

Innovations in Sericulture: A Review of IoT- and AI-Based Monitoring Systems

C. Karthik^{1*}, M. Mallikarjun¹, Kavithagowda¹, D.T. Bhuvanhegde¹, Charan Gowda N.¹

Abstract

Sericulture is a science that deals with the rearing of silkworms and production of silk. In India, sericulture is mostly a rural livelihood and is the base for financial, social, political, and intellectual advancements and upliftment. Silk is called the queen of textiles due to its glittering luster, softness, elegance, durability, and tensile properties. There exist several commercial species of silkworms, yet the commonly used one is Bombyx mori. Silkworm is one of the most vital domesticated insects producing rich silk thread in the form of cocoon as it feeds on mulberry leaves during its larva phase. However, during this transformation from larva to silk, the silkworm must undergo many stages. In each of these stages, the monitoring of silkworm is regarded as one of the major challenges for a farmer. In this paper, we propose a method towards automation in the sericulture system using an Arduino board. It deals with the regulation of climatic conditions, such as temperature and humidity, in the farm. In many nations, sericulture—the raising of silkworms for the manufacture of silk—is an essential business. Disease outbreaks, irregular environmental conditions, and time-consuming monitoring procedures are some of the difficulties facing traditional sericulture methods. To maximize silkworm rearing conditions, this article describes the creation and deployment of an automated sericulture monitoring system that makes use of internet of things, artificial intelligence, and sensor technologies. Technology guarantees data analytics, real-time monitoring, and automation of environmental adjustments, which raises productivity, decreases reliance on labor, and improves the quality of silk production.

Keywords: Sericulture, automation, temperature, humidity, GSM800 module, Arduino, TCS320, RTC DS1307

INTRODUCTION

The world's present scenario is maximum dependency on communication for our day-to-day activities. India is at the second position in the production of silk in the world next to China. In rural areas, majority of farmers are surviving through sericulture. Karnataka's sericulture farming has a history that is more than 215 years. This silkworm farming provides jobs for about 10 lakh people. Natural calamities such as change in temperature and humidity are the prevailing calamities causing problems for the farmers while rearing silkworms. The main problem of the present scenario we saw was that several abiotic factors such as temperature and humidity are supposed to be maintained properly for good productivity, and in many of the farms, the monitoring was purely manual. The owner of the sericulture farm should stay one day near the silkworms monitoring the values of temperature and humidity. Hence, we proposed an

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automated sericulture plant. The main vision of this paper is to provide an automatic method for determining the temperature and humidity in the sericulture farm. It is also helpful in determining whether the food is present or not and killing the pests at the main door. In this design, the sensors check and verify the temperature and the level of moisture within the room. These values are then displayed on the liquid crystal display (LCD). Our proposed method keeps a proper parametric value related to the temperature and moisture level within a certain range. The day-to-day variations of the temperature and the humidity levels along with season-to-season variations prove that management of room temperature and relative humidity is required in cocoon production. Overall process is monitored through Arduino board. This technology reduces the cost to farmers and saves time and labor.

LITERATURE REVIEW

Banerjee and Singhal [1] discussed a microcontroller-based approach to controlling the temperature and relative humidity within a poly home. With the use of input sensors, the greenhouse controller in the suggested technique detects changes in temperature and relative humidity and processes the output to initiate the proper control action. The suggested system has excellent stability and dependability, is inexpensive, and is easy to use [1]. In their research, Poornima et al. [2] suggested an Arduino board-based automation technique for sericulture systems. It deals with controlling the farm's climate, including humidity and temperature [2]. The automated agricultural system that Dondapati and Rajulu created [3] is entirely sensor-based, cost-effective, long-lasting, and has the highest success rate. It can handle everything without the need for human intervention. By activating a cooler, fogger, dripper, and lights in accordance with the required conditions of the crops, it effectively controlled the light, aeration, and drainage processes inside a greenhouse by interacting in real-time with the numerous sensor modules. To show the state of the various devices and the data collected from the various sensors in real time, an integrated LCD was also utilized [3]. Rahmathulla et al. [4] went into great depth regarding how humidity and temperature affect silkworm growth and development, including new research on heat shock protein. The impact of air and light on silkworm development was also covered in the study. Additionally, this study focused on the impact of several environmental conditions on the silkworm egg's embryonic development, the silkworm larva's nutritional indices, and the silkworm moth's capacity for reproduction. The study also emphasizes the need for caution when spinning silkworms and the impact of humidity and temperature on the silkworms' post-cocoon characteristics. Future directions for managing the climate for a successful cocoon harvest were included in the study [4]. Oviposition is one of the most important behaviors in the lives of several insects because the location of the egg-laying site has a significant impact on reproductive fitness. A study by Gámez and León [5] examined how Pavlovian conditioning affected the silkworm's oviposition preferences. Their findings demonstrated that when mulberry leaves—the moths' preferred oviposition site—and an odor (a conditioned stimulus) were present together, moths that experienced both stimuli preferred to lay their eggs close to the odor, while moths that never experienced either of these stimuli showed no preference. The outcome demonstrated the significance of a psychological mechanism like Pavlovian conditioning for this species' survival [5]. Makita et al. [6] investigated how temperature and light affected specific traits of the silkworm, *Bombyx mori*, including egg color, hibernation, and larval molts [6]. Wongsorn et al. [7] investigated the effects of high temperatures on the growth, yields, and production of heat shock protein in Eri silkworms (*Samia ricini* D.) by exposing the larvae on their third day of the fifth instar to varying temperatures for 3 hours: $36 \pm 1^\circ\text{C}$, $40 \pm 1^\circ\text{C}$, $42 \pm 1^\circ\text{C}$, $45 \pm 1^\circ\text{C}$, and $48 \pm 1^\circ\text{C}$. This was done in comparison to a control treatment that involved continuously rearing Eri silkworms at a normal temperature of $25 \pm 2^\circ\text{C}$ and $80 \pm 5\%$ relative humidity [7]. Sericulture is regarded as an entrepreneurial potential for Chhattisgarh's unemployed professionals. A thorough review of the literature revealed several topics pertaining to human resource utilization, production, and marketing. Tripathi et al. discuss each of the facts [8]. Ranjith Kumar et al. [9] created a spinning cutter and a moving holder or arm for mulberry plant. The mulberry plant was first held in the arm while the cutter began cutting it. The plant cutter had a place to keep the plants [9]. The plant is dropped into the storage room by the arm holding it. To locate the plant correctly, the complete plant cutter needs to be moved by hand. The procedure of cutting and holding is automated [10]. Islam et al. [11] investigated how

machine learning techniques might be used to classify crops and weeds using unmanned aerial vehicle (UAV) photos. The difficult task of weed identification in crops has been tackled by orthomosaicing photos, extracting features, and labeling images to train machine learning algorithms. Using UAV photos taken from an Australian chilli crop field, the effectiveness of several machine learning techniques, including random forest (RF), support vector machine (SVM), and K-nearest neighbors (KNN), was examined to identify weeds. Accuracy, precision, recall, false positive rate, and kappa coefficient were the evaluation criteria utilized to compare performance [11].

An overview of different machine vision-based plant detection techniques was given by Li et al. [12], with a focus on two primary issues: crop/weed distinction and handling fluctuating light. There have been both computational and physical approaches put out to address the first difficulty. While computational approaches are less reliable, physical approaches may produce a more unwieldy machine. Deep learning-based techniques have demonstrated clear improvements over conventional methods based on manually created characteristics for crop/weed discrimination [12, 13].

In this paper, we talk about the control of temperature and humidity inside a poly house using microcontroller. Here the method is proposed for the greenhouse controller which senses the temperature and humidity, and it will take appropriate action. In this method we can maintain cost and it is user friendly [1]. This paper talks about the changes in the microcontroller parameters which are monitored for the cultivation of the specific plant species. Production in crop growth will be maximum, and it will eliminate the difficulties involved by the system. It will reduce human intervention, when any climatic factors cross the threshold range the microcontroller reads the changes and then performs the specific action until the system is brought back to its optimum level [3]. This paper discusses the quantity and quality of cocoon crops in the silkworm farm. Silkworms are more sensitive due to the high temperature during fourth and fifth stages. Silkworms are qualitative in nature and influenced by environmental factors such as temperature, humidity, light, and nutrition [6, 8]. Temperature and humidity are the various factors which influence the growth behavior and instar larva periods in silkworm. Discussion about the adaptation of insects to varying the environmental condition is also presented [7].

METHODOLOGY

System design is the phase where we address a solution to the problem statement we mentioned earlier and planned the entire process to achieve all the requirements. This is used to understand the different modules in the system and development of each module and a detailed description of the entire module. Figure 1 illustrates the detailed block diagram of our paper. The above architecture depicts the systems various components and how they are interconnected the Arduino board is the core of the entire setup. The Arduino board has inside its ATmega2560 microcontroller the instructions written in Arduino C dumped in it. The ATmega2560 is preprogrammed with a boot loader that allows you to load the code to it without the use of external hardware programmer. An LCD displays the values of room temperature and humidity, date, time and year routinely with some delay. The relay board connected to the Arduino is used for regulating the power supply to the DC motors, exhaust fan, and pest killer. Real-time clock (RTC) counts the second minutes, hours, date, month, and the year. The TCS230 programmable color sensor detects the color(green) of the leaf and checks the availability of the food to the silkworm. Bulb and fan are used to maintain the room temperature and humidity as per specified range of temperature values.

RESULTS

The prototype of our system is shown in Figure 2, which displays the temperature (in degrees) and humidity (in %) values in the farm, so that respective measures will be taken. FD represents the food present or absent in the farm, if there is an absence of food, owner gets the message through GSM module stating that “food is not present”. M2T refers to indicate the water level content in the tank with the help of rain sensor. M2S indicates motor to spray which will maintain the moisture level.

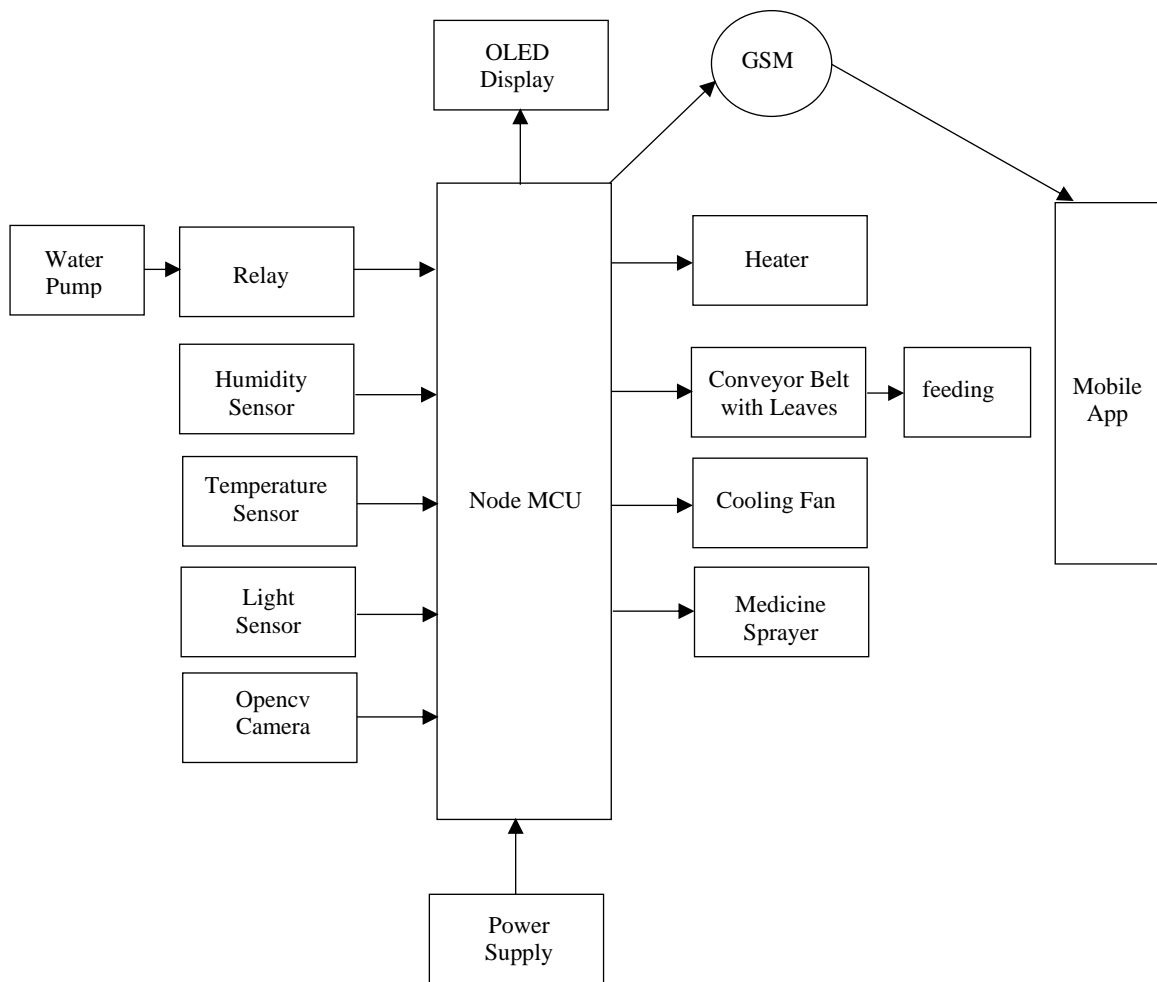


Figure 1. Block diagram of the proposed system.

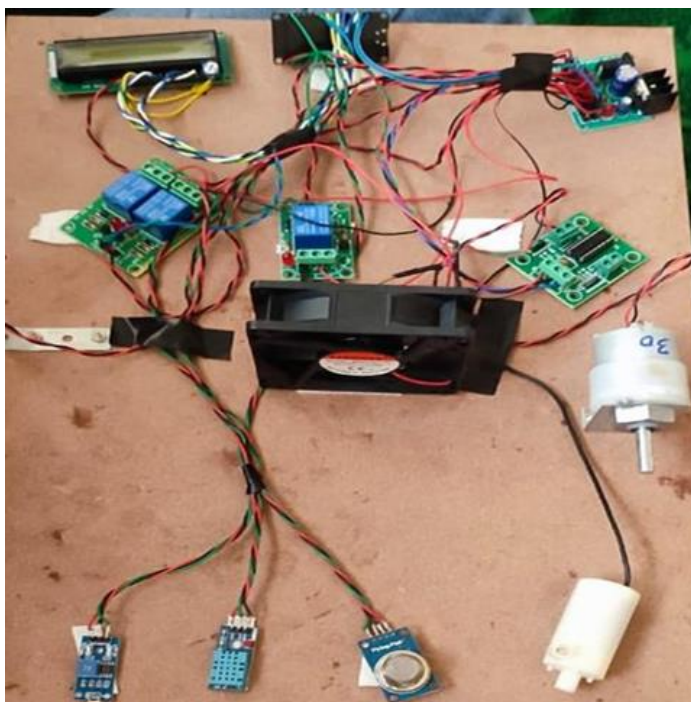


Figure 2. Prototype of the proposed system.

CONCLUSION

This technique helps farmers to get out of their economic crisis. We have proposed an automated sericulture plant which includes less human intervention towards maintaining proper environmental requirements for the growth of silkworms, thus reducing the chances of reduction in silk production. This paper discusses the role of different factors affecting growth, survivability, productivity, and disease incidence in silkworms. The system has low maintenance cost, making it suitable for rural usage. This implementation increases the quality and quantity of silk production in the rural areas.

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