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Neural Networks and Wireless Sensors for Smarter Pest Management in Agriculture

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A B S T R A C T

Software that is "burned into" microchips is known as an embedded system. Devices that support, monitor, or control machines, plants, or other pieces of equipment fall under the category of embedded systems. Applications of artificial neural networks (ANNs) in models for agricultural machinery have been investigated. Multiple Input/Single Output neural network architectures (ANNs), which can simulate both linear and non-linear surfaces, have been the foundation of most applications. In situations where response surface modeling has been applied previously, these kinds of models might be useful. The article discusses the configuration, adaption, noise tolerance, and training characteristics of artificial neural networks. Furthermore, the application of ANN models to embedded systems is examined. We talk about weed identification, blueberry bush pruning, grain elevators, combine harvesters, and precision agriculture.

Keywords: Artificial Neural Network, Harvesters, modeling, embedded system

I. Introduction

Embedded chips, or embedded systems, are one of the true unknowns when it comes to Y2K problems. Finding embedded systems is a true problem for all community sectors as they are present in a vast array of items. For instance, a basic VCR and the most advanced factory automation process. This fact sheet aims to familiarize readers with embedded systems and provide guidance on identifying and resolving issues with them. ..The introduction of microprocessors has created a number of new product options that were not possible in the past. All areas of agriculture have been overtaken and infiltrated by these clever processors. Many benefits arise from using an operating system as embedded application complexity rises. Using an embedded system breaks up the application code into discrete jobs, which streamlines the design process. Even though agriculture uses 85% of fresh water, this essential natural resource is becoming more and more scarce [1,2] . In highly populated countries like China and India, where it accounts for the majority of national income, a sizeable population is dependent on agriculture3. Despite what the general public may think, the agriculture industry is evolving and becoming more precise, sophisticated, and data-driven than ever.

II. Artificial Neural Network

In almost every business, including "smart agriculture," the swift advancements of artificial intelligence (AI) and Internet-of-things (IoT)-based technologies have resulted in a change from statistical to quantitative techniques. Such significant modifications are radically changing traditional farming practices and bringing with them a host of new opportunities as well as difficulties. Additionally, there are plenty of chances to design mechanisms for intelligent decision support and process control systems that will improve the monitoring of plant and fruit health, automate water sprinkling, conserve resources, and more. It is crucial to look into the performance benefits that come from combining popular, reliable, and optimized DL networks with sensors, computer vision and regression algorithms, and Internet of Things configurations into a cohesive system. Considering the aforementioned, considerable attempts have been made over the years to employ cutting-edge developments in AI and IoT to raise the sector's productivity and efficiency [4,5,6]. The agricultural industry has made substantial use of IoT, sensors, and machine learning/deep learning in recent years, especially in relation to monitoring, process control, and management.5, 6. IoT and ML use sensor data to produce reliable decision support systems (DSS) [7, 8].

III. Related Works

Numerous technologies have already been documented that make efficient use of water through a variety of techniques, and the employment of precise tools in agriculture is beneficial. A distributed wireless sensor network with soil moisture and temperature sensors placed in agricultural areas makes up the system described in [1]. In an automated drip irrigation system, sensor data is managed via the Zigbee protocol [2]. Soil pH and nitrogen content are regularly measured. The authors of that paper [3] described designing a method to support an automatic irrigation system by keeping an eye on the level of moisture in the ground. The sensors for moisture and water content[9] measure the temperature and moisture content of the plants. If the moisture level is found to be below the necessary level, the Raspberry Pi uses the moisture sensor to activate the water pump and provide the plant water[10]. An Internet of Things (IoT) smart irrigation system has been presented in. It states that users may remotely monitor, control, and collect data via an internet website, and that the system can adjust soil moisture levels in accordance with requirements. There are numerous sensors that can be used in agriculture[11]. The authors of [12] describe the development of a system that makes it possible to maintain an indoor farm automatically and affordably.

The findings of a survey on illnesses, insect pests, and parasitic weeds that was carried out in rib regions were presented by the authors of [13]. Additionally, it was indicated that in order to control the primary pests that have been documented, some sort of monitoring approach and research and development would be necessary. Eleven crops were evaluated during the survey periods, including pepper, tomato, onion, potato, cabbage, and others. It was found that these crops were impacted by numerous pests and diseases. A table listing the main pests and diseases that affect different crops and need to be managed promptly is also included in that publication. It also says that timely observation is necessary since, given enough time, a small insect can grow into a serious problem.

The writers of [14] evaluated modern management approaches as well as Sri Lanka's existing understanding of insects and pests. Future strategies for controlling insects and raising rice yield while preserving the environment were also covered. In relation to host plant resilience, natural predators of pests that affect rice crops are also studied. The techniques employed by Sri Lankan farmers to manage pests are the main topic. Also highlighted are some of the most important problems that crops encounter as a result of the invasion of several dangerous pest insects that feed on crops. Additionally, novel insecticides with insect selectivity, reduced dosage requirements, and less toxicity are recommended for use in the study. The authors recommend that an establishment of a surveillance and forecasting system for rice pests be pursued in Sri Lanka.

IV. Insects in Agriculture

A farmer may be seriously threatened by a variety of pests, such as weeds, insects, diseases, and vertebrates. They could destroy crop quality, lower agricultural yields, and inflict damage to crops [23]. If an insect endangers people's health or a valuable resource, it is deemed a nuisance. While using a toxic chemical to eradicate the pest is a common method of pest control, behavior analysis of insects can also be used. To tackle numerous pests that threaten their crops, traditional farmers utilize synthetic pesticides; but, because they often do not know how much pesticide is needed to kill a bacteria, they often apply more pesticide than is necessary. Because they target and eliminate a variety of deadly pests of different crops by consuming them, natural predators are thought of as farmers' allies because they lower the population of dangerous insect pests.

Pheromones are used to trap these natural predators in fields. When needed, they are released from farm traps and a pheromone switch is triggered to capture them once more. The scent of these pheromones attracts people in and tempts them to utilize them again in the future. Aphids are a serious pest of numerous key crops, yet ladybirds are natural predators of them. As an illustration, consider the ladybird versus the aphid. Aphids are consumed by ladybirds, which results in their death and crop protection by lowering pest populations.

Figure 1 : Insects present in Tomato

The idea of controlling insect behavior to safeguard crops is completely novel. If we understand how insects act, we can assist farmers in applying pesticides in the proper proportions to safeguard crop quality while also conserving the environment. The behavior category covers an insect's color, noise it makes, substance it releases to communicate with other members of its community, size, speed at which it walks or flies, host plant it belongs to, and whether it is good or bad for crops. Based on an insect's behavior, one may readily calculate the amount of insecticide that needs to be sprayed.

The majority of farmers apply excessive amounts of pesticides to their fields because they are unaware of the amount required to manage the insect pest. This extra spray kills both beneficial and detrimental insects to their crop, and the chemicals seep into the ground altering both the food's nutritional value and the water we drink. The precise amount of insecticide needed to control insects can be determined if their behavior is easily observed. Farmers can also improve crop quality and yield by using a variety of sensors in the field. Based on information gathered from examining the traits of several pests of important crops like wheat, rice, maize, potatoes, tomatoes, and numerous other vegetables, an intelligent monitoring system is created. This technology, which is based on MATLAB data processing, allows a farmer to intelligently avoid useful insects while preserving their harvest. Thus, as was already said, this paper will address the beneficial and dangerous insects of important crops that need to be managed sensibly in order to protect human health and the environment.

However, because there are only so many pheromones on the market, this technique is still unable to control every variety of bug. Therefore, additional research in this area is required to fully control insect pests in all crops grown in India. In this paper, we propose an intelligent monitoring system based on insect behavior that reads feeding insect behavior based on data collected, calculating and informing farmers of the precise amount of pesticide required. This will help reduce the amount of pesticide applied and target a specific area, making it safe for the land and environment depicted in Figure2.

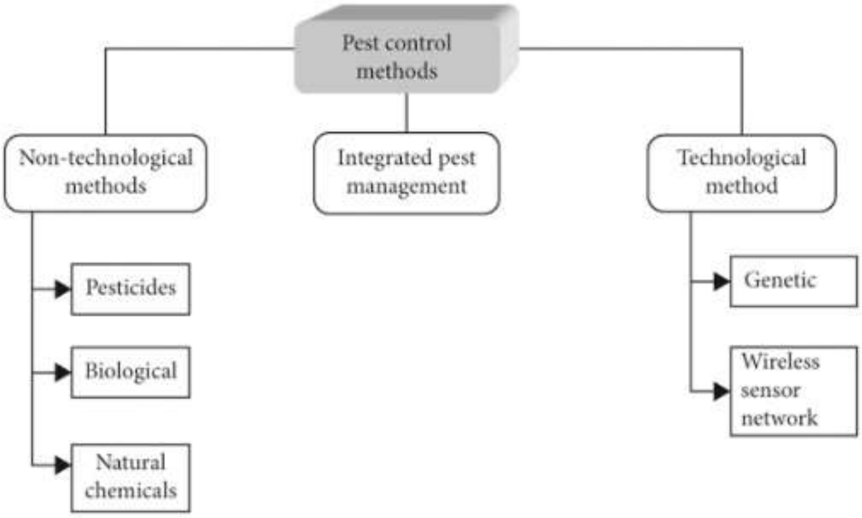

Figure 2 : Pest control Methods

V. Pest Control Methods

Three primary categories can be used to classify pest control techniques.

Farmers employ a number of methods, as previously mentioned, to manage these insect pests and prevent harm to their crops. Since we depend on these products for daily sustenance, excessive pesticide use has an adverse effect on subsurface water quality as well as humans. Moreover, pesticides are not environmentally friendly. Farmers simply spray pesticides over the entire area where they are not needed, which is risky since they do not know the right amount of pesticide required in a certain area to kill these harmful organisms. Additionally, certain beneficial insects that aid in plant pollination are killed by this ignorance. Utilizing these pesticides sparingly will prevent any negative effects. These helpful creatures can be preserved if it is possible to observe insect behavior, which makes it simple to discriminate between dangerous and beneficial organisms. In order to classify insects as beneficial or harmful, we implement an intelligent monitoring system that reads out their behavior, including their color, sound they make, chemicals they release, and flying or crawling speed. Based on this behavior, we can also determine the appropriate amount of pesticide based on the category of insect, determining whether it is more or less harmful. To create a comprehensive monitoring system, this technology is used in conjunction with WSN sensors that determine the temperature, soil moisture, water level, and other variables.

We have gathered the behavioral patterns of several insects from important crops, including wheat, potatoes, tomatoes, corn, and rice, for this aim; we highlight the characteristics of 28 insects in this study. In the fields, image sensors are used to take timely pictures of the crops. If an insect problem is found, the image is transmitted to the base station where an artificial neural network is used to process it further. The characteristics of insects that have been the subject of investigation include their color, sound, host plant, chemicals they emit, size, speed at which they fly or crawl, and classification—that is, whether they are hazardous or useful. These statistics make it simpler for a specialist to distinguish between different types of pests.

VI. Neural Netwok

Neural networks are based on the nerve system of the human brain and were inspired by the human learning technique. The architecture of an ANN's network structure is similar to that of the human nervous system. The system is example-based, meaning that learning occurs. The neurons within the neural network have a scattered structure. Spikes and neurons both have enormous amounts of information. Both calculations and flexibility are on exhibit at the greatest level. Stated differently, weight in the brain is correlated with the amount of synapses. Something is being used to store information in a neural network when it has a high weight. The weights are first set to random values, and the previous weights are then utilized to determine the new weight, bias, and neuron. The total of the input and the bias is the input to the transfer function. The transfer function is used to obtain the output with the help of the activation function. Neural network processing relies heavily on the activation function's weight and behavior. The function that first activates a cell determines how active it is in every way.

This is a hybrid strategy where two technologies can be employed sequentially or combined. Multilayer feedforward neural networks can be used to achieve this strategy. The sequential hybrid system, which uses technologies in a pipeline fashion, has been used in this paper. As a result, one technology's output turns into another's input. Since there is no integrated form of technology, this hybridization is regarded as the weakest kind. In a similar vein, the neural network used to identify the total risk in the software project receives as input the result of another type of project risk. The overall anticipated danger likelihood between low and high is the result of the partially integrated technologies, which between 0 and 1.

VII. Conclusion and Future Work

The results of this study showed that employing wireless sensor networking for autonomous insect pest monitoring in agricultural settings is feasible. Our primary objective is to develop a pest monitoring and control system that leverages wireless sensor networks (WSN) to identify insect infestations early on and alert farmers to the area, thus minimizing the labor-intensive task of thoroughly examining the entire field. An artificial neural network-based automatic detection and classification technique was presented to identify the pest based on sensory data gathered in the field. The system that is being provided is easy to use and efficient. Hardware for the suggested sensor circuits to be utilized in agriculture can be made in the future. Furthermore, the precise location of the infestation can be determined by combining GPS and GSM technology with hardware circuitry. An emergency message can then be sent to the farmer informing them of the infestation's location in their field, enabling them to take the appropriate action to safeguard the crop and boost productivity.

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