of the silkworm. Humidity also indirectly influences the rate of withering of the leaves in the silkworms rearing beds. Under dry conditions particularly winter and summer the leaves wilt quickly and utilization by hatchlings will be less. This influences development of the hatchlings and results in wastage of leaf in the raising bed. Hindered development of youthful hatchlings makes them powerless and vulnerable to infections.

II. OBJECTIVES OF THE PROPOSED SYSTEM

The objectives of the proposed work is to minimize manual invention of the farmer, by automating the process of silkworm rearing unit by interfacing sensors and actuators to Arduino and connecting it to a computer, obtaining the soil moisture content, temperature, humidity from silkworm rearing room and controlling the environment parameters with the help of actuators and interfacing camera to the Arduino and performing the image processing operations on the captured image of the silkworm thereby able to distinguish between healthy and unhealthy silkworms after performing the operations.

III. LITERATURE SURVEY

Nisha. S. Ali.proposedanimage classification for silkworm using deep neural network vgg 19 [1]. This paper categorizes the silk worm using Deep Neural Network that advances the seed production of silkworms, which upsurges silk production by making a desired high precision model for silkworm classification and also to identify the diseased and healthy silkworm to improve the production of silk. To extracts general features and then categorizes them under multiple tags based upon features perceived and to recognize the diseased and healthy silk worm so that the quality and quantity production of seed cocoon and revolving cocoons with pecuniary support for building of nurture house cocooning shed, and rearing equipment's progresses. This proposed paper is very useful for the farmers as it helps them financially. This project is to classify the silk worm images using Deep Neural Network that will helps in optimizing the seed production of silkworms, which increases silk production. They have used the subset of the images an achieved accuracy of 98%. The accuracy would increase if used whole datasets. Currently people are manually classifying the diseased and un-diseased silkworm. This helps to maintaining the quality and quantity of the silkworm production. Deepthi H S,Anitha S Sastry et al. proposed a Image Processing Based Smart Sericulture System Using IOT. The proposed framework introduces Internet of Things (ESP8266) empowered Wireless Personal Area Network (WPAN) system[2].Image processing will classify the worms as healthy and diseased by identifying the disease using colour change and texture analysis which involves masking the image using binary mask to obtain the silkworm. On applying the colour threshold for the histogram of the silkworm and classify them into three classes as healthy, Flacherie infected and Pebrine infected and notifying the Seri-culturist about the diseased worm detected through send mail function of the MATLAB. The result will be sent to the farmer through E-mail. The proposed system could be a probable solution for productivity in silkworms. Farmers receive E-mail notifying about healthy or infected silkworm.

Yashaswini B, Madhusudhan et al. proposed a Automated Smart Sericulture Based on IOT and Image Processing Technique. This project presents a design of smart monitoring and actuating sericulture system using ARM7 LPC2148 and Image processing technologies [3].The ARM7 LPC2148 will enable the end user to monitor and to actuate the sericulture system in real time by making use of GSM. Image processing helps to recognize the infection or ill health and non-identical stages of the silkworms. The specimen, keep the collection of the real time statistics by using ARM7 Controller. The web camera is used to detect the ill health silkworms and spray the respective medicines. The total organization statistics and execute with help of ARM7 controller. In identical stages of the silkworm the ARM7 is used to control the atmospheric environment or surrounding inside the room of the silkworms rearing.This helps minimizes the manual intervention of the farmer by

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automating the process of irrigation of mulberry plantation and also testing the temperature and controlling the silkworm rearing unit by using ARM7 board.

Khaja Moinuddin, E. Vandana et al. proposed a IoT Based Automated Sericulture System [4].The present review paper discusses in details about the role of temperature and humidity on growth and development of silkworm including recent studies on heat shock protein. In addition to this study emphasis on the role of various environmental factors on embryonic development of silkworm egg, nutritional indices of silkworm larva and reproductive potential of silkworm moth. The study also highlights about the care to be required during silkworm spinning and influence of temperature and humidity on post cocoon parameters of silkworm. The study included future strategies to be taken for the management climatic condition for successful cocoon crop. This venture gives mechanization and supervisory control in sericulture cultivates by utilizing microcontroller and WIFI based innovation. A framework was proposed that introduces an Internet of Things (IoT) empowered Wireless Personal Area Network (WPAN) system in order to deal with a continuous observation of silkworm development in sericulture. Picture handling innovation to recognize the phases of silk worm life cycle[5]. A research is proposed to design an automatic monitoring system based on Internet of Things technology [6] which utilizing the DHT22 sensor and Cayenne API as information retrieval medium to the computer. Using this device, the farmers can check their cultivation in the meantime without going inside the cultivation. A model facilitates and controls the climatic conditions to be kept up inside the raising condition. The system involves the combined usage of the Microcontroller and GSM module providing automated control features to the farm and the user. [7] The automated system senses the inputs such as the temperature, light intensity, humidity, and gases such as the LPG, Carbon-di-oxide from the environment inside the sericulture farm. Thresholding is considered as a statistical-decision making theory which can lessen the average error incurred in allocating pixels to two or more groups[8]. The traditional Bayes decision rule can be applied with the prior knowledge of the Probability Density Function (PDF) of each class.

IV. METHODOLOGY

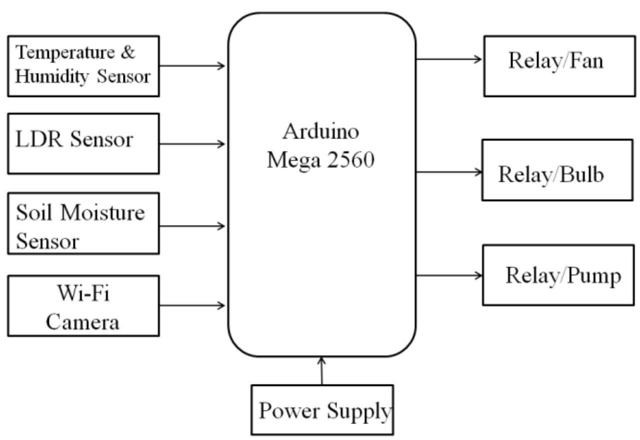

Fig 1: Block diagram of Automated Sericulture system

The proposed system is an embedded system which will closely monitor and control the environmental parameters as in Fig 1. The system consists of sensors, microcontroller and actuators. The sensors circuit comprises of three analog sensors namely temperature, humidity and light. Controller is programmed in such a way that it will have the threshold values and the capacity to monitor and control the system. The project starts with the initialization of Microcontroller board. The information is received about environmental changes in the silkworm rearing room through temperature and humidity sensor. If the temperature is greater than the threshold value fan will turn on and if the temperature is lesser than the threshold value heater will turn on. LDR is required to maintain light in the silkworm-rearing room. The soil moisture sensor monitors the moisture content present in the mulberry plantation, based on the value motor pumps. Web camera is used to observe the real time physical changes in the system. The image processing technique is used to segregate the healthy and unhealthy worms.

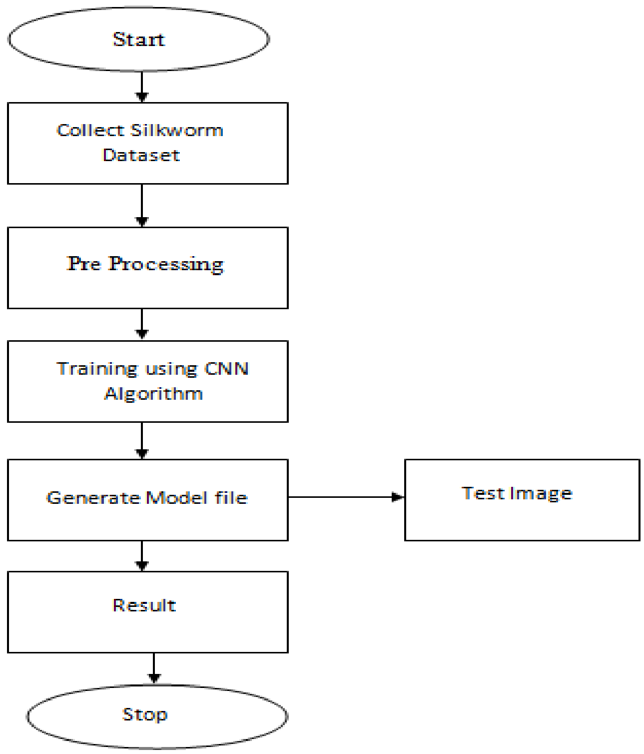

Fig 2: Flow chart of Image Processing

The above figure shows the flowchart of image processing, where the process of image processing begins. The first step includes gathering the Dataset of silkworms. The dataset is collected from the online website called Kaggle. It contains variety of images of healthy and unhealthy silkworms. Pre-processing ensures that the images are in same format and same size.

The algorithm (vgg19) will learn to recognize different features in the images and will adjust its weights and biases accordingly to improve its accuracy. Vgg19 is one of the convolution neural networks, which has 19 layers like convolution layer, fully connected layer, SoftMax layer, and max pool layer. When an RGB image is given as an input to the network the vgg19 resizes it to (224, 224, 3). It is a fixed size. During pre-processing it subtracts the RGB mean value. With the help of the kernel the pixels in images are processed. The spatial resolution process is mandatory to identify the differences in the images by spatial padding. Soft max layer is the final layer which will have output based on the number of classes.

Images are processed which generates a set of values that represent the predicted class probabilities for each image. These output values can be saved as a model file. Images from the data set are tested after training. The process yields the worms as diseased and healthy and graphs are plotted for the accuracy and loss of the process. After displaying the graphs and final output the process gets terminated.

V. RESULTS

The below figure 5.1(i) and 5.1(j) shows the images of silkworm rearing room and Sensor reading on the serial monitor respectively. In the beginning ,when the system is turned ON i.e., In the monitoring phase , the sensors such as soil moisture, temperature and humidity sensor and LDR sensor are interfaced with the Arduino mega.

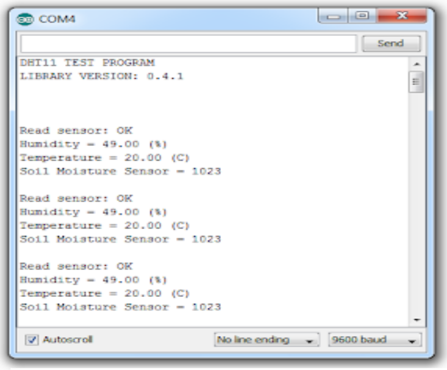

Fig3(a): Sensor reading on serial monitor.

Fig3(b): silkworm rearing room

When the soil moisture sensor checks the moisture content of the soil, if there is dryness in the mulberry plantation field in silkworm rearing room motor will turn ON and pumps water. Otherwise the motor will turns OFF.As shown in the figure 5.1(j) the value of soil moisture sensor is higher than the optimum value (1000) hence the motor will turn OFF, similarly the value of temperature is lower than the threshold value (30℃), hence fan will turn OFF, but if it is more than the threshold value fan will turn ON.

At the same instant of time, if the temperature is above the optimum level the Fan will turn ON automatically, here the relay module will act as switch.The LDR will sense the amount of light present in the silkworm rearing room. When the room is dark, the LDR value will be below its threshold level, hence the bulb will switch ON. Otherwise the bulb remains switched OFF. Based on the value of the LDR the light will turn ON/OFF by using a Relay module.

Hence, the mulberry plantation has been taken care based on sensor readings on serial monitor.

Fig4(a): Healthy silkworm

Fig4(b): Diseased Silkworm

The above figures 5.1(c) and 5.1(d) shows the comparison of images of diseased and Healthy silkworms from the dataset.

After implementing the model, the output from a sericulture-based image processing monitoring system can be used to categorize silkworms into healthy and unhealthy groups based on their physical characteristics. Image processing algorithms can be trained to detect specific features of healthy silkworms, such as their size, color, and movement patterns. Conversely, the algorithms can also identify abnormal characteristics that are indicative of unhealthy silkworms, such as discoloration, deformities, or sluggish movement.

By using these image processing techniques, the monitoring system can automatically categorize silkworms based on their health status, enabling farmers to take appropriate action. For instance, unhealthy silkworms can be isolated and treated for diseases or pests to prevent their spread to the rest of the silkworm population.

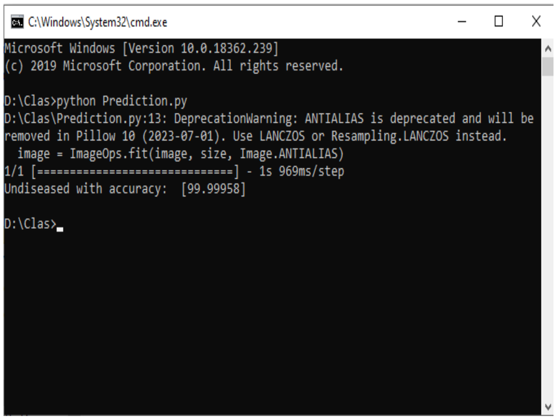

Fig 5.1(e): Image processing output of Healthy silkworm

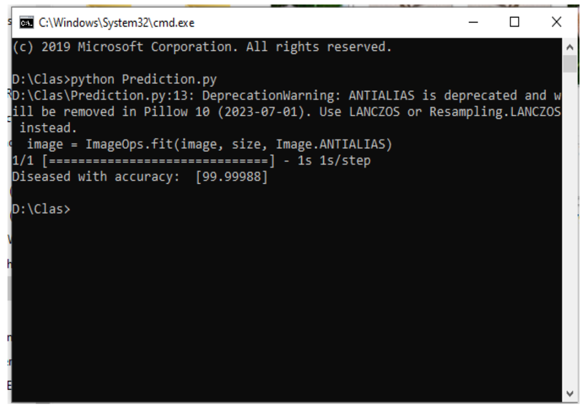

Fig 5.1(f): Image processing output of diseased silkworm

After the dataset is uploaded to the training code, the prediction code is executed which generates the output, whether the silkworms are diseased or healthy displaying the accuracy and losses of the processed image as shown in the above figure.

While compiling the VGG19 model, it is trained for 2 epochs. The end result of training that is train accuracy, test accuracy, train loss, test loss and epochs. The overall performance in VGG19 model has been recorded trained and tested the data by using the dataset images. The whole system is enforced in Python language.

VI. CONCLUSION

By implementing this project, the objectives have met that is, the system is based on a network of sensors that collect data on the silkworms, such as temperature, humidity, and light intensity. The data is then processed using image processing algorithms to monitor the health and growth of the silkworms. The system also includes a user interface that allows the user to monitor the data in real-time and make adjustments to the production process if necessary.

In conclusion, the development of an automated sericulture monitoring system using IoT and image processing techniques has the potential to revolutionize the silk production industry. This system can improve the quality and quantity of silk produced, reduce labour and time required for monitoring, and ultimately increase the profitability of sericulture.

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