International Conference on Recent Trends in Data Science and its Applications
DOI: rp-9788770040723.067

Use of Sensor Networks with Self-Organizing Algorithm to Increase the Agricultural Productivity

Deepika A. Ajalkar,
Assistant Professor,
Department of IT, G H Raisoni College of Engineering and Management,
Pune, India, dipikaus@gmail.com

Bappaditya Das
Assistant Professor, Department of Computer Science & Engineering,
Dr. B. C. Roy Engineering College,
Durgapur, West Bengal, India,
bappaditya.das@bcrec.ac.in

Pravin Mane
Assistant Professor,
BhartiVidyapeeth(Deemed to be) University Institute of Management and Entrepreneurship Development
Pune,India,
Pravin.Mane@bharatividyapeeth.edu

H.Pradeep
Assistant Professor,
Department of Mechanical Engineering,
BGS Institute of Technology,
BG Nagara, 571448, MandyaDistrict,
Karnataka,India,pradeephgowda@gmail.com

Mohd. Shaikhul Ashraf,
Assistant Professor,
Department of Botany,
HKM Govt. Degree College Bandipora,
Kashmir-193505,
India,mohdshaikhulashraf@gmail.com

Ravi Ray Chaudhari,
Assistant Professor (CSA), ITM University Gwalior,
Madhya Pradesh, India,glaitmravi@gmail.com

Abstract—Traditional farming methods are becoming incapable of keeping up with global population growth. As a result, innovative farming ideas are desperately necessary to meet the food needs of a growing population. Intelligent farming systems based on sensor networks with self-organizing algorithms have gained popularity in recent years as a means of increasing agricultural production. In this study, we will use sensor networks with self-organizing algorithms to boost agricultural productivity. Finally, the paper describes the future applications of appropriate technology in agricultural production.

Keywords—Sensor Networks, Self-Organizing Algorithm, Agricultural Productivity.

I. Introduction

The ratio of agricultural outputs to inputs is used to calculate agricultural productivity. While individual products are typically measured by weight, which is referred to as crop yield, the variety of products makes evaluating overall agricultural production difficult. As a result, agricultural productivity is generally measured as the market value of the finished product. This productivity can be compared to a variety of inputs, including labor and land. These types of comparisons are known as partial measures of productivity. Agricultural productivity is the amount of output generated with a given amount of inputs. Long-term productivity growth is a result of improvements in farmer productivity efficiency and technological advancement [1]. A sensor network is a collection of sensors that monitor data in different locations and send it to a centralized location for backups, observation, and analysis. Wireless sensor networks are networks of sensors that are spatial and temporal dispersed and dedicated to monitoring and recording the physical environmental parameters and transmitting the collected information to a data location. Temperature, noise, pollution levels, humidity, and wind can all be measured by WSNs. Fig.1 illustrates the self-organizing map algorithm.

In general, monthly and annual meteorological statistics provide very rough information about respective weather factors. These statistics do not substantially reflect the overall phenomenon of weather features during a certain period, and they do not give any characteristics on the temporal and sequential distribution of repetition and alteration trends. Instead, these statistics provide very general information [2-3].

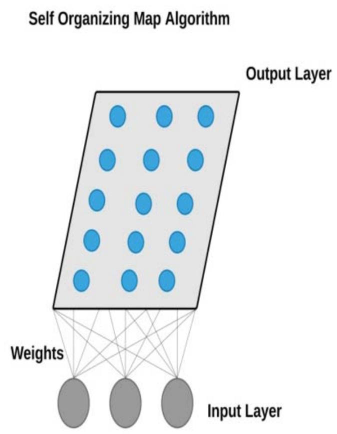

Fig.1 Self-Organizing Map Algorithm

The status of the atmospheric circulation in the surrounding area is used to produce predictions of the weather. Both of these sorts of information are often utilised by farmers as reference guides for crop cultivation; yet, it is difficult for farmers to forecast and comprehend exactly what meteorological phenomena and characteristics may possibly occur within a certain time range. Therefore, the purpose of this research was to use data-mining techniques to discover/induce the annual pattern and distribution of weather types and features of a region based on historical meteorological data, including their occurrence time, frequency, continuity, and intensity, in order to provide agricultural operationists with the ability to anticipate the occurrences and trends of weather types and features during each specified period for the purpose of engaging in appropriate cultivation tasks in advance. SOA makes it easier to provide compound services that encompass the whole of a client's operations; in this context, a customer may be either a citizen or an organisation [4-5]. Existing systems have difficulties integrating the data from the many cloud servers because of these problems. Insufficient

DOI: rp-9788770040723.067

agricultural infrastructure and support facilities, Inadequate ability on the part of institutions to provide services tailored to the needs of farmers due to the farmers' lack of information about appropriate farming procedures, Agricultural content development and its up gradations [6-8].

II. Literature Review

Mohan et al. (2018) proposed a SOM in conjunction with LDA.Self Organizing Map strategy is an excellent dimensionality reduction strategy for emphasizing the self-arranging outline. The dimensionality lowered data is used to predict climate for a reasonable solution after reducing the measurement [9]. The experimental results reveal that the improved approach outperformed existing methods in terms of climate and crop prediction accuracy. Hidalgo et al. (2021) and Sivakumar P (2015) suggested an unsupervised methodology based on Kohonen self-organized maps for reducing the dimensionality of hyperspectral images. This paper's results are based on an RBF classifier. In comparison to other popular algorithms, the results indicate the reduction of dimensionality methodology based on the maps that are always being self-organized in an effective system [10]. This is due to maps' ability to automate the identity relation that creates a set of patterns that are passed as inputand offers to deal with hyperspectral image features with most advancements. Ghadge, Rushika, et al. (2018) Sridaran K et. al. (2018), and Buvana M et al (2021) propose using a data mining approach to assist farmers in determining soil quality. Thus, the system focuses on assessing soil quality to predict which crops are suitable for cultivation based on soil type and to maximize crop yield by recommending appropriate fertilizer. Kumar, Navsal, et al. (2021)Karnan B et al (2022), and Latchoumi TP et al (2022 used microclimatic variables such as air temperature, canopy temperature, and relative humidity to develop a map-based model to analyze CWSI [11]. The canopy temperature was measured on Indian mustard cultivated in a humid climate.Mekonnen, Yemeserach, and colleagues (2019) provided an in-depth examination of the use of various ML algorithms in sensor data analytics within the agroecosystem [12-13]. It goes on to talk about a case study of Internet of Things-based data options that are driven by an intelligent farm prototype of incorporated energy, food, and water(EFW) schemes.Kumar et al. (2018) surveyed the significance of sensors in PA as well as WSN techniques for remote monitoring in various agricultural applications [14].

Sanjeevi, P., et al. (2020) investigated the WSN structure from the perspectives of throughput maximization, latency reductions, high SNR ratio, least mean square error, and enhanced coverage area. The experimental results show that the proposed technique outperforms traditional IoT-based agricultural production and farming. Hamami et al. (2020) researched to examine the use of WSN in irrigation [15]. The use of WSN technology to manage and control irrigation systems is an optimal solution for ensuring efficient and rational water use and thus contributing to the occurrence of the global water crisis.MobasshirMahbub (2020) recommended systems that are used for fields and create livestock in the fields where the controls are supplied from the embedded systems, and wireless network system [16-17]. This system describes systems with electron circuitry, protocols, and intelligent monitoring devices using the remote process for computers and Smartphones. It then includes some propositions before concluding with a description of the prospective scopes of appropriate technology in smart farming[18].

III. Proposed Work

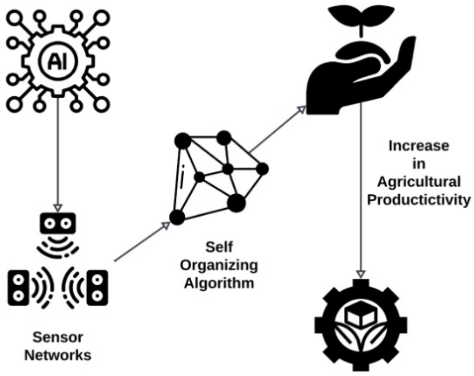

Fig.2 Illustration of Sensor networks with SOM Algorithm in Agriculture

Fig.2 Illustrates the use of Sensor networks with SOM Algorithm in Agriculture productivity increase. Watering, fertilizing, and pesticides are necessary for successful farming and food production. To create an automated type of system that will perform every activity. Systems recommended in this model include agri-field humidity remote motorizationand watering, pest detection and pesticide spraying using automation technique, pH scale tracking and filtering using the copters used for the quad purpose, and agri-field intruder and sometimes it can be an animal alert model, and so on. The agricultural sector has made tremendous progress. These advancements have resulted in a computerized method in which crop growth can be monitored and devices can be controlled using WSN [19]. A WSN's fundamental function is to gather data from a distance and send it across wireless networks that the receiver can monitor. The agri-sector may benefit from the adoption of WSN technology, especially for dispersed data collection from agricultural surroundings and, more crucially, for providing farmers with real-time information from the farming field [20].

Here the suggested model includes an optimization method that can handle time series-based rules to manage a variety of jobs. It is carried out to conserve energy. The only tasks involved are the execution of local data and it's unloading. More emphasis is placed on queue-based algorithms since queueing is crucial for managing the system's duties is presented in Equation (1).

$$B_{u_m} = P^{*}\left(ru_m \vee \phi_{target}\right) + c(1)$$

DOI: rp-9788770040723.067

The parameters of the neural network are updated using the deterministic policy gradient shown in the following Equation (2).

$$\nabla_{\phi_{target}}\, g\left(R^*(u_m)\right) = E_{r_{u_m}}\left[\nabla_{\phi_{target}}\, f\left(p^*(U_{u_m})\right)\nabla_{A_k} p(U_{u_m}, B_c)\right] \quad (2)$$

The device and critic network parameters are provided by the DDPG using the least-squares method. Buffer queue length L(t n), channel matrix$M(u_m)$, SINR, and offloading ratio are the components of state-space s (t n). The action space A (t n) consists of the energy used by the three levels of the devices and the bandwidth distribution between the layers are presented in Equation (3), Equation (4), and Equation (5) respectively.

$$su_m = -F[\psi_1 j_1 \alpha_3 j_2 + (1-\psi_1)\alpha_4 M(u_m) - Q(u)] \quad (3)$$

$$I_1 = \alpha_1 \sum_{i=1}^{c} F_i\,(u_m) + \alpha_2 \sum_{j=1}^{c} \pi_i\, C_n(u_m) \quad (4)$$

$$I_2 = \sum_{i=1}^{c}\sum_{j=1}^{m} \pi_m\, c_m(u_m) \quad (5)$$

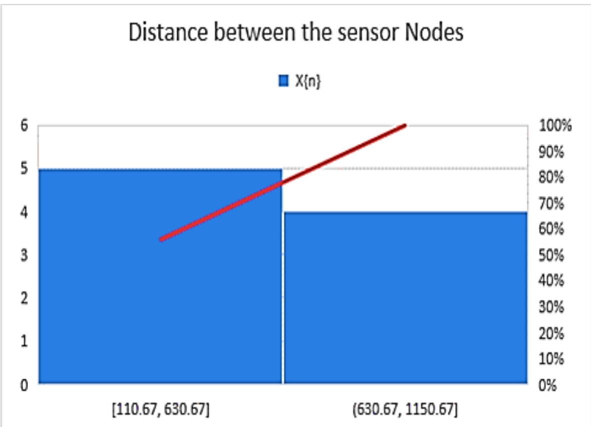

Fig.3. Analysis based on the distance between two sensors

IV. Experimental Results

The distance between two sensors nodes play a vital role in data collection in the agricultural land. The collected data aids in taking necessary action in increasing the productivity of the agriculture is presented in the Fig.3 as shown above.The recommended system also includes a WSN with all the detection systems and some of the sensors that monitor the entire agri-environment. A SOM is an unlabelled dataset that can be processed using an unsupervised learning model in machine ML technique that generates a dimensional representation in the lower range while keeping the data's topological structure, an average-dimensional data set. A SOM is a type of ANN model that, unlike other artificial neural networks, is taught through competitive learning as opposed to error-correction learning

TABLE 1: Algorithm Comparison with the Previous Models

Algorithm	Crop Protection (%)	Crop Yielding (%)	Overall Accuracy (%)
Machine Learning Algorithm	89.78	94.67	95.01
The algorithm used in the existing Model	87.98	91.45	93.60

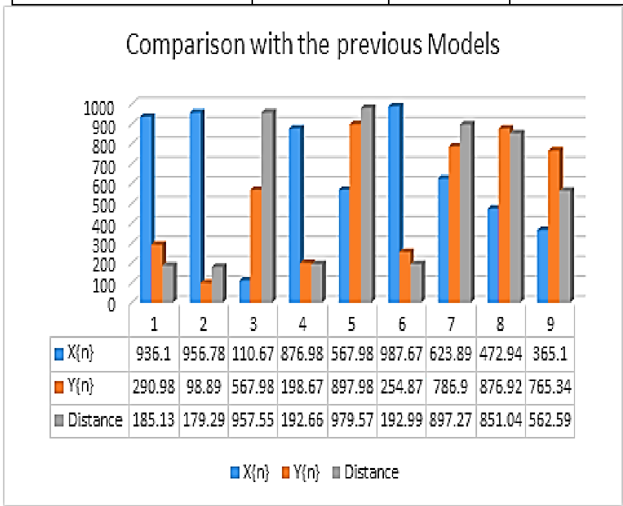

Fig. 4. Comparison on different models on agriculture productivity

Fig.4 and Fig.5 depicts the comparative analysis of the proposed model based on the distance among the different nodes and location of the given area.

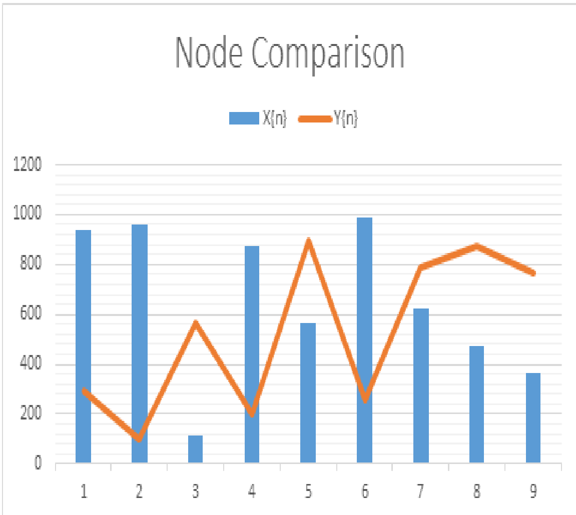

Fig.5. Comparison based on Performance among nodes

V. Conclusion

A mapping is an un-labeled dataset with the ML tool that generates a dimensional representation with a reduced range of increased dimensional data while handling the data's structure. The training process for a SOM differs from that of other artificial neural networks in that it uses competitive learning rather than error-correction learning.

DOI: rp-9788770040723.067

The SOM, also known as a Kohonen map or Kohonen network, was created in the 1980s by the Finnish academic TeuvoKohonen.

REFERENCES

[1] Mohan, Pushpa, and KiranKumariPatil, "Deep learning based weighted SOM to forecast weather and crop prediction for agriculture application," Int. J. Intell. Eng. Syst., vol. 11, pp. 167-176, 2018.

[2] Hidalgo, David Ruiz, Bladimir Bacca Cortés, and Eduardo Caicedo Bravo,"Dimensionality reduction of hyperspectral images of vegetation and crops based on self-organized maps," Information Processing in Agriculture, vol. 8.2, pp. 310-327, 2021.

[3] Ghadge, and Rushika, et al. "Prediction of crop yield using machine learning," Int. Res. J. Eng. Technol. (IRJET), p. 5, 2018.

[4] Kumar, and Navsal, et al. "Self-organizing map estimator for the crop water stress index," Computers and Electronics in Agriculture, vol. 187,p. 106232, 2021.

[5] Li, Tao, et al. "Using self-organizing map for coastal water quality classification: Towards a better understanding of patterns and processes," Science of the Total Environment, vol. 628,pp. 1446-1459, 2018.

[6] Mekonnen, and Yemeserach, et al. "Machine learning techniques in wireless sensor network based precision agriculture." Journal of the Electrochemical Society, vol. 167.3, p. 037522, 2019.

[7] Kumar, Subramania Ananda, and Paramasivam Ilango,"The impact of a wireless sensor network in the field of precision agriculture: A review," Wireless Personal Communications, vol. 98.1, pp. 685-698, 2018.

[8] P.Sanjeevi, et al., "Precision agriculture and farming using Internet of Things based on wireless sensor network," Transactions on Emerging Telecommunications Technologies, vol. 31.12, p. e3978, 2020.

[9] Hamami, Loubna, and BouchaibNassereddine, "Application of wireless sensor networks in the field of irrigation: A review," Computers and Electronics in Agriculture, vol. 179,p. 105782, 2020.

[10] Mahbub, and Mobasshir, "A smart farming concept based on smart embedded electronics, internet of things and wireless sensor network," Internet of Things, vol. 9,p. 100161, 2020.

[11] Sitharthan, R., Vimal, S., Verma, A., Karthikeyan, M., Dhanabalan, S. S., Prabaharan, N., ...&Eswaran, T. (2023). Smart microgrid with the internet of things for adequate energy management and analysis. Computers and Electrical Engineering, 106, 108556.

[12] B.Karnan, A.Kuppusamy, T. P.Latchoumi, A.Banerjee, A.Sinha, A.Biswas,and A. K. Subramanian, “Multi-response Optimization of Turning Parameters for Cryogenically Treated and Tempered WC–Co Inserts,” Journal of The Institution of Engineers (India): Series D, pp. 1-12, 2022.

[13] M. Monica, P.Sivakumar, S. J.Isac,and K. Ranjitha, “PMSG based WECS: Control techniques, MPPT methods and control strategies for standalone battery integrated system,” In AIP Conference Proceedings, AIP Publishing LLC, vol. 2405, no. 1, p. 040013, April, 2022.

[14] P. Sivakumar, “Effectual web content mining using noise removal from web pages,” Wireless Personal Communications, vol. 84, no. 1, pp. 99-121, 2015.

[15] Vemuri, RatnaKumari, Pundru Chandra Shaker Reddy, Puneeth Kumar, Jayavadivel Ravi, Sudhir Sharma, and SivakumarPonnusamy. “Deep learning based remote sensing technique for environmental parameter retrieval and data fusion from physical models,” Arabian Journal of Geosciences, vol. 14, no. 13,pp. 1-10, 2021.

[16] K.Sridharan,and P. Sivakumar, “A systematic review on techniques of feature selection and classification for text mining,” International Journal of Business Information Systems, vol. 28, no. 4, pp. 504-518, 2018.

[17] M.Buvana, K.Loheswaran, K.Madhavi, S.Ponnusamy, A.Behura,and R. Jayavadivel, “Improved resource management and utilization based on a fog-cloud computing system with IOT incorporated with classifier systems,” Microprocessors and Microsystems, p. 103815, 2021.

[18] Moshika, A., Thirumaran, M., Natarajan, B., Andal, K., Sambasivam, G., &Manoharan, R. (2021). Vulnerability assessment in heterogeneous web environment using probabilistic arithmetic automata. IEEE Access, 9, 74659-74673.

[19] ManjunathanAlagarsam, Sterlin Rani Devakadacham, HariharanSubramani, SrinathViswanathan, JazizevelynJohnmathew, and KannadhasanSuriyan, “Automation irrigation system using arduino for smart crop field productivity”, International Journal of Reconfigurable and Embedded Systems (IJRES), vol. 12, no. 1, pp. 70-77, March 2023.

[20] ChitraRaju, SudarmaniRajagopal, KanagarajVenusamy, KannadhasanSuriyan, and ManjunathanAlagarsamy, “SDSFLF: fault localization framework for optical communication using software digital switching network” , International Journal of Reconfigurable and Embedded Systems (IJRES), vol. 12, no. 1, pp. 113-124, March 2023.