IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 12, Issue 5, May 2023

DOI: 10.17148/IJARCCE.2023.12565

SENSORS DRIVEN AI-BASED AGRICULTURE RECOMMENDATION MODEL FOR ASSESSING LAND SUITABILITY

Dr. Nagendra Kumar M[1], Darshan k Gowda[2]

Professor, Dept. of Electronics and Communication SJC Institute of Technology, Chikkaballapura, India[1]

Student, Dept. of Electronics and Communication, SJC Institute of Technology, Chikkaballapura, India[2]

Abstract: The world population is expected to grow by another two billion in 2050, according to the survey taken by the Food and Agriculture Organization, while the arable area is likely to grow only by 5%. Therefore, smart and efficient farming techniques are necessary to improve agriculture productivity. Agriculture land suitability assessment is one of the essential tools for agriculture development. Several new technologies and innovations are being implemented in agriculture as an alternative to collect and process farm information. The rapid development of wireless sensor networks has triggered the design of low-cost and small sensor devices with the Internet of Things (IoT) empowered as a feasible tool for automating and decision-making in the domain of agriculture. This research proposes an expert system by integrating sensor networks with Artificial Intelligence systems such as neural networks and Multi-Layer Perceptron (MLP) for the assessment of agriculture land suitability. This proposed system will help the farmers to assess the agriculture land for cultivation in terms of four decision classes, namely more suitable, suitable, moderately suitable, and unsuitable. This assessment is determined based on the input collected from the various sensor devices, which are used for training the system. The results obtained using MLP with four hidden layers is found to be effective for the multiclass classification system when compared to the other existing model. This trained model will be used for evaluating future assessments and classifying the land after every cultivation

I. INTRODUCTION

Agriculture farming is considered as the base for human living because it is the primary source of food and income for most of the countries in the world. The economy of the country depends on agriculture production as it provides food, raw materials, employment, etc., to the people living in that country [1]. It has been observed in recent times that there is no significant development in crop production in the agriculture sector. Also, there is a rapid increase in the price of food because the production of the crop is not meeting demand [2]. One of the causes for the decrease in crop production is the farmers use of the traditional way of cultivation, which leads to less crop yield. The farmers new to the agriculture field have insufficient knowledge about the characteristics of soil for crop cultivation [3]. They are not conscious of the fact that agriculture land needs to be assessed before cultivation [4].

Land suitability analysis is a mandatory prerequisite for crop cultivation, which helps to obtain maximum production. In order to acquire the properties of the soil, farmers depend on soil testing labs, which are not sufficient enough to help them, and sometimes the data provided by the labs are inaccurate [5]. In order to get enough knowledge about cultivation, data need to be collected manually, which is very difficult for farmers. The solution is the replacement of traditional methods of data collection with Internet of Things (IoT)-based sensors [6]. Sensors play a significant role in collecting information about various factors such as soil, water, climate, etc., for agriculture development. With the help of data gathered from different sensors, land suitability analysis could be done, which would help farmers identify the current status of their agriculture land and improve their crop production. Several decision models have been developed so far to assist the farmers in taking a decision on crop cultivation to maximize their profit [7].

Ever-changing real-world conditions like monsoons to temperate are the dominant factors in affecting agriculture productivity. Soil parameters to weather prediction are essential in knowing the future yield [8]. The key factors that are influencing the crop yield are climatic conditions, soil productivity, and groundwater characteristics, as well as its availability. An extensive study on phenotyping is helping researchers to understand these factors [9]. One of the significant challenges involved in identifying the different land conditions is based on the influence of various soil parameters. Over the past few decades, soil testing has been practised, which is widely accepted by agriculture experts

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 12, Issue 5, May 2023
DOI: 10.17148/IJARCCE.2023.12565

and farmers to determine the properties of soil for agriculture production [10]. The Agriculture Management Information System (AMIS) is mandatory to store the data acquired in various formats and exchanges the data for digital agriculture technology [11]. Currently, AMIS has enhanced its facilities by accumulating the latest technologies, such as the Internet and the Internet of Things (IoT).

Introduction of the usage of sensors actually reduces the cost and time involved in assessing the land suitability in the traditional manner [12]. The uses of sensors are plenty, and it is possible to use as many sensors in the field of agriculture. Soil sensors, water sensors, and biosensors are few that have been shown to have a significant role in measuring nature. These sensors contribute to the smart farming system, especially in the handling of appropriate irrigation systems to help farmers. The Radio Frequency Identification (RFID) technology is used for the detection of animals entering into the farmland. The Global Positioning System (GPS) position-based seeding recommendation is emerging as another benefit in the field of agriculture benefiting from the latest technological developments [13]. Some of the benefits it has achieved in recent days are improved efficiency, sustainable growth, as well as costeffectiveness. It is considered to be the connection between the collection of physical devices through internet connection such as WIFI, Data cards, etc.As a revolutionary change, the sensor-driven network has a considerable role in precision agriculture [14]. Timely forecast based on soil parameters will ensure proper irrigation systems. IoT has a significant role in handling the recorded data from sensors. General Purpose Input/Output facilitates various sensor inputs and the corresponding outputs in Raspberry Pi. Further, this could really help in hosting different sensors. Cloud computing is helping the IoT sensor networks to record the measured data through its sensors. The wireless medium is transferring the data to the cloud, which is used later for data analysis [15].

Data Analytics has brought impactful results for future predictions in almost every single application. Artificial intelligence-based model building is a challenging task as the model should replicate the observed parameters in the dataset. Parametric estimations are helpful in solving the problems in a futuristic way, and agriculture problems are among those [16]. Agriculture data analysis is done with different machine learning algorithms. Maximizing the outcome is the agenda for any machine learning model, and model assessment metrics are helpful in analysing the results obtained. Appropriate training of the machine learning model will produce the results with utmost accuracy. Neural network-based models are used widely, as they have the capability to improve the efficiency of the model over every iteration [17]. Classification problems are handled by various algorithms, such as support vector machines, decision tree algorithms, etc. Multiclass classifications are expertly handled by neural network algorithms [18]. When the model is trained with the appropriate number of inputs and outputs, it is expected to give better results compared to other machine learning models. The integration of IoT, along with machine learning models, are providing the farmer recommendation system with appropriate inputs [19].

In this work, an agriculture dataset has been obtained through various IoT sensor devices such as a pH sensor, soil moisture sensor, salinity sensor, and electromagnetic sensor. A sensor is a device which is used to detect and respond to some type of input obtained from the physical environment [20]. As it requires less labour and consumes less time, it is used in many real-time applications. As the Internet plays a mediatory role in various kinds of communication and data exchange, it is advisable to integrate the agriculture data with the cloud platform. The data acquired from the various IoT devices could be stored to the cloud platform [21].

II. LITERATURE SURVEY

A.K.Pushkala, et al evaluated to control and monitor the sensor device, one mobile application was created and it was adopted with the sensor device. For wireless data transmission, the Bluetooth wireless technology was used in the data transformation. A Bluetooth device uses radio waves instead of wires or cables to connect to a phone or computer. The communication between Bluetooth devices happens over short-range, ad hoc networks known as Pico nets. This paper aims at developing an intelligent system capable of monitoring and controlling of different parameters using Bluetooth technology [23].

V.R.Satpute, et al evaluated the IoT based on a smart agriculture system was developed using deep reinforcement learning integrated with a cloud environment, in which four layers were included, namely data collection, edge computing, data transmission, and cloud computing. IoT has been integrated with agriculture systems to yield maximum profit, and the applications of IoT in agriculture have been categorized into restricted environment planning, open farm planting, livestock farm monitoring, and aquaculture development [22].

H.Park, et al evaluated that Artificial intelligence-based model building is a challenging task as the model should replicate the observed parameters in the dataset. Parametric estimations are helpful in solving the problems in a futuristic way, and agriculture problems are among those. Agriculture data analysis is done with different machine learning algorithms [16].

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 12, Issue 5, May 2023

DOI: 10.17148/IJARCCE.2023.12565

III. TECHNOLOGY

Artificial intelligence: Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving. The ideal characteristic of artificial intelligence is its ability to rationalize and take actions that have the best chance of achieving a specific goal. A subset of artificial intelligence is machine learning (ML), which refers to the concept that computer programs can automatically learn from and adapt to new data without being assisted by humans. Deep learning techniques enable this automatic learning through the absorption of huge amounts of unstructured data such as text, images, or video. AI is continuously evolving to benefit many different industries. Machines are wired using a cross-disciplinary approach based on mathematics, computer science, linguistics, psychology, and more.

Machine Learning: Machine learning is a growing technology which enables computers to learn automatically from past data. Machine learning uses various algorithms for building mathematical models and making predictions using historical data or information. Currently, it is being used for various tasks such as image recognition, speech recognition, email filtering, Facebook auto-tagging, recommender system, and many more. Machine Learning is said as a subset of artificial intelligence that is mainly concerned with the development of algorithms which allow a computer to learn from the data and past experiences on their own. The term machine learning was first introduced by Arthur Samuel in 1959. The need for machine learning is increasing day by day. The reason behind the need for machine learning is that it is capable of doing tasks that are too complex for a person to implement directly. As a human, we have some limitations as we cannot access the huge amount of data manually, so for this, we need some computer systems and here comes the machine learning to make things easy for us.

Cloud Computing: In 2006, Amazon Web Services (AWS) started to offer IT services to the market in the form of web services, which is nowadays known as cloud computing. With this cloud, we need not plan for servers and other IT infrastructure which takes up much of time in advance. Instead, these services can instantly spin up hundreds or thousands of servers in minutes and deliver results faster. We pay only for what we use with no up-front expenses and no long-term commitments, which makes AWS cost efficient.

IV. WORKING PRINCIPLE

The raspberry Pi 3 system is used here to handle inputs from multiple sensors, and the data are sent to a cloud for storage, since it has the most powerful CPU comparatively, as well as the IEEE 802.11 wireless standard. A wi-fi facility is also available and is used to transfer the data from the remote agriculture land. For the better handling of data, the data is sent further to the cloud with the help of the internet. The cloud facility used here is Amazon Web Service (AWS), and the stored data is used for machine learning for the purpose of analysis. The data is accessed on the local machine through a cloud facility.

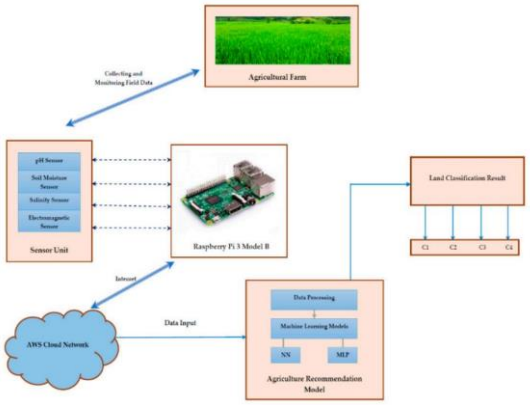

Fig 1 operational block diagram

The algorithm is developed in the machine and it is tested on the collected data to verify the accuracy of the results obtained. The Raspberry Pi controller is used to collect the data from various sensors for a sampling period of one day. Then the average values of various sensors are moved to the AWS Cloud Network with the help of the Internet. From the AWS, the data is accessed by the proposed model, which is developed in the system for normalization and training purposes. Thus, the data obtained from various sensors for six months are considered for the development of the sensor

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 12, Issue 5, May 2023
DOI: 10.17148/IJARCCE.2023.12565

driven model. Electromagnetic sensors have been used to obtain the measurements for soil texture, internal drainage, available water content, organic matter, cation exchange capacity, carbonates, and degree of saturation. pH sensors are used to obtain the pH value, and salinity sensors are used to get the salinity value. The porousness value is obtained based on the measurement of the soil moisture sensor and granularity of the soil is obtained using the measurement acquired from the moisture content of the soil. The values of the structure of the soil and the compact and cementation are obtained from the agriculture experts.

Figure 1 states the architectural diagram of the proposed model. The steps involved in this process are shown in this figure. The data is collected from the farmland using sensors, and is then transferred and stored with the help of the Raspberry Pi system in the cloud. The stored data is used here to build the artificial intelligence recommendation model shown in the figure. The constructed model is expected to classify the results into four different categories. Amazon Web Service (AWS) is used here for the storage of the data. The learning model construction is explained in the algorithm part given below. The built model will be assessed with inputs received after every cultivation period, and accordingly, assessment results will be provided. Different classes are considered here for land suitability assessment as most suitable (class 1), suitable (class 2), moderately suitable (class 3), and unsuitable (class 4). The Algorithm presented here explains the steps involved in the processing the collected data from the different sensors. Since the size of the data is quite high in size, it is necessary to handle the data with the algorithm that is capable of handling the expected size of the data. That is the reason why a neural network approach is considered here for processing the data.

V. ADVANTAGES

- Helps in decision making in land suitability.
- Provides Real – time data of the land.
- Reduces the loss of Vegetation.
- Helps to improve the agricultural productivity

VI. APPLICATION

- **Education Service:** The challenge of learning how to use technology is for the students and the teachers. In most cases, the problem is that teachers are not being trained on how to use the new technology in their classrooms. As a result, they have to figure it out themselves or find someone they already know. Teachers need help in understanding how these tools can be used in order to provide students with an engaging learning experience.

- **E- Commerce Field:** e commerce virtual assistants (VAs) are chatbots that use language processing and machine learning technologies to understand customer queries and offer the needed support accordingly. This is not new to us anymore. We're all well versed with Google Assistant, Amazon's Alexa, and Apple's Siri. eCommerce businesses prioritize using virtual assistants because they're active 24/7 and can handle queries effortlessly. Importantly, this improves a business's scalability, too. Virtual assistants can perform several tasks ranging from product research to listing to handling inventory. For customers, VAs represent easy and quick access to information and assistance.

- **Tourism Service:** For hotels and other businesses in the tourism industry, one of the most exciting uses for artificial intelligence is assisting customers online. In particular, there has already been widespread adoption for the purposes of powering chatbots on social media platforms, as well as instant messaging apps. Used in this way, AI is able to respond to questions and provide valuable information to customers, even when a customer service rep is not available. Customers demand faster and faster response times on online platforms, and artificial intelligence allows businesses to deliver times that would be impossible for humans.

- **Social Network Service**: One of the main ways that AI has helped in social media marketing is through the use of chatbots. Chatbots are computer programs that mimic human conversation and are often used to interact with customers on social media platforms. They can be programmed to answer frequently asked questions, provide customer support, and even make recommendations for products or services. The use of chatbots allows businesses to provide 24/7 customer service and engage with their customers in a more personal and efficient way.

- **Streaming Service:** The OTT industry is booming and making huge profits with this personalization of brands/services. From content discovery to content editing to video indenting, AI contributes majorly to selling online content and establishing perfect user engagement in the streaming media industry. So basically, what makes AI so powerful and influential.

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified ⁜ Impact Factor 8.102 ⁜ Peer-reviewed / Refereed journal ⁜ Vol. 12, Issue 5, May 2023
DOI: 10.17148/IJARCCE.2023.12565

CONCLUSION

Since agriculture is the backbone of any country, it is necessary to ensure its sustainable growth over the years. This work has presented a model that would be as accurate as 99%, which would be the most desirable. The data collected through various sensors, handled here with MLP with four hidden layers, has ensured better efficiency. A proper advisory system with precise instructions would always deliver better results. Thus, the accuracy score to precision score presented depicts the efficiency of this proposed approach, which will ensure appropriate classification. Multiclass classification in agriculture would further fine-tune the recommendation system to guide farmers appropriately. Rather than binary classification, this one would guide the farmers' precisely. Thus, this approach would provide real-time data to ensure better crop yield productivity

REFERENCES

[1] Ahmed, A.N.; de Hussain, I.D. Internet of Things (IoT) for smart precision agriculture and farming in rural areas. IEEE Internet Things J. 2018, 5, 4890–4899.
[2] Elijah, O.; Rahman, T.A.; Orikumhi, I.; Leow, C.Y.; Hindia, M.N. An overview of Internet of Things (IoT) and data analytics in agriculture: benefits and challenges. IEEE Internet Things J. 2018, 5, 3758–3773.
[3] Somov, A.; Shadrin, D.; Fastovets, I.; Nikitin, A.; Matveev, S.; Hrinchuk, O. Pervasive Agriculture: IoT-Enabled Greenhouse for Plant Growth Control. IEEE Pervasive Comput. 2018, 17, 65–75.
[4] Bu, F.; Wang, X. A smart agriculture IoT system based on deep reinforcement learning. Future Gener. Comput. Syst. 2019, 99, 500–507.
[5] Alreshidi, E. Smart Sustainable Agriculture (SSA) solution underpinned by Internet of Things (IoT) and Artificial Intelligence (AI). arXiv 2019, arXiv:1906.03106.
[6] Kamienski, C.; Soininen, J.-P.; Taumberger, M.; Dantas, R.; Toscano, A.; Cinotti, T.S.; Maia, R.F.; Neto, A.T. Smart water management platform: Iot-based precision irrigation for agriculture. Sensors 2019, 19, 276.
[7] Stoˇces, M.; Vanˇek, J.; Masner, J.; Pavlík, J. Internet of Things (iot) in agriculturesselected aspects. Agris-line Pap. Econ. Inf. 2016, 8, 83–88.
[8] Guardo, E.; Di Stefano, A.; La Corte, A.; Sapienza, M.; Scatà, M. A fog computingbased iot framework for precision agriculture. J. Internet Technol. 2018, 19, 1401–1411.
[9] Keswani, B.; Mohapatra, A.G.; Mohanty, A.; Khanna, A.; Rodrigues, J.J.; Gupta, D.; de Albuquerque, V.H.C. Adapting weather conditions based IoT enabled smart irrigation technique in precision agriculture mechanisms. Neural Comput. Appl. 2019, 31, 277– 292.
[10] Liu, S.; Guo, L.; Webb, H.; Ya, X.; Chang, X.; Yao, X. Internet of Things Monitoring System of Modern Eco-Agriculture Based on Cloud Computing. IEEE Access 2019, 7, 37050–37058.
[11] Khanna, A.; Kaur, S. Evolution of Internet of Things (IoT) and its significant impact in the field of Precision Agriculture. Comput. Electron. Agric. 2019, 157, 218–231.
[12]Ray, P.P. Internet of things for smart agriculture: Technologies, practices and future direction. J. Ambient. Intell. Smart Environ. 2017, 9, 395–420.
[13] Muangprathub, J.; Boonnam, N.; Kajornkasirat, S.; Lekbangpong, N.; Wanichsombat, A.; Nillaor, P. IoT and agriculture data analysis for smart farm. Comput. Electron. Agric. 2019, 156, 467–474.
[14] Himesh, S. Digital revolution and Big Data: a new revolution in agriculture. CAB Rev. 2018, 13, 1–7.
[15] Mukherjee, A.; Misra, S.; Raghuwanshi, N.S.; Mitra, S. Blind Entity Identification for Agricultural IoT Deployments. IEEE Internet Things J. 2018, 6, 3156–3163.
[16] Park, H. MLP modeling for search advertising price prediction. J. Ambient. Intell. Humaniz. Comput. 2019, 1–7.
[17] Pouladi, N.; Jafarzadeh, A.A.; Shahbazi, F.; Ghorbani, M.A. Design and implementation of a hybrid MLP-FFA model for soil salinity prediction. Environ. Earth Sci. 2019, 78, 159.
[18] Tamouridou, A.A.; Pantazi, X.E.; Alexandridis, T.; Lagopodi, A.; Kontouris, G.; Moshou, D. Spectral identification of disease in weeds using multilayer perceptron with automatic relevance determination. Sensors 2018, 18, 2770.
[19] Niedbała, G. Application of artificial neural networks for multi-criteria yield prediction of winter rapeseed. Sustain. 2019, 11, 533.
[20] Ruan, J.; Wang, Y.; Chan, F.T.S.; Hu, X.; Zhao, M.; Zhu, F.; Shi, B.; Shi, Y.; Lin, F. A Life Cycle Framework of Green IoT-Based Agriculture and Its Finance, Operation, and Management Issues. IEEE Commun. Mag. 2019, 57, 90–96.
[21] Khishe, M.; Safari, A. Classification of Sonar Targets Using an MLP Neural Network Trained by Dragonfly Algorithm. Wirel. Pers. Commun. 2019, 1–20.
[22] Nawandar, N.K.; Satpute, V.R. IoT based low cost and intelligent module for smart irrigation system. Comput. Electron. Agric. 2019, 162, 979–990.
[23] A. K. Pushkala, B. Gayathri, B. Naga Susmitha, J. Kumari, V. Murali Krishna, MODERN AGRICULTURE USING BLUETOOTH MODULE, Anveshana's International Journal Of Research In Engineering And Applied Sciences, Volume 3, Issue 4(2018, Apr), (ISSN-2455-6300) Online.

