Role of Machine Learning and Internet of Thing in Agriculture- A Survey

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2022 IEEE International Conference on Current Development in Engineering and Technology (CCET) | 978-1-6654-5415-5/22/$31.00 ©2022 IEEE

***Abstract*—Agriculture is the backbone of the economy and a source of jobs for developing nations like India. For human life, food is a necessity that can be fulfilled only through farming. Agricultural activities are usually classified into three broad categories: post-harvest, harvest, and pre-harvest. Farmers are doing their best to produce grain, but there is grain loss at the time of various post-harvest activities like cutting, storage, etc. Various studies have already been conducted in the fields of pre-harvest, harvest, and food quality. But in the field of post-harvest, there is lots of scope for work. For food sustainability reduction in post-harvest activities is necessary. This paper presents a broad survey of the post-harvest activities, Internet of Things (IoT) and machine learning (ML) applications in the agricultural domain to mitigate the post-harvest issue. Applying machine learning (ML) and the internet of things (IoT) in agriculture allows more efficient and accurate monitoring of grain so food loss problem can be solved in effective manner.**

Keywords—Internet of Things (IoT), Supervised learning, Unsupervised Learning, post-harvest, Pre-harvest, Harvest, Machine Learning (ML).

I. Introduction

As the world's population increases the need of food is also increased, to fulfil the requirement of food, it's necessary to increase grain fertilization by 60% of the population. Despite of saving grain, global food waste is approximate 1.3 billion tons every year. If these grain waste will cure, then feeding millions people all over the world will be possible [1]. According to the United Nations environment program's food waste index 2021, household waste of food in India is 50 kilogrammes per person per year, or 68,760,163 tonnes a year. Around 1% of the GDP is depleted in the form of food waste. According to the ministry of agriculture, INR 50,000 crore of food produced every year gets wasted [2]. In today's scenario, where agricultural land is reduced by various ways, increasing the fertilization of grain is not the satisfactory solution; the only possible solution is to cure the post-harvest grain losses. Inadequate knowledge at every stage of agriculture results in new issues or exacerbates existing ones, which raises the cost of farming. Daily population growth adds to the burden on the agricultural and cultural industries. There are significant overall losses across the entire agricultural process, from various crops to product sales. According to the adage "Information is power," farmers may be able to make better decisions and solve agricultural problems by keeping track of data on the crops, climate, and market. Information can be gathered and processed using technology like blockchain, IoT, deep learning, machine learning, cloud computing, and edge computing. Applications of machine learning, and IoT will aid in improving the quantity and quality of the output, which will ultimately increase the viability of farmers and related industries. To upsurge the total harvesting output, precision learning is vital in the world of agriculture. [3]

There are three subcategories of agricultural tasks performed by the farmer.

- Pre- Harvest
- Harvest
- Post- Harvest

Pre-Harvest**:** Before starting organic production, it is important to do a survey and study regarding the quality of crops, seeds, planting periods, planting density, and irrigation system.

Harvest: Harvesting is the operation of collecting parts of plants and monitoring growing crops.

Post-Harvest: In agriculture, post-harvest processing is the stage of crop production immediately after harvest and includes cooling, washing, grading, and packaging. Decay begins the moment a plant is removed from the soil or separated from its parent plant. Common task performed by Farmer's in post-harvest are: Crop cleaning, Sun drying, shelling, fumigating, curing, storing, grading, packing and cooling. [4] [5]

II. Machine Learning Techniques

Machine learning (ML) becomes the turning point for different disciplines such as statistics, artificial intelligence (AI), Theory, probability, optimization, information, etc. [6] [7] [8]. There are four major types of machine learning techniques [7], namely supervised learning [8], unsupervised learning [9], semi-supervised learning, and reinforcement learning.

Supervised learning is a technique in which a model is trained on a labeled dataset, and the trained model is used to predict the output given a new input. It is divided into two subcategories: classification, which predicts discrete labels, and regression, which predicts continuous values. Examples of supervised learning include logistic regression, support vector machine, and decision trees, fig. 1 define the process flow of supervised learning [10].

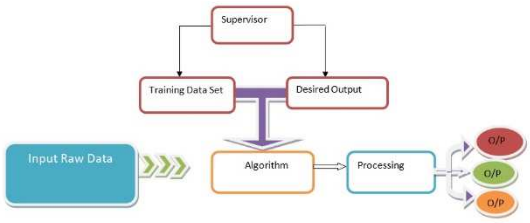

Fig. 1. Supervised Learning

Unsupervised learning is a machine-learning technique that uses a training dataset to train a model unsupervised. Instead, the model itself finds hidden patterns and insights in your specific data. This can be compared to the learning that occurs in the human brain when learning new things, fig. 2 define the process flow of unsupervised learning[11].

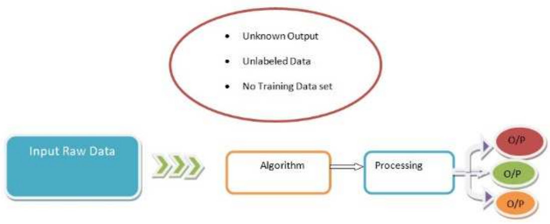

Fig. 2. Unsupervised Learning

Semi-supervised learning is an approach to machine learning that combines supervised and unsupervised learning. In this technique, a small portion of the data is labeled, and the remaining data is used in an unsupervised manner. This type of learning is useful when labeled data is scarce. Examples of semi-supervised learning include deep generative models and graph-based, fig. 3 defines the process flow of supervised learning [12]

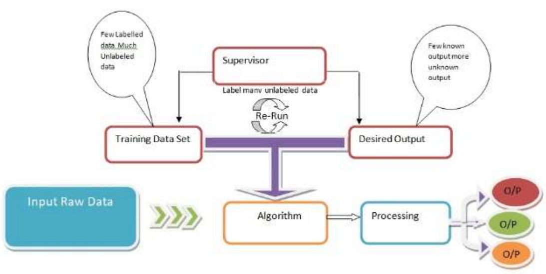

Fig. 3. Semi- Supervised Learning

Reinforcement learning (RL) refers to a self feedback based machine learning techniques in which machine learns from continuously experience which requires to be done to find the prime solution. More specifically, in reinforcement learning agents are learn by themselves while interacting with the environment and observe the consequences of precise actions. To maximize the performance in a given context to RL allows the agents to determine the ideal behavior and take action according to the need. This requires simply returning results to learn how the machine behaves, fig. 4 define the process flow of reinforcement learning [13].

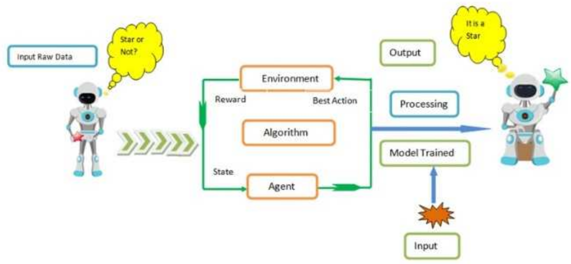

Fig. 4. Reinforcement Learning

TABLE I. MACHINE LEARNING CATEGORIES AND PURPOSE

ML Categories	Input/output	Purpose
Unsupervised Learning	Unlabeled and Unknown Data	Illustrate the distribution of data without discriminating between the observed variables and the variables to be predicted
Reinforcement Learning	Rewards/ Actions	Learning spotlight on experiences determined sequential decision-making by using rewards where response is actions
Semi-Supervised Learning	Few stamped data+ More Unstamped data / Few Known Output	Learn parameters for making predictions Illustrate the distribution of data without discriminating between the observed variables and the variables to be predicted
Supervised Learning	Labeled Data/ Known Output	Learn parameters for making predictions

III. INTERNET OF THINGS AND SENSORS

Internet of Things (IoT) is a new standard for enables usual electronic and wireless connectivity. A recognition system for identifying and communicating physical objects. So measure IoT will play an important role in exchanging data between the physical and virtual worlds. In other words, we can define the IoT as a set of things with latent names that operate in a smart space while in use. Intelligent interfaces [14] for connecting and communicating in different use cases Connected devices can collect and transmit data over the Internet or other technologies for display, storage, and analysis. These devices are automobiles, industrial machines, smartphones, etc. [15]. Sensors enable you to interact with your surroundings by measuring temperature, speed, humidity, and vibration. Furthermore, the IoT consists of a various set of networks with which these objects can communicate.

TABLE II. DIFFERENT SENSORS WITH ITS WORK [16] [17]

Sensors	Work
PH Sensor	Monitor nutrition in soil
PIR Sensor	Track the movement of any object in field
UV Sensor	Monitor effect of ultra violate rays on crop production
Soil moisture sensor	Monitor the availability of water in soil
Temperature sensor	Monitor nutrition in soil and water on the surface
Gas Sensor	Monitor the presence of poisonous gas in farmland
Humidity sensors	Monitor the humidity that effect the growth of leaf and photosynthesis

IV. MACHINE LEARNING AND INTERNET OF THINGS IN VERIOUS FIELD

S. Durga, Mr. Rishabh Nag, Esther Daniel [18] Describes how various machine learning algorithms can be used in healthcare with IoT to achieve the best results with the least amount of complexity and computation time.

T. Bharath Kumar and D. Prashar [19] discuss about the Smart Agriculture which uses technology to increase the efficiency and productivity of agricultural production. This technology helps farmers to monitor and manage their crops, livestock, and other resources with the help of sensors, automation, and communication tools. Smart Agriculture also involves the use of IoT, Cloud, Big Data, Machine Learning, and Artificial Intelligence technologies to optimize agricultural production. Sensors are one of the most important components of Smart Agriculture. Sensors can be used to monitor soil moisture, temperature, humidity, and other environmental conditions. They can also be used to track the growth of crops, measure crop yield, and detect pests and diseases. They can even be used to monitor livestock health and behaviour. IoT-enabled technologies such as Cloud, Big Data, and Machine Learning can collect, analyze, and share data in real-time. This data is used to create predictive models that can be used to plan and optimize the agricultural production process. Communication protocols such as MQTT, CoAP, and LoRaWAN can be used to connect sensors and other devices in the network and to transfer data. These protocols can also be used to control the devices in the network remotely.

Bam Bahadur Sinha , R. Dhanalakshmi [20] begins paper by discussing the fundamentals of IoT and its role in smart agriculture, including the challenges and opportunities it presents. The various components of an agricultural IoT system including sensors, communication networks, gateways, and cloud services have been presented. A comprehensive overview of the different types of IoT-based technologies and architectures used in agriculture such as blockchain-based, Long Range Wide Area Networks, and Wireless Sensor Networks systems has been provided. The security issues associated with agricultural IoT systems have been highlighted, followed by a discussion on the challenges and trends of IoT-based agricultural systems. Finally, the paper concludes on the potential of Data Analytics in the agricultural domain.

N. Javaid [21] highlights the potential of using machine learning and artificial intelligence algorithms to enable a smart farming system. The proposed framework has the potential to revolutionize the existing agricultural practices and can be used to enhance the productivity of crops. This work can provide an efficient solution for agrarian societies and can serve as a stepping stone for a successful adaptation of automation technologies in the agricultural sector.

Dr. Aaisha Makkar, Dr. Sahil , Dr. Neeraj Kumar, Prof. M. Shamim Hussain,Prof. Ahmed Ghoneim, Dr. Mubarak Alrashoud [22] After studying the five different machine learning models using various metrics, the author prepares a framework that detects the spam of IoT devices by using machine learning models. An IoT dataset is used for the experiments after pre-processing through the use of a feature engineering procedure. After the experiment, the framework with machine learning models for each IoT device assigns a spam score. The spam score refines the condition of IoT devices to be used in the smart home.

Mohamed I. AlHajri, Nazar T. Ali, and Raed M. Shubair [23] Explain a machine-learning approach for the indoor environment based on real-time measurements of the RF signals. After studying different machine-learning classification models with RF features, As a result, the machine learning approach using the weighted KNN method, utilising the transfer function and frequency coherence function, identified the indoor environment with a classification accuracy of 99.3% and a prediction time of 10µs.

Sudianto, AnggraHaristu, YeniHerdiyeni, and MedriaHardhienata [24] used the deep learning method YOLO (you only look once) to create a decision-making system. They prepare a model in which several iterations influence the level of accuracy of chilli quality detection. The detection accuracy value for the 9000 iteration value is 99.4%. However, accuracy was detected at 75.6% in the 9000 iteration value for curly red chilli conditions.

Himanshu Purandare, Niranjan Ketkar, Shreyas Pansare, Prathamesh Padhye, and Archana Ghotkar [25] Prepare a model in which a machine learning algorithm is used to analyze the various parameters, like time investment in harvesting and expected diseases, based on the active data that is gathered with the help of sensors and metrological data. As a result, to minimize overall loss of grain warehouse managers can predict the correct stock dispatch sequence and the temperature to store food.

Rekha Kaushik, Jyoti Singhai [25,26] Explain an approach to increasing the shelf life of grain in an efficient, rapid, and accurate manner. In this system, temperature, moisture, and CO_2 concentration can be used to detect containment in stored grain.

V. Porkodi, S. Anbu Karuppusamy, D. Yuvaraj, Pallavi Murghai Goel, Juveriya Khan, and M. Sivaram [27] IoT consists of many devices that handle many connections and the transmission of vast amounts of information. Smart cities are regarded as one of the most important applications of IoT in the areas of urban planning, and mobility. In addition, the handling of data properties and security takes top priority. By analysing the data collected from diffrent fields, we can optimise , improve, and protect these services. data analysis algorithms are used to extract knowledge and protect collected data.This article explores the adoption of various machine learning algorithm algorithms in IoT applications such as smart city application scenario, data analytics, and security. It is sprinkled with basic IoT services that are integrated with IoT services used in different domains. It successfully addresses open issues in the field of IoT.

V. CONCLUSION

As the world's population grows the demand for food increases and agricultural land condense, so the focus to cure grain loss should be smarter and more efficient. In particular, the use of machine learning and IoT in agriculture will greatly contribute to making the agricultural sector well-groomed and more sustainable. With use of machine learning and IoT agriculture sector may get benefits in many ways. Through the strategic use of machine learning and IoT, we can effectively promote food safety for current and future generations. This article provides a detailed overview of machine learning algorithms and internet of things in various field.According to this review, agricultural activity is broadly categorized into three main areas: pre-harvest, harvest, and post-harvest. Machine learning is a progressive technology that solves complex agricultural problems and helps farmers reduce losses.

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