

SMART AGRICULTURE IN SPRINKLER IRRIGATION USING DEEP LEARNING NETWORK

Amudaria S^{1,*} and Joseph Jawhar S²

¹Assistant professor, Department of Computer science and engineering, Arunachala college of engineering for women, Manavilai, Vellichanthai, Nagercoil, India.

²Professor, Department of Electrical and Electronics Engineering, Arunachala College of Engineering for Women, Kanyakumari, 629203, India.

*Corresponding e-mail: amudaria@sxce.edu.in

Abstract – An Internet of Things (IoT) is used to provide information about agricultural areas and then take action based on user input in "smart agriculture," an emerging idea. In this paper, a novel Smart agriculture based on Solar panel for Sprinkler irrigation (SSS) system that collects and monitors the environmental temperature, soil moisture and humidity. The temperature, humidity, and soil moisture measurements are kept in the cloud for analysis. Data obtained from cloud storage is validated by MobileNet. A farmer receives an alarm message from the mobile net if the soil moisture content is less than 20%, if the temperature and humidity are less than -40°C to +80°C, and if the relative humidity is between 0% and 100%. A mobile net alarm message is sent to a farmer if the pH is lower than 5.5. Solar panels are the renewable energy source for the farm and battery. When needed, the water pumps are powered by the element that stores extra electrical energy produced by the solar panels. A farmer uses sprinkling irrigation to remotely access the field after receiving an alert message from the mobile network. A farmer can remotely access a field and irrigate a farm using sprinkler irrigation when they receive an alarm message from the mobile network. The proposed method improves the overall accuracy of 98.57%, 96.24%, 89.65%, 91.68% and 99.37% AlexNet, ResNet-50, DenseNet, GoogleNet and MobileNet respectively.

Keywords – Deep learning, DC converter, sprinkler irrigation.

1. INTRODUCTION

India and China, the countries with the largest populations, have smaller farmland areas and lower production values, while land yields per unit are lower than in the developed nations. so, the production of food is essential for reducing hunger in the country [1]. They must integrate cutting-edge technology like the IoT and cloud computing into the agriculture industry along with different machinery or devices in order to overcome these issues given the limited natural resources available [2]. IOT is a network of attached computers, users with individual IDs, and users who can communicate over a network without face-to-face contact [3]. IoT aims to use the internet for data sharing and

connectivity across the digital and physical realms. IoT applications include smart manufacturing, smart agriculture, smart homes, smart cities, connected vehicles, smart energy, connected buildings and campuses, health care, and logistics [4]. Over 70% of the world's yearly water demand is used for agricultural purposes, including aquaculture, irrigation, and animal cleaning [5]. High levels of nutrients, pesticides, and other contaminants are polluted into the water by these treatments. The world's population is expected to grow; thus, it appears that food production must increase [6]. A lot of agricultural data is often gathered from production, and it is necessary to handle and evaluate it quickly. In the field of big data computing, cloud computing has proven to be quite powerful. For example, large data processing and deep computation models have both benefited from the use of cloud computing [7]. Even while collecting the raw data is necessary, mining and analyzing the data is also regarded as a crucial duty. It may be able to track the development of the crops and their environment by creating an intelligent system that uses IoT for agriculture. IoT can be used to control their cycle and resolve a number of problems with agricultural field products [8]. IoT automation is used in agriculture to gather data for the Farm Management System (FMS), which is used for planning, monitoring, decision-making, documenting, and managing the agricultural process. The IoT has many applications in agriculture, including better resource management, increased economic efficiency, increased quantitative productivity, and monitoring of plants, crops, fields, and water. The sensors used in WSN could measure pH levels, water, soil, and humidity [9]. The main contribution of this research is,

- In this research, a novel smart agriculture based on solar panel for sprinkler irrigation (SSS) system that collects and monitors the environmental temperature, soil moisture, and humidity.

- The temperature, soil moisture and humidity measurements are stored in a cloud for analysis.
- MobileNet validates data received from cloud storage. The mobile net alerts farmers when the soil moisture content drops below 20% and when the temperature and humidity decrease between -40°C and +80°C and between 0% and 100% relative humidity. A mobile net alarm message is sent to a farmer if the pH is lower than 5.5.
- The farm and battery's renewable energy source is made up of solar panels. The element that stores excess electrical energy generated by the solar panels is used to power the water pumps whenever necessary.
- When the farmer receives an alert message from the mobile net, the farmer remotely accesses the field and irrigates the farm through sprinkler irrigation.

2. LITERATURE SURVEY

In order to monitor, track, evaluate, and process a variety of activities and services in real-time, the modern agriculture systems compete to take advantage of technological advancements in the industry, such as the artificial intelligence, cloud/fog/edge computing, agricultural robots and IoT. In this section, an overview of a few recent studies is provided.

In 2019 Jaiswal, S.P., et al. [10] had been developed for the operation of agricultural activities using an IoT-based system. It can be scaled up and is affordable, allowing rural areas and underdeveloped nations to maximize their throughput using the current infrastructure, such as the internet. The economically beneficial crop that will be grown throughout the year can be planned using the acquired data, which can then be further assessed for environmental and climatic circumstances.

In 2022 Dhanaraju, M., [11] had investigated the difficulties of incorporating technology into traditional farming practices and suggested using wireless sensors in Internet of Things agriculture. In addition to uses in packaging and shipping, growers can benefit from the technical expertise throughout the entire crop cycle, from planting to harvest.

In 2021 Almalki, F.A., [12] has introduced a low-cost platform for thorough IoT monitoring of environmental parameters. The specifications for automatic and real-time environmental parameter monitoring with both above- and belowground sensors. The smart actions support precision agriculture, which in turn greatly increases agricultural output and conserves natural resources.

In 2020 Kumar, K.A. and Aju, D., [13] has recommended an IoT-enabled intelligent water framework gadget called Agri Bot for the agriculture industry to decrease water waste and increase the supply of growing materials. IOT-AgriBot will improve the water infrastructure, increase water usage that is more economical, and reduce on labour to achieve precision agriculture.

In 2022 Arshad, J., et al. [14] has implemented a Smart Decision Support System that optimizes yields to attain

stability by increasing production per hectare and lowering water seepage loss while accounting for real-time monitoring of input parameters. In addition to advancing crop yields, the sensors contributed to the realization of sustainable and inclusive economic goals.

In 2021 Alharbi, H.A. and Aldossary, M., [15] has introduced an integrated edge-fog-cloud architectural paradigm designed to lower carbon emissions and boost smart agriculture systems' energy efficiency. This architecture (edge, fog, and cloud) allows for the processing and analysis of real-time agricultural data from various sensors in different layers, such as weather temperature, soil acidity, soil moisture, irrigation, etc.

Farmers must deal with a variety of issues, such as biodiversity loss, soil erosion, and climate change. However, the agricultural sector has faced persistent challenges that have resulted in low farm incomes, low employment in rural areas, low levels of food security, and low agricultural competitiveness.

3. PROPOSED METHOD

The irrigation system is turned on based on the reading from a soil moisture sensor. The field is automatically watered by means of a solenoid valve or sprinkler. The sprinkler and solenoid valve were connected to the controller through a relay switch. In this paper, using sprinkler irrigation to provide water in agriculture field according to its demand without depleting the soil fertility.

PH sensor

One of the most important tools for testing water is the PH sensor. The PH sensor is a device that converts the amount of hydrogen ions in a solution into a signal that can be used. Typically, it consists of a chemical component and a signal transmission component. The measuring range is represented digitally as 0 to 14. Seven is the neutral number. Increased ph is indicated by a higher number, whereas greater acidity is shown by a lower value. The PH sensor is frequently utilized in industry to identify materials like water and solutions.

Soil moisture sensor

The amount of water and moisture in the soil is measured by soil moisture sensors. Soil moisture sensors estimate the volumetric water content indirectly by using another property of the soil as a stand-in for the moisture content, such as electrical resistance, the dielectric constant, or interaction with neutrons. This is due to the fact that the direct gravimetric measurement of free-soil moisture requires sample removal, drying, and weighing.

DHT11 sensor

A basic digital sensor for measuring humidity and temperature is the DHT11. To monitor temperature and humidity, this sensor may easily be connected to any microcontroller, Raspberry Pi, Arduino, and other devices. There are two components to the DHT11 sensor: a sensor and a module. Because of the power-on LED and pull-up resistor, this sensor is different from the module. The DHT11 is a sensor for relative humidity. Using a thermistor and a

capacitive humidity sensor, this sensor gauges the surrounding air.

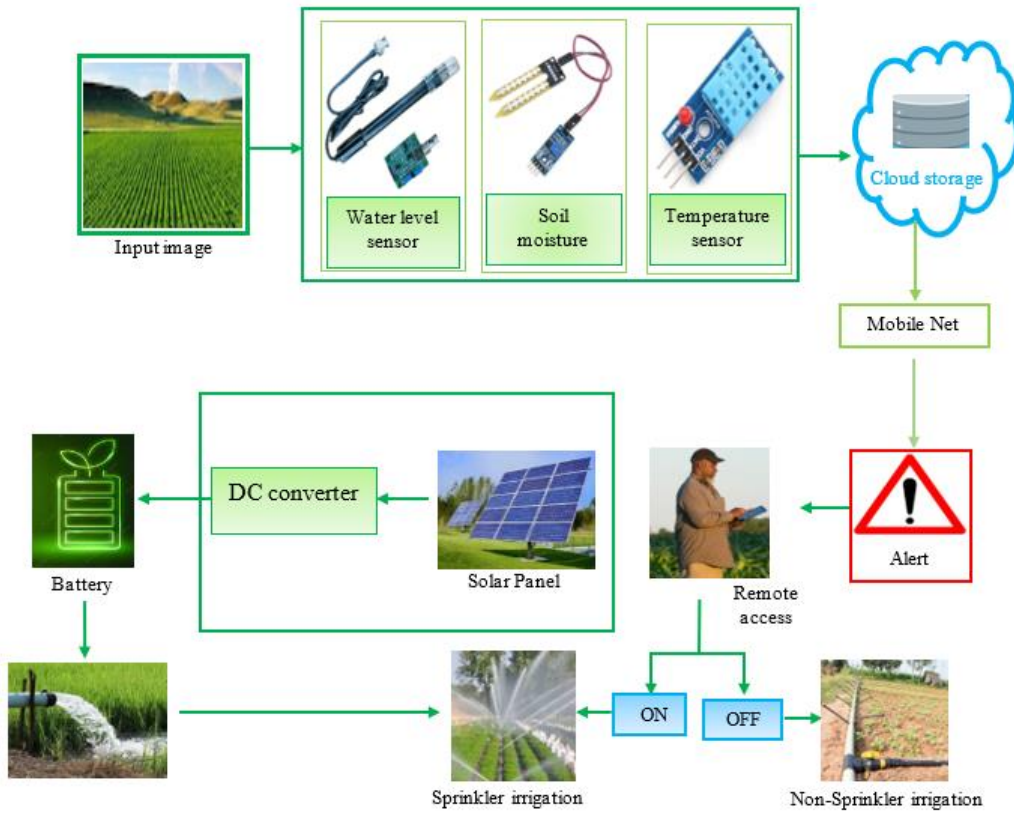


Figure 1. The overall workflow of proposed model

3.1. Mobile Network

MobileNet validates data received from cloud storage. A farmer receives an alarm message from the mobile net if the soil moisture content is below 20% and if the temperature and humidity are below -40°C to $+80^{\circ}\text{C}$ and 0%RH to 100%RH. The mobile network notifies the farmer if the pH

is lower than 5.5. This section describes the depth-wise separable filters that comprise MobileNet's basic layers. The resolution multiplier and width multiplier, as well as the two-model shrinkage hyperparameters, are then described after talking about the MobileNet. The mobile net architecture diagram is shown in fig 2.

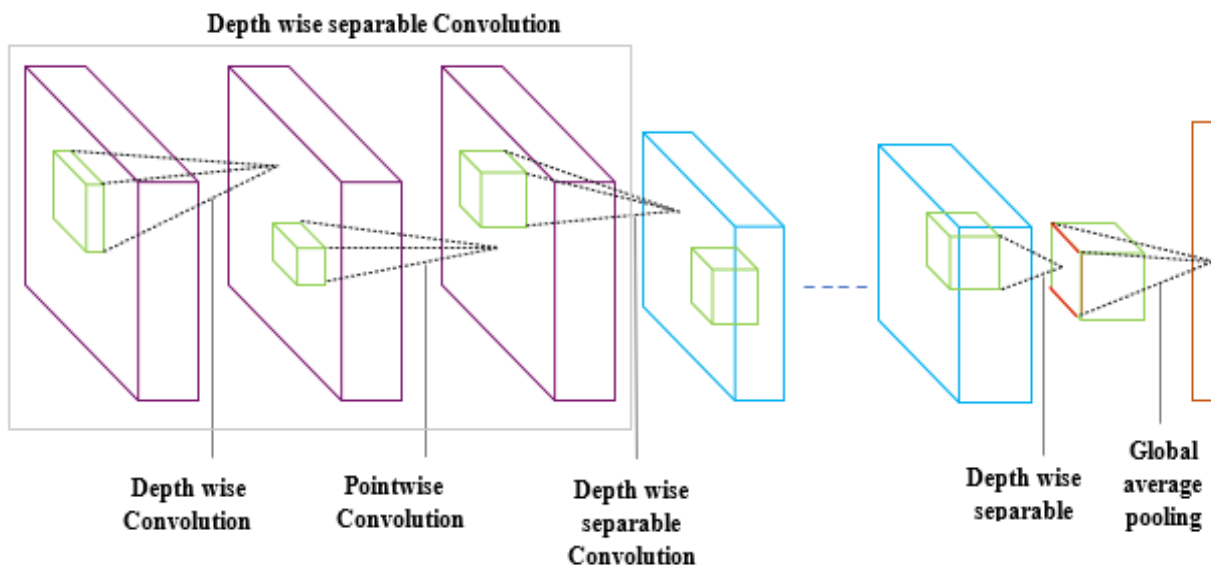


Figure 2. Architecture of Mobile Network

3.1.1. Depth wise separable convolution

DWC is the foundation of the MobileNet model. Factorized convolutions, i.e., 1 x 1, are utilized to convert the normal convolution operation into depth-wise convolution and point-wise convolution operations. As suggested in the PWC, the 1x1 convolution operation is utilized to combine the results obtained from the DWC operation. In the entire process of DWC, a filter is applied to all the input channels when the Mobile Nets are utilized. In the normal convolution operation, the inputs are filtered in one go before they are combined to produce the new set of outputs. A filter layer and a combine layer are created using the DWSC operation, which reduces the processing size considerably.

An $E_F \times E_F \times N$ feature map F is input to the convolutional layer, which produces an $E_F \times E_F \times M$ feature map H , where E_F is the spatial width and height of the square input feature map, N is the number of input channels, and E_F , A , and M are the spatial width, height, respectively, of the square output feature map.

$$H_{k,m,s} = \sum_{p,q,r} k_{p,q,r,s} \cdot F_{k+p-1,m+q-r} \quad (1)$$

The computational cost of typical convolutions is:

$$E_k \cdot E_k \cdot N \cdot M \cdot E_F \cdot E_F \quad (2)$$

If the cost of computing N , size of the feature map $E_k \times E_k$, and number of output channels M are all affected multiplicatively by the number of input channels. PWC and DWC are the two levels that make up a DWSC. The only filter that is to be applied to every input channel is the DWC. The output is linearly combined using PWC, a traditional 1 x 1 convolution approach. Both the Mobile Net layers use ReLU nonlinearities and batch norms. The use of a single filter for every input channel is shown in the following representation for the input depth:

$$\hat{H}_{k,m,r} = \sum_{p,q} \hat{K}_{p,q,r} \cdot F_{k+p-1,m+q-1,r} \quad (3)$$

The r_{th} channel in F generates the DWC kernel \hat{K} of size $E_k \times E_k \times N$ and the feature map's channel in the filtered output \hat{H} . The DWC computation cost is:

$$E_k \cdot E_k \cdot N \cdot E_F \cdot E_F \quad (4)$$

DWC is more effective than standard convolution. It only filters channels instead of combining them to create new ones.

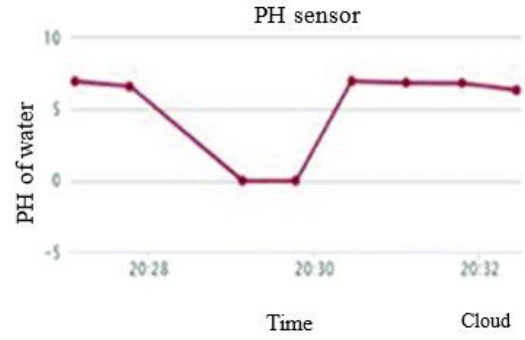
$$E_k \cdot E_k \cdot N \cdot E_F \cdot E_F + N \cdot M \cdot E_F \cdot E_F \quad (5)$$

$$\frac{E_k \cdot E_k \cdot N \cdot E_F \cdot E_F + N \cdot M \cdot E_F \cdot E_F}{E_k \cdot E_k \cdot N \cdot M \cdot E_F \cdot E_F} \quad (6)$$

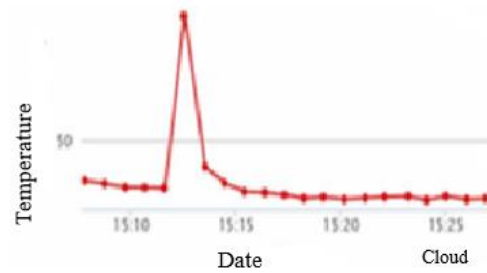
3x3 DWSC is used in Mobile Net, which is almost less accurate than standard convolution but needs 8-9 times fewer computations.

4. RESULT AND DISCUSSIONS

Temperature, humidity, soil moisture, and water level sensor values are collected in real-time by the experimental setup of the proposed system. For analysis in real time, the cloud system gets these detected instances.



(a) variation in pH level of water over time



(b) average temperature for the last three days



(c) operational time of water motor operated to wet the soil

Figure 3. Graphical representation of proposed system

Where (a) denotes the variation in pH level of water over time, (b) denotes average temperature for the last three days and (c) denotes operational time of water motor operated to wet the soil. Figure 3 shows a graphical representation of proposed system.

An IoT-based cloud platform offers live stream data processing, visualization, and aggregation services. The data from the sensed field is sent to the cloud platform via a gateway module, and warnings are generated and sent using a web service as well as an instant display of the data.

4.1. Comparative Analysis

This section presents a comparison between the current DL models and the proposed model. The effectiveness of the proposed approach was demonstrated by using precision, specificity, recall, accuracy, and F1 score to assess the performance of existing methods. Table 1 compares the overall performance of deep learning models with the recommended approach. Deep neural networks like Alex

Net, ResNet-50, Dense Net, and Google Net were contrasted with the proposed model.

Table.1: A comparison was conducted of deep learning networks

Networks	Accuracy	precision	specificity	recall	F1 score
Alex Net	98.57	90.47	89.37	94.26	91.27
ResNet-50	96.24	89.49	92.76	91.90	87.29
Dense Net	89.65	92.56	86.48	90.38	89.49
Google Net	91.68	95.79	89.93	89.37	93.59
Mobile Net	99.37	97.48	93.87	96.37	96.38

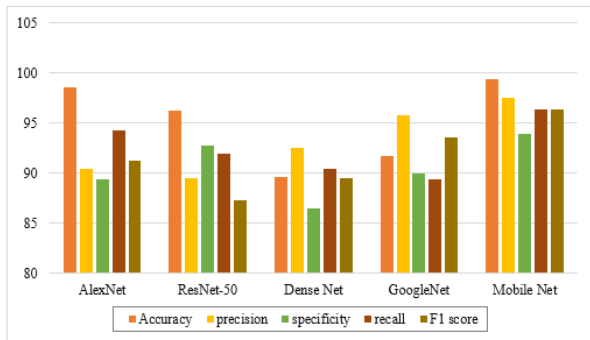


Figure 4. Comparison of Existing deep learning networks with Mobile Net

Figure 4 illustrates the proposed method improves the overall accuracy of 98.57%, 96.24%, 89.65%, 91.68% and 99.37% Alex Net, ResNet-50, Dense Net, Google Net and Mobile Net respectively. The suggested network's effectiveness is assessed using the networks' particular parameters.

5. CONCLUSION

In this research, a novel Smart agriculture based on Solar panel for Sprinkler irrigation (SSS) system that collects and monitors the environmental temperature, soil moisture and humidity. For analysis, the measurements of the humidity, temperature, and soil moisture are stored in the cloud. MobileNet validates data received from cloud storage. The mobile net alerts a farmer if the relative humidity is between 0% and 100%, the temperature and humidity are between -40°C and +80°C, or the soil moisture content is less than 20%. A mobile net alarm message is sent to a farmer if the pH is lower than 5.5. Solar panels are the renewable energy source for the farm and battery. The element that stores excess electrical energy generated by the solar panels is used to power the water pumps whenever necessary. A farmer can remotely access a field and irrigate a farm using sprinkler irrigation when they receive an alarm message from the mobile network. The proposed method improves the overall accuracy of 98.57%, 96.24%, 89.65%, 91.68% and 99.37%

AlexNet, ResNet-50, DenseNet, GoogleNet and MobileNet respectively.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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AUTHORS



Amudaria S received her B.E. degree in computer science and engineering from the Vins Christian college of engineering under Anna University chennai in 2008, the M.E. degree in computer and communication engineering from SSN college, Chennai in 2011 and started the Ph.D. degree in engineering from anna University, Chennai, in 2023, respectively. In 2008, She had one year working experience as Software tester in GM Software, Nagercoil, India. In 2011, she joined as

an Assistant Professor at the Department of Computer Science and Engineering, in infant Jesus college of engineering, Thoothukudi. She has published 5 research papers in various journals and conference proceedings. Her research interests include image and video processing, optimization algorithms, and computer vision. Currently she is working as assistant professor in Arunachala college of engineering for women, Nagercoil.



Joseph Jawhar S obtained the B.E. degree from Madurai Kamaraj University, Tamilnadu in 1990, M. Tech. degree from Bharthiyar University, Tamilnadu in 1993. He obtained his Ph.D. degree from Anna University, Chennai, Tamilnadu in 2009. His present research interests are Soft Computing Techniques and Power Electronics. He is now Principal, Arunachala College of Engineering for Women, Vellichanthai, Kanyakumari District, Tamilnadu.

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