Deployment of IoT and A I in a Smart Sericulture Framework: Streamlining Silk Production Processes

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ABSTRACT - This research investigates the potential synergies between artificial intelligence (AI) and Internet of Things (IoT) technologies within the context of sericulture, which is the rearing of silkworms for the purpose of producing silk. The old industry of sericulture is changing as a result of the incorporation of contemporary technology. Sericulturists may transform a number of facets of silkworm rearing and silk production by using Internet of Things (IoT) devices that are outfitted with cameras and sophisticated artificial intelligence architecture. An overview of the creative uses made possible by this convergence is given in this study. These uses include supply chain optimization, intelligent farming techniques, automated silkworm health monitoring, environmental monitoring and management, and predictive analytics for cocoon quality. Stakeholders in sericulture may increase production, maximize resource use, and raise the caliber of silk goods by utilizing real-time data collection and analysis capabilities.

Key words: Artificial intelligence, Internet of Things, Sericulture, Silkworms, Cocoon.

INTRODUCTION

The age-old method of raising silkworms to produce silk, known as sericulture, has long been valued for its artistry and legacy. But because to the confluence of artificial intelligence and Internet of Things (IoT) technologies, this age-old business is undergoing a significant metamorphosis in the modern environment of technological growth. This confluence creates opportunities for a world of imaginative and creative applications that might transform sericulture methods and improve productivity, quality, and efficiency across the whole silk manufacturing process.

In this paper, we investigate the many innovative applications that result from the confluence of artificial intelligence and IoT, delving into the interesting field of sericulture. We travel through the silkworm's life cycle, from its early stages as larvae to its cocooning into opulent silk strands, revealing the transformational power of technology at each turn.

We want to offer a complete overview of how IoT devices, in conjunction with advanced atificial intelligence architecture, are revolutionizing sericulture techniques through a thorough analysis of the most recent developments and cutting-edge applications. We reveal the numerous ways that technology is improving every aspect of sericulture, from environmental control systems to smart farming solutions, from automated health monitoring of silkworms to predictive analytics for cocoon quality evaluation.

We further clarified the effects of these technical advancements on farmers, researchers, and business experts, among other players in sericulture. We hope to promote a better understanding of the revolutionary potential of these technologies by clarifying the advantages and difficulties of integrating IoT and artificial intelligence in sericulture.

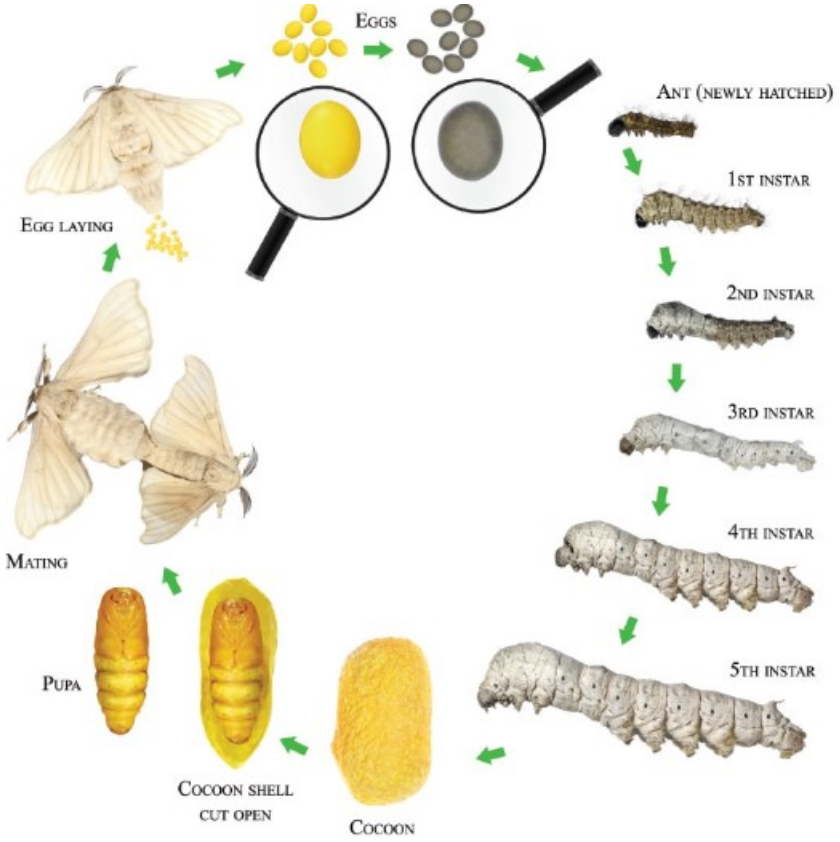

Fig.1.lifecycle of bombyx mori

In the end, this article acts as a lighthouse, leading practitioners of sericulture into a new era of sustainability and creativity. We are paving the path for a future in which sericulture flourishes in harmony with contemporary technology, maintaining its rich legacy while seizing the prospects of the digital era, by utilizing the power of the Internet of Things and artificial intelligence.

The main goal is to automate the process of streamlining the operation by using sensors to identify dangerous gases, temperature, moisture, and vibration. It also intends to install a fire alarm preventive system and develop timer-based disinfection and lime water sprayers for illness prevention.

This research offers a fresh strategy for addressing the aforementioned sericulture difficulties. The technique that has been suggested involves many phases, including data collection, processing, and activation in the context of sericulture. It comprises the design and implementation of a Wireless Sensor Network (WSN) to use a variety of sensors to monitor temperature and humidity in sericulture units. The information gathered from various sericulture units will be wirelessly sent to a distant location, where it will be interfaced with a host computer that can connect to a network. All of the data that was received will then be shown in real time on a webpage. By using this data, actuators may be used to control certain parameters and keep the unit within allowable limits. If needed, organic chemicals may also be included.

PARAMETERS	REQUIREMENT
Temperature	20°c to 30°c
Humidity	70°c to 90°c
Light intensity	15 to 30 LUX(dim light)

Air flow	Well ventilated room
Air quality(carbon dioxide)	Not more than 1%(avoid polluted air)

TABLE 1: Parameters necessary for Achieving Maximum Yield

Each environmental factor's function may be comprehended as follows:
i. Temperature: It has a major impact on how much and what kind of silk is produced. The optimal temperature range for silkworm rearing is between 20˚C and 30˚C.
ii. Relative Humidity: Moisture is essential to the silkworm's life cycle in both direct and indirect ways. The right growth of silkworms and the creation of superior cocoons are greatly influenced by temperature and humidity together. The ideal range for relativehumidity is 70–90%.
iii. Airflow: Depending on the surrounding environmental factors, sufficient airflow is necessary for the development of robust cocoons. In the rainy season, more airflow is required to drive out more moisture from the raising region; in the summer and winter, the converse is true. To keep carbon dioxide from building up in the rearing room, adequate ventilation is also essential. Proper airflow makes sure that the room's carbon dioxide concentration stays below 1%.
iv. Light: Silkworms that have just hatched like low light, between 15 and 30 lux. Strong, intense light should be avoided, especially in the area surrounding the frames that house the silkworms. The tray that holds the hatchlings is usually covered with sheets coated with wax to protect them from intense light.

LITERATURE ANALYSIS

B. Srinivas [1], In India, sericulture is a significant industry, however antiquated methods are still in use. Through the use of IoT and intelligent sericulture technologies, this initiative seeks to automate the sericulture industry. It entails employing sensors to keep an eye on temperature, humidity, and light intensity and notifying the user's mobile application when any of the parameters change. Programming and data analysis are possible with the device using the Arduino IDE software.

N. A. Dawande, Prof [2], The study report emphasises the significance of sericulture in India, the necessity of automation in the silk industry, and the use of data analytics and the Internet of Things to monitor and enhance sericulture. For data processing and visualisation, it recommends utilising Tableau, an Oracle database, and Internet of Things sensors.

Poornima, G. R. [3], The introduction of sericulture—the raising of silk worms—and its significance for rural subsistence are highlighted in this study. It emphasises the benefits of silk and the importance of silkworms, as well as the difficulties encountered during their metamorphosis. The suggested approach recommends use an Arduino board for automating the cultivation of sericulture and controlling weather.

Shilpa Saikia1[4], The article describes how Internet of Things (IoT) may be used in sericulture to automate maintenance and monitoring. It implies that IoT may support sericulture in a number of ways, including mapping, increasing productivity, and monitoring for diseases and pests. The potential for IoT and artificial intelligence (AI) to be combined for sustainable sericulture is also mentioned.

Zaw Lin Oo [5], An Internet of Things-based weather monitoring system is described in the study. It uses an Arduino microcontroller with other sensors, including rain, humidity, and temperature. The system provides an affordable and low-power solution by storing data in a Firebase real-time database and presenting real-time weather conditions through a mobile application.

An Automated Smart Sericulture Based on IOT and was proposed by Yashaswini B., Madhusudhan et al.ARM7 LPC2148 and atificial intelligence technologies are used in this project's design to create an intelligent sericulture system that can be monitored and controlled .The end user will be able to watch over and control the sericulture system in using GSM in real time. Image processing aids in the identification of silkworm infections, illnesses, and different phases. The ARM7 Controller is used by the specimen to maintain the collecting of real-time information.

An IoT-Based Automated Sericulture System was proposed by Khaja Moinuddin, E. Vandana, and colleagues [6].This review study delves into the intricate relationship between temperature and humidity and the growth and development of silkworms, encompassing the latest research on heat shock protein. This study also emphasises the impact of several environmental variables on embryonic development of the silkworm egg, the silkworm larvae's nutritional indicators, and the silkworm moth's capacity for reproduction. The study also emphasises the need for caution when spinning silkworms and the impact of humidity and temperature on silkworm post-cocoon parameters. Future climate management techniques for a successful cocoon crop were included in the study.

METHODOLOGY

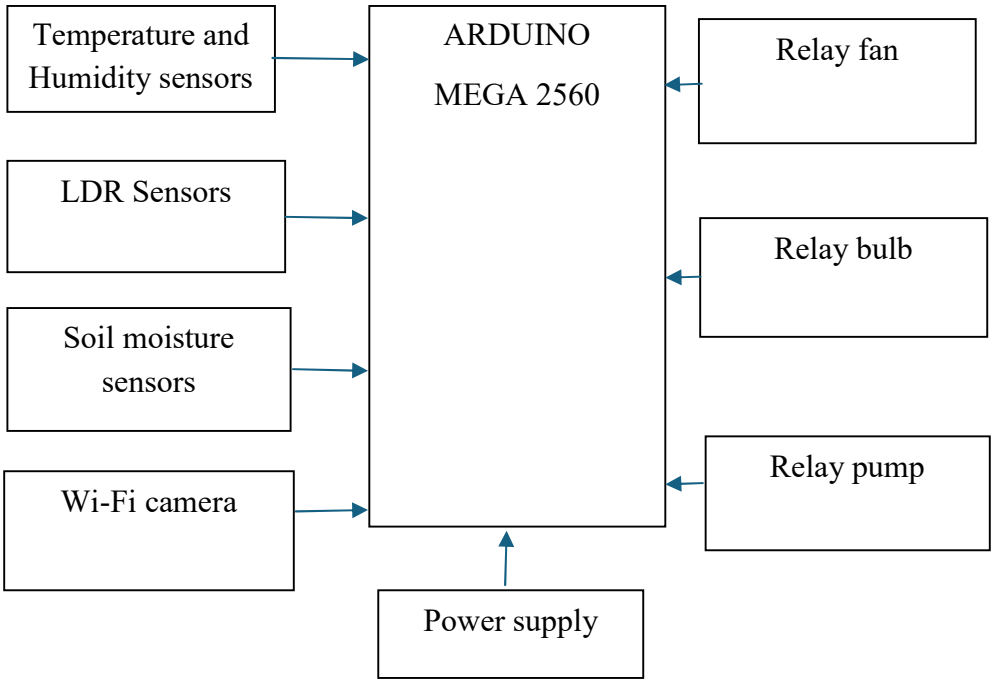

Fig.2. Block diagram of Automated Sericulture system

As seen in block diagram of automated sericulture system the suggested system is an embedded configuration designed to carefully monitor and control environmental variables. This system, which consists of actuators, a microprocessor, and sensors, functions inside a closely coordinated system. Three analogue sensors—temperature, humidity, and light—that are essential to environmental monitoring are included into the sensor circuit. Predefined threshold values are preprogrammed into the controller, which may then monitor and adjust the system as necessary.

The microcontroller board is initialized to start the project. Then, temperature and humidity sensors in the silkworm raising chamber identify changes in the environment. When the temperature rises beyond the set threshold, the fan starts up; when the temperature drops below the threshold, the heater starts up. A Light Dependent Resistor (LDR) is used to regulate the amount of light in the silkworm-rearing chamber. Additionally, the mulberry plantation's soil moisture sensor continuously measures the amount of moisture present, activating motor pumps in response to the moisture content observed[7]. A webcam is also installed in order to monitor any physical changes that occur within the system in real time. By utilising image processing techniques, the camera makes it easier to distinguish between healthy and unwell silkworms, which contributes to more effective management procedures.

This initiative is run independently of the OCF, so anybody may donate, regardless of organisation. This might have a knock-on effect on OCF standards. On the other hand, patent cross-licensing protection is advantageous to OCF members.

IoT technology is employed in this suggested system to monitor and regulate variables including temperature, humidity, and light intensity. The silkworm rearing house's sensors track changes in humidity and temperature[8]. An agriculturalist's mobile application receives this data, which is then utilised to plan any required alterations on an OLED screen. For instance, a fan will turn on when the temperature increases, and a heater will turn on when the temperature falls. More light will be supplied if it is not bright enough. The farmer may keep an eye on temperature fluctuations, as seen in the image below.

The system's intelligence has increased once edge analytics were included[9]. Now, local actuation mechanisms are carried out by the AI algorithm using data on humidity and temperature in real time. Additionally, utilising information from extra sensors including vibration, infrared, and gas sensors, an alerting and notification system has been put in place. The gadget can function in real-time and take action even when it is offline thanks to these edge analytics.

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Starting : THE SMART SERICULTURE MONITORING SYSTEM P
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Fig.3.Reading sericulture system output

Using UART connectivity and Python, sensor data was collected and sent to an Oracle database. Then, using machine learning (ML) techniques, the data saved in Oracle was used to forecast the humidity and temperature for the next seven days. A Tableau Public dashboard had data that was both historical and projected.

Fig.4.Silkworm rearing room

There are several steps involved in the implementation of an Internet of Things-based smart sericulture system. First, put together the necessary hardware, such as actuators, power supply connections, communication modules, and sensors. Next, create software specifically for the microcontroller or Internet of Things platform so that it can communicate with the sensors, actuators, and communication modules in an easy-to-use manner. Add Firebase for storing sensor data after that, then set up a synchronisation with the Firebase Realtime Database. Create a webpage or web application that displays real-time sensor data by using web development capabilities. Completely verify every part on your own, combine them all together harmoniously, and carry out extensive testing[10]. After that, implement the system in the chosen setting and keep an eye on its functionality on a regular basis. For the sake of future reference and maintenance, thorough documentation of the hardware settings, software code, system architecture, and integration processes is essential.

RESULTS AND DISCUSSION

The integration of IoT and AI into a smart sericulture framework has yielded notable outcomes in terms of optimising silk manufacturing procedures. Sericulture producers may monitor and optimise environmental parameters like temperature, humidity, and light levels, resulting in better cocoon quality and increased silk output, by combining IoT sensors, data analytics, and AI algorithms. Predictive analytics powered by AI aids in disease diagnosis, pest control, and choosing the best times to harvest, increasing overall output and lowering losses. AI-enabled automation also improves productivity for jobs like feeding silkworms, gathering cocoons, and processing silk, which eventually leads to higher-quality silk products and more money for sericulture farmers.

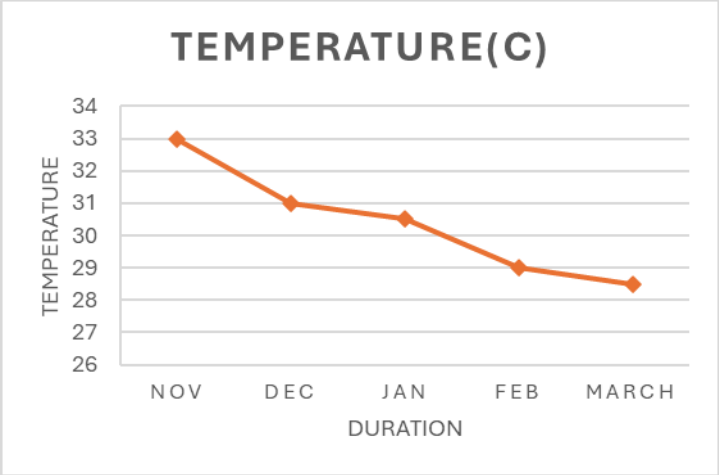

Fig.5.Temperature Sensor Data for Sericulture Systems

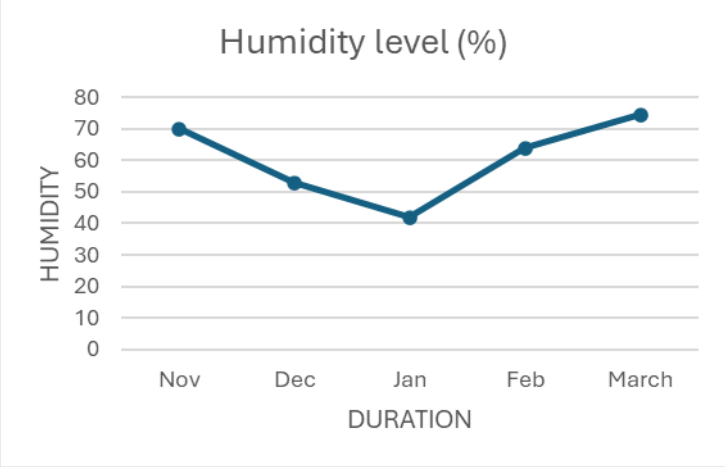

Fig.6.Sensor Data for Humidity in Sericulture Systems

CONCLUSION

In conclusion, the sericulture business is experiencing a paradigm change due to the confluence of Internet of Things (IoT) and artificial intelligence, which offers a plethora of creative applications and game-changing advantages. By incorporating Internet of Things (IoT) devices with sophisticated artificial intelligence architecture and sensors, silkworm rearing and silk manufacturing may be transformed in a number of ways by horticulturists.

The potential of IoT and artificial intelligence to improve productivity, quality, and sustainability in sericulture is highlighted by the creative applications covered in this overview, which include supply chain optimisation, environmental control, automated health monitoring of silkworms, and predictive analytics for silk production.

Moreover, real-time monitoring, early disease identification, optimal resource utilisation, and simplified operations are made possible by the use of smart sericulture systems. For those that practise sericulture, these developments lead to higher profitability, decreased losses, and enhanced efficiency.

Utilising IoT and artificial intelligence technology will be crucial to the sericulture industry's further evolution in order to stay competitive and satisfy the expanding need for premium silk goods. Therefore, the modernization and viability of the sericulture business depend heavily on the ongoing study, development, and acceptance of these technologies. Through innovation and the use of IoT and artificial intelligence, sericulture may prosper in the digital era while maintaining its rich history and customs.

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