Analysis of Crop Protection Techniques Involving IoT

Prakriti Bhardwaj, Ranjan Verma, Parul Kalra, and Deepti Mehrotra

Abstract The protection of crops is very important for the improved quality of agricultural production. It plays an important role in mankind and the environment. It is significant to protect the crops from pests and plant diseases that harm the crops. Proper and accurate information about the plant/crop and soil while growing can make the crop healthy and also prevent from serious harm that may occur in the future, by using pesticides and other prevention techniques. Yield and crop production can be escalated by implementing optimum methods. With the advancement of science and technology, the growing work in this domain using sensors and other IoT equipment will be a boon for the society and environment. This research paper focuses to explore different IoT-based techniques that are available or are being researched upon for protection of crops. The paper presents an IOT-based anti-noise technique that on the protection of plants by using several techniques that bring out the best possible results in crop protection.

Keywords Crop protection · Pesticides · IoT · Pest detection · Noise-based technique

1 Introduction

Crop protection has been an important concern since the emergence of agricultural practices to enhance the quality of yield by effectively diminishing the degradation. Some enhanced techniques based on AI.

IoT and image processing are limited to disease prediction and identification, smart irrigation system, and pest identification but all these methods rely on the use of pesticides for protecting crops from pests. An approach proposed by a research paper is to monitor the monkeys approaching the farmland and producing noise as a warning signal to the farmer and also, to send the monkeys away. This method, however, does not solve the problem of pesticides usage. A majority of farmers have

P. Bhardwaj (✉) · R. Verma · P. Kalra · D. Mehrotra
Amity University Uttar Pradesh, Noida, India
e-mail: bhardwaj.prakriti@gmail.com

Y. A. Mehta et al. (eds.), *Advances in Water Resources and Transportation Engineering*,
Lecture Notes in Civil Engineering 149,
https://doi.org/10.1007/978-981-16-1303-6_18

to suffer by the damage caused by the use of pesticides. It is important to protect crops from pests by reducing the use of pesticides, thereby improving the quality of crop yields without damaging the environment.

This research paper focuses on the protection of plants by using several techniques that bring out the best possible results on crop protection. Along with the protection of crops from pests, it is important to maintain good health of the crops. Improving moisture content of the soil can contribute greatly to producing healthy crops.

2 Crop Protection Involving IOT

The main objective of this paper was to study and analyze the recent trends and techniques in the field of crop protection associated with Internet of Things. To achieve this, we scrutinized the existing research papers and journals available online. The search started with keyword mapping containing the keywords, namely crop protection, crop protection using IoT, crop protection system from pests, technologies used to protect crops from pests. The search was advanced by using keywords such as smart irrigation system, animal detection system to protect crops, IoT techniques for pest control, pest prediction system, disease prediction system, effects of pesticides on crops, anti-noise system to protect crops from pests and insects.

Based on the selected papers, it was found that the existing IoT techniques can be into three major heads, namely disease/pest prediction based, smart irrigation based, and animal detection based. Table 1 presents the studies considered in each of these categories.

A study by Qian Jing, et al., propounds an approach for acquiring the characteristics of pests based on live data of farmland. It gives detailed description of pest activity for protection of plant [1]. Heamin Lee, et al., "Disease and pest prediction IoT system in orchard: A preliminary study" proposes an IoT-based system that identifies the decrease in crop productivity and quality due to various pests and crop diseases. It notifies when the infection rate is high which in turn reduces the need of frequent use of insecticides and fungicides [2]. A study by Dattatraya Vhatkar Shivling, et al., aims to anticipate the occurrence of risk factor in apple caused by apple scab in Himalayan region based on certain parameters. A model is developed which predicts the pest accumulation up to seven days, and based on this data,

Table 1 Crop protection involving IOT

S. no.	Focus of the studies in agriculture and crop protection	Supporting studies
1.	Studies involving prediction and identification of disease and pest damaging crops	[1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
2.	Studies involving smart irrigation system	[11, 12, 13, 14, 15, 16, 17, 18, 19]
3.	Studies focused on animal detection	[20, 21, 22]

corresponding pesticides may be used [3, 8]. A research by Zhengang Yang, et al., propounds a case-based reasoning (CBR) approach for the prevention and treatment of crop disease on the basis of generated results by the forecast and prediction of crop disease and the possible extent of damage to growing crops. This CBR-based system was efficiently implemented in cucumber, taking into consideration downy mildew of cucumber [4, 16, 22].

A. K. Tripathy, et al., "Data mining and wireless sensor network for groundnut pest/disease precision protection" collects statistics and specifics of microclimate and applies multivariate regression and empirical models to improve environmental conditions and groundnut yield conditions based on the prediction of pest and disease damaging the groundnut. It does so by identifying and analyzing the correlation pattern between crop-pest and disease-weather criteria [5, 9]. A study by Kaushik Kunal Singh focuses on identification of plant disease precisely without delay by capturing images of the affected areas of the plant. This technique is 95% accurate [6]. "Application for diagnosis of diseases in crops using image processing. International Journal of life Sciences Biotechnology and Pharma Research" by Arunkumar Beyyala1 and Sai Priya Beyyala, research paper propounds the comprehensible techniques for diagnosis of plant maladies and disorders by a software system. It involves the capturing of images for the inspection and identification of diseases using image processing. It is used in farms to understand image patterns. The system is being modified so as to make early detection possible by the enhanced technologies [7, 10].

S. Harishankar et al., "Solar-Powered Smart Irrigation System." The main objective of this paper is to design a model that will prove fruitful for the problem of energy crisis faced in the long run. It does so by focusing on the energy conservation and avoidance of water wastage [11]. Andre Boehman, et al., "Solar-Powered Irrigation System" present an archetype of irrigation system controlled by solar energy. Based on the requirements, water will be irrigated to the crops from the pump using solar energy. Shelek and Kazakstan are the cities chosen for the field work. It proposes a cost-effective model that is viable and eco-friendly [12, 18].

An automatically controlled irrigation system that supplies water to the plants based on the need as recorded by sensor that checks moisture content of the soil from time-to-time. PIC controller is the main component of this model. The entire system uses solar energy for its working [13]. A smart farm irrigation system based on IoT, android, and cloud computing. The data is received and handled in real time. It is a wireless communication system and reduces the human effort to a great extent. The system also allows remote controlling through android phone [14]. A study by Wali Mohammad Abdullah and Sharmin Islam proposes a smart irrigation system that uses fuzzy logic to operate the working of motor for pumping water along with the optimized use of solar energy to utilize maximum power by retaining minimal wastage of power [15, 17].

A study done by Kuei-Chung Chang and Zi-Wen Guo uses IP cameras to monitor the monkeys approaching the farmland and sends a warning signal to the farmer. When monkeys start advancing the farmland, noise is produced to send the monkeys away [20]. Bharath, H. P., "Vision-Based Animal Detection and Alerting For Crop Protection". This paper proposes vision-based animal detection system, effective for

crop protection that constitutes a camera and a computer coupled using the technologies of computer vision and deep learning using Python. The camera is used to capture images and videos of the animals approaching the crop field. Using image processing, the captured image is matched with the database. An additional option to download the data of unregistered animals from the Web is also provided. Based on the identified creature, their details are sent as an alert message, and buzzer is played to keep the intruder at Bay [21, 19].

3 Proposed Architecture

From review of papers, we concluded that the anti-noise-based IoT technique has a better future scope as it is based on minimizing the crop destruction by removing the pest at the initial stage of crop growth.

Considering the above, we attempted to design an anti-noise device. Figure 1 shows the architecture of the proposed model with the components used to build and design the product in the paper. **ThingSpeak** is an open-source application of IoT that is used as a server to send and receive statistical data provided by the sensors for collecting and analyzing values of temperature, moisture, and humidity. **Voice Recognition kit** is used to listen and analyze voice received as input to it. Depending on the input of the voice recognition kit, anti-noise will be generated to annoy the inspects that will compel them to move away from the crops.

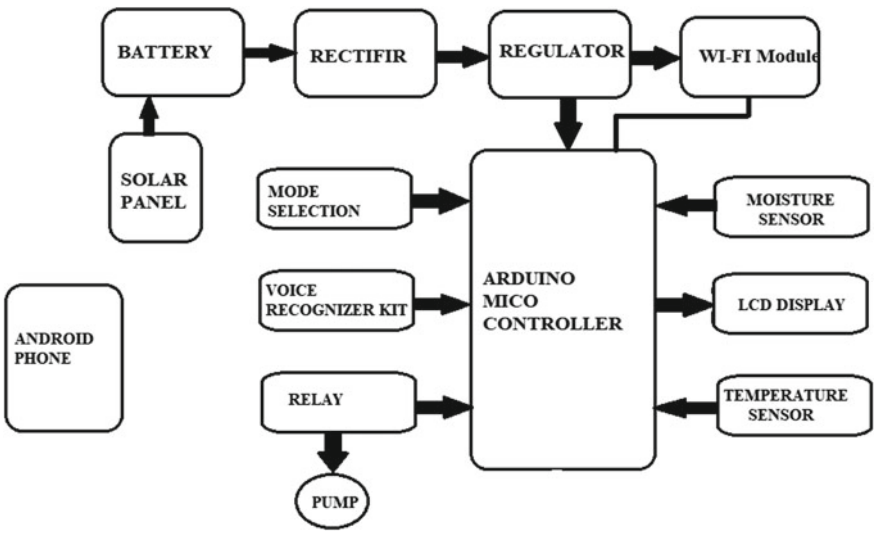

Fig. 1 Block diagram of the proposed anti-noise technique-based product

Photovoltaic solar panels get energy from sunlight which is then converted into electricity (DC current). It acts like a central control panel. It generates clean and green electricity. Moisture sensor is a sensor which senses the amount of moisture present in the soil. It has outputs in form of analog as well as digital signals. **Arduino micro-controller** is a single-board micro-controller that reads inputs and turns them into outputs. The readings from moisture sensor, temperature sensor, mode selection, relay, and voice recognition kit serve as inputs to the Arduino board. The resultant reading is shown on the screen of LCD display. All the equipments and components are inter-connected.

4 Analysis and Discussion

Crop protection has been an important concern since the emergence of agricultural practices, and its awareness has spread significantly over the past years.

This research paper analyzes the protection of plants by using the techniques mentioned in our studies and brings out the best possible results on crop protection.

Pesticides cause huge damage to the soil and environment. They kill the respective pests but also harm other living organisms and the environment, thus degrading the soil fertility. Hence, their use should be minimized.

An alternative approach should be used to protect crops from pests by reducing the use of pesticides, thereby improving the quality of crop yields without damaging the environment.

Table 2 shows a list of the pests and insects, with their respective pesticide category, whose anti-noise is available. Using the technique of anti-noise generation, use of pesticides can be reduced as the insects will be compelled to move away from the crops using anti-noise itself. In order to use anti-noise generation technique, it is important to know about the pests whose anti-noise is already known.

If a pest, whose anti-noise is not in record, approaches the crops, this method is not recommended. Although it is not recommended to use pesticide every time a pest approaches the crop, pesticides are suggested in case their anti-noise is not available or pest accumulation is in excess. If not controlled in time, pests will cause great harm to the crops.

5 Conclusion

Awareness for crop protection has spread significantly over the past years. It is important to protect crops from pests by reducing the use of pesticides, thereby improving the quality of crop yields without damaging the environment. Pesticides are used to kill and remove pests from soil and plants which decrease the nutrients of the soil and harm the environment and henceforth, damaging the crops and degeneration of their yield. To worsen the condition, impact of the pesticides remains for a long time

Table 2 List of pests/insects whose anti-noise is available

S. no.	Insects	Availability of anti-noise	Categories of pesticides used
1	Rats	Yes	Rodenticides
2	Mice	Yes	Rodenticides
3	Cockroaches	Yes	Insecticides
4	Squirrels	Yes	Rodenticides
5	Mosquitoes	Yes	Insecticides
6	Flies	Yes	Insecticides
7	Bedbugs	Yes	Insecticides
8	Reptiles	Yes	Insecticides
9	Ants	Yes	Insecticides
10	Snake	Yes	Insecticides
11	Worm	Yes	Insecticides
12	Cricket	Yes	Insecticides
13	Caterpillar	Yes	Insecticides
14	Larvae	Yes	Larvicides
15	Spider	Yes	Insecticides
16	Field Cricket	Yes	Insecticides
17	Moths	Yes	Insecticides
18	Fruit flies	Yes	Insecticides
19	Midges	Yes	Insecticides

even when pests are not present on the crops. Hence, anti-noise technique should be used to remove pests from plants as it compels the pests to move away from the plants without damaging the crops and environment. However, pesticides protect the crops by getting rid of the accumulation of pests near it. Such techniques can further be complemented with smart irrigation technique for improving the crop yield and improving the quality of produce. Thus, the advent of IoT has opened many new opportunities to improve the overall agriculture health and produce of our country.

References

1. Jing Q, Yu-man N, Yong-ping W, Ping-guo C, Jian-he L, Quan-jun S (2018, May) Dynamic features extraction system of live pests in farmland. In: 2018 33rd Youth academic annual conference of Chinese association of automation (YAC). IEEE, pp 1141–1146
2. Lee H, Moon A, Moon K, Lee Y (2017, July) Disease and pest prediction IoT system in orchard: a preliminary study. In: 2017 Ninth international conference on ubiquitous and future networks (ICUFN). IEEE, pp 525–527
3. Shivling DV, Sharma SK, Ghanshyam C, Dogra S, Mokheria P, Kaur R, Arora D (2015, October) Low cost sensor based embedded system for plant protection and pest control. In:

2015 International conference on soft computing techniques and implementations (ICSCTI). IEEE, pp 179–184
4. Yang Z, Luo Y, Deng F, Li L (2006) Crop disease dynamic forecast integrated with case-based reasoning methodology. In: 2006 6th World congress on intelligent control and automation, vol 1. IEEE, pp 2551–2554
5. Tripathy AK, Adinarayana J, Merchant SN, Desai UB, Ninomiya S, Hirafuji M, Kiura T (2013) Data mining and wireless sensor network for groundnut pest/disease precision protection. In: 2013 National conference on parallel computing technologies (PARCOMPTECH). IEEE, pp 1–8
6. Singh KK (2018) An artificial intelligence and cloud based collaborative platform for plant disease identification, tracking and forecasting for farmers. In: 2018 IEEE International conference on cloud computing in emerging markets (CCEM). IEEE, pp 49–56
7. Beyyala A, Beyyala SP (2012) Application for diagnosis of diseases in crops using image processing. Int J Life Sci Biotechnol Pharma Res 1(1):172–175
8. Sreekantha DK, Kavya AM (2017, January) Agricultural crop monitoring using IOT-a study. In: 2017 11th International conference on intelligent systems and control (ISCO). IEEE, pp 134–139
9. Radha R, Tyagi AK, Kathiravan K, Betzy GS (2018) Precision crop protection using wireless sensor network. In: International conference on intelligent systems design and applications. Springer, Cham, pp 280–290
10. Jha RK, Kumar S, Joshi K, Pandey R (2017) Field monitoring using IoT in agriculture. In: 2017 International conference on intelligent computing, instrumentation and control technologies (ICICICT). IEEE, pp 1417–1420
11. Harishankar S, Kumar RS, Sudharsan KP, Vignesh U, Viveknath T (2014) Solar powered smart irrigation system. Adv Electron Electr Eng 4(4):341–346
12. Abbott S, Baker I, Nakkula RJ (2015) Solar-powered irrigation for Shelek, Kazakhstan
13. Prakash N, Balaji VR, Sudha M (2016) Solar powered automated irrigation system for agriculture. Int J Adv Eng Technol VII(I):854, 858
14. Saraf SB, Gawali DH (2017) IoT based smart irrigation monitoring and controlling system. In: 2017 2nd IEEE international conference on recent trends in electronics, information & communication technology (RTEICT). IEEE, pp 815–819
15. Abdullah WM, Islam S (2015) A proposed smart irrigation system with enhanced solar power and logic based power generation systems. In: Proceedings of the sixth international conference on computer and communication technology 2015, pp 91–94
16. Rau AJ, Sankar J, Mohan AR, Krishna DD, Mathew J (2017) IoT based smart irrigation system and nutrient detection with disease analysis. In: 2017 IEEE Region 10 Symposium (TENSYMP). IEEE, pp 1–4
17. Gayatri MK, Jayasakthi J, Mala GA (2015) Providing smart agricultural solutions to farmers for better yielding using IoT. In: 2015 IEEE technological innovation in ICT for agriculture and rural development (TIAR). IEEE, pp 40–43
18. García L, Parra L, Jimenez JM, Lloret J, Lorenz P (2020) IoT-based smart irrigation systems: an overview on the recent trends on sensors and IoT systems for irrigation in precision agriculture. Sensors 20(4):1042
19. Galedar MN, Jafari A, Mohtasebi SS, Tabatabaeefar A, Sharifi A, O'Dogherty MJ, Richard G (2008) Effects of moisture content and level in the crop on the engineering properties of alfalfa stems. Biosyst Eng 101(2):199–208
20. Chang KC, Guo ZW (2018) The Monkeys are coming—design of agricultural damage warning system by IoT-based objects detection and tracking. In: 2018 IEEE International conference on consumer electronics-Taiwan (ICCE-TW). IEEE, pp 1–2
21. Mohanraj K, Karthikeyan BS, Vivek-Ananth RP, Chand RB, Aparna SR, Mangalapandi P, Samal A (2018) IMPPAT: a curated database of Indian medicinal plants, phytochemistry and therapeutics. Sci Rep 8(1):1–17
22. Kramer PJ (1969) Plant and soil water relationships: a modern synthesis. In: Plant and soil water relationships: a modern synthesis