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IoT-Based Smart Irrigation System Based Adaptive Radial Deep Neural Network (ARDNN) Algorithm Applicable for Various Agricultural Production

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Abstract: Agriculture Specific Land or crop monitoring-based Networking technology has played an essential role in the current farming system. Because Farmers can manage their activity even more efficiently, work and water management in irrigation systems make it possible to make decisions even when farmers are not present. The Internet of Things (IoT) monitors real-time data analysis collected through sensors and devices from each agricultural crop. The patterns of Wireless Sensor Networks (WSN), in which nodes are separated to separate data from the different crops. Sequential learning is a supervised technique using a parameter with drawbacks such as uncalculating error, Time delay, and low sensitivity data from getting sensors. To overcome these drawbacks, intelligent irrigation systems are developed using the Adaptive Radial Deep Neural Network (ARDNN) algorithm and the Internet of Things (IoT). Each sensor remains analyzed from root depth and soil water level based on the first step. Developers of the Arduino Controller have discussed utilizing IOT technology to help farmers find important environmental issues including temperature, humidity, soil moisture, and water level. The Arduino Controller analyzes different sensor setups and signal from the sensor and the Arduino controller are used to drive a water pump, which opens and closes the flow in response to the signal. Water is given to the plant's roots by a rain gun drop by drop, and when the moisture level returns to normal, the sensor recognizes it and signals the controller to cut off the water pump. Additionally, utilizing Wireless Sensor Networks (WSNs) powered by the Internet of Things (IoT), Smart Farming is used to monitor plant status. Adaptive Radial Deep Neural Network (ARDNN) algorithm aggregate classifier-based classification algorithm. The dataset will be split into training and testing data. The decision tree is constructed using the additional training dataset. To create an extra substantial prototype, the model resolve considers preparation data and then removes the weaker node from the training data before making a decision tree. The output results from gain accuracy and reliability and enables a more accurate data management system, getting proper water management and specific crops in agriculture.

Keywords: *Adaptive Radial Deep Neural Network (ARDNN) algorithm, Internet of Things (IoT) based Wireless Sensor Networks (WSNs)*

1. Introduction

1.1. Need for Agriculture

Irrigation Procedures: If it is synchronized with the water flow, the user may specify the irrigation time and the amount in liter as well as the days and hours of the week or month. In essence, this is a pair of interlinked timers, the first of which starts the irrigation system and the second of which controls the flow of water. Commercial items are widely available, economical, and typically have an interface for smart home accessories.

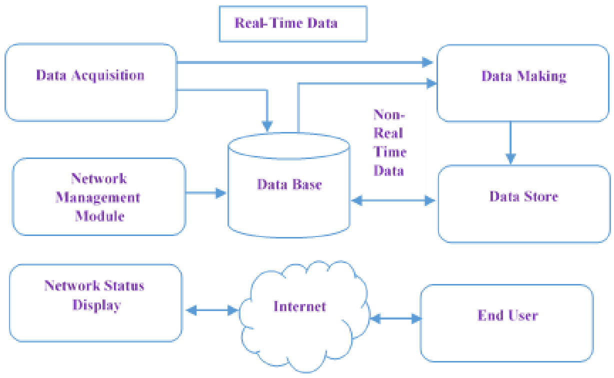

Fig 1. Irrigation system based on data analysis

Controlled moisture: In contrast to plan-based watering systems, a moisture sensor is also required. This makes the water more useful where it is required. Multiple systems additionally include a moisture sensor to slow or stop watering if a certain level of soil moisture is reached. Plant-based systems frequently contain such processes, making them more adaptive.

Network communication: The Wireless Sensor Network

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(WSN) has many linked sensor nodes. Each node receives a substantial quantity of sensor observations, adding to the complexity of the network. As the Internet is a virtual network of devices, it plays a big part in each application examined, which is the downside of typical Internet usage.

The Internet of Things (IoT) based Neural Network algorithm techniques used to collect the generated data must first be identified for them to be examined and calculated. To carry out these tasks, a significant quantity of data is necessary. This data will lose all relevance, structure, and process. Some challenges in implementing precision agriculture are linked to data management, network management, and plant health condition and Fig 1 shows the smart irrigation system using networking communication.

2. Previous Research Work

2.1. Overview

A survey from different authors is presented below which is analysed on agriculture based on networking and electrical sensors technologies for improving the agriculture field. Information technology, connectivity, and the countless data created by sensors are used as inputs and stored in massive quantities. Crops are especially susceptible to climatic and meteorological variations. Since wireless sensor networks include hundreds of data for monitoring sensors based on temperature, speed, data creation, humidity, and other characteristics, they are ideal for gathering real-time data for creating smart analyses based on Big Data sources. This approach, may cheaply place several sensor nodes in the field and assurance that communication between them is effective.

2.2. Smart Irrigation system –based Non-Emergency Data

Smart agriculture for load control in information processing IoT-based Wireless sensor networks and the Penman-Monteith equation examine essential issues, such as congestion control. The increased packet propagation via the IoT network system is developed in the overall access amount (A1 + A2) attained is determined using the work and the feedback. According to the testing results, the flow rate is 1.24, making it additional significant than the connection capacity charge. Data that suggest enhanced congestion control supports the difficulties, outperforming various parameters by 0.3% and 1.2%, accordingly, when considering additive increase and progressive decrease conditions [1].

According to the results of hundreds of farm sensors, the traditional system based on the cloud may reduce carbon emissions by 43% and overall energy consumption by 36%. In addition to this advancement, the results show that our proposed design may reduce network traffic by as much as 86%, which reduces congestion. To reproduce and verify the suggested approach, in this work a heuristic algorithm, and produces outcomes that are equivalent to those of the MILP model [2].

To establish a pixel-wise dense relative attention between the lower and higher picture scales, writers create a hierarchical model of image properties taken from the smaller size image. To generate a 0.5 scaled input picture in addition to the original one, the original input image is scaled down by a factor of 2 to create the 0.5 scaled input image [3].

Cutting-edge method for combining IoT and artificial intelligence in agricultural irrigation systems. This data analysis presents the different parts, of the modern irrigation system, many comparative metrics, and its needs. The Internet of Things (IoT) and machine learning principles enable cent centralized data processing, analysis, and decision-making from many universal sensors. An irrigation system is what is used to artificially distribute resources like water in the agricultural process. This irrigation technique is mostly employed in regions with little rainfall to keep the soil wet and warm. The novelty of the work prevents insects and undesired plant development in agricultural fields [4].

The plant watering schedule and our suggested irrigation system take these considerations into account. The kind of soil, its fertility, its moisture content, its humidity, and its temperature are just a few of the many variables that should be considered when determining how much water should be supplied to the plant when employing an irrigation system. Over time, the amount of rainfall has decreased, and springs are becoming drier than the output employed in agriculture [5].

Usage can increase by as much as 71.8% when used in conjunction with a regular watering system. Due to the open-source nature of our technology, it is simple for other researchers to adopt it and make changes to it to support the creation of a specific platform for water-table usage [6].

The amount of water that must be provided to the crops is to be measured in this work. In various techniques, water is typically applied to the crop while the system detects that the conditions have reached the desired value, and water is applied at intervals. However, at that time, it was not adequately measured how much water was being sprayed on the crop. The recommended system initially determines the weather conditions and soil wetness using sensors like the soil moisture sensor and DHT11 sensor. The Arduino Nano and these sensors then communicate successively to relay their collected data. This sensor input is used as input parameters by the ML code on the local device and the Arduino Nano [7].

Water pumping system that considers the areas that will be watered, the anticipated pressures, and the dripper flow rates. Water meters for water storage that display updates in real time. IoT devices customized for each filtering device (such as a sand filter), the physical characteristics of water and drippers, are taken into account. In this work, Fertilizers are sensors for the injection of manure (such as NPK fertilizers) and fertilizer storage. IoT devices regulate electrical conductivity and pH to achieve the appropriate nutrition solution value, and IoT sensors for small solar panels regulate temperature and moisture rates [8]. The soil moisture sensor sends data to the Node MCU ESP8266, which then transmits it via the internet to Firebase and displays it on the mobile app. comparatively, a system-supporting device keeps data variables from mobile apps sent to Firebase first before reading them with its Node MCU ESP8266. [9].

Smart irrigation depends on soil moisture sensors near the plant roots to determine how much water is needed for their roots, not the surface of the field. In contrast, the traditional system measures the level of the land's surface water and based its judgments on that measurement. As a result, as soon as the water reaches the plant roots, excess water is delivered to the soil as waste [10].

Design of a smart drip irrigation system with the Internet of Things. Drip irrigation, Internet-of-Things (IoT) technology offers a far more straightforward and quick solution. Data sent to the cloud in the server is sent using a microcontroller and a node MCU. Additionally, to enable users to react to drip irrigations correctly, a web-based application is developed. The scheme of this system, the control system for monitoring and managing the water is coupled with the soil moisture, temperature, and humidity [11].

They describe a Long-Range network-based IoT-based intelligent irrigation system. The system uses IoT sensors to gather data from paddy fields and store it on a cloud server and automated temperature, soil moisture, and water level monitoring, which will create and maintain the weather stations, sensor nodes, valve-control nodes, and a controller node. Additionally, this method can be used with two sensor nodes that include four sensors: water level, soil moisture, pH, and subsurface water, as well as gates designed to manage the flow of water in paddy fields and weather stations [12].

WSN is more productive than IoT because it avoids connected all sensor nodes directly to the Internet, lowering throughput over the Internet and sensor network energy usage. The system uses a clustered tree architecture to expand the area of operation, connection, and to continuously link new nodes. Sensor nodes represent the leaves, local gateways represent the branches, and the global gateway represents the root node [13].

To manage water effectively, an automatic irrigation system with the Inlet node, Outlet node, and Weather Station sensors will send data to the NECTEC server using the LoRa technology. The nodes that control inflow and outflow are detectable. In drainage canals, fields, sensor readings, and solar power supplies, sensors are used to measure water level, soil moisture, soil pH, soil temperature, water level, water pH, and pressure. Other sources of outlets include file systems, river systems, and solar power. Weather stations may be used to monitor GSM signal dependability, barometric pressure, humidity, light, rain, temperature, wind direction, wind speed, and solar power source. The gadget collects the gathered information, which is subsequently sent via the controller to the NECTEC Serve [14].

Wi-Fi module and an ultrasonic sensor to measure the chlorophyll and nitrogen content of leaves. The driver circuit and server receive the output from the Arduino and Wi-Fi modules, respectively. According to the information sent to the drive circuit, the pump activates when it is required. The ultrasonic, which is an evolutionary step beyond the sensor in terms of flexibility and range, has been created to further cut expenses. The range is extended from three to four meters, and an analogue input of this measured value is supplied to the Arduino Uno. The Arduino's LDR and laser serve as its second input, by using Arduino Uno, these two analogue inputs are transformed into digital output values [15].

The third (middle) Microcontroller receives data from the second (monitoring) Microcontroller, which is employed to regulate the gate valve. This microcontroller decides whether to turn the pump on or off. In this method MPS 1 and 2. Pump1 supplies water to the land, and Pump2 drains the extra water from the land. Gate valves and three-level water level monitors are present in each field. MCU is wired to each gate valve and water detection. The gate valve is managed by the MCU following the water level sensors, MCU is coupled to a rain detector, and it sends the MCU a signal about rain [16].

2.1.1Summary

The above literature review discussion about algorithm technique of the non-emergency data irrigation system and discusses Depending on the amount of soil moisture, the water pump is turned on or off, thus automating the monitoring, control, and wireless communication module operation that reduce takes a lot of human resources to do in an acceptable length of time. From our work, our smart irrigation systems have several gains. Water levels can be optimally managed by smart irrigation systems based on factors like soil moisture and estimates have overcome the drawbacks of conventional irrigation systems.

2.3. Irrigation Systems Data Derived based Emergency Autonomous

The water parameters, and the sensor with water samples in a river, stream, dam, etc. It is comprised of several sensors that are grouped and constructed into a vertical pole with the designation "sensor probe." This layer is made up of low-end processing units (edge modules), including peripherals or single-board computers. A distant highly efficient computer infrastructure called the Cloud offers on-demand computing [17].

Stakeholders to transform decision-making knowledge that may be derived from readily available data and is in-depth and correct is one of the most significant issues intelligent irrigation systems in Indonesia are facing. Creating a smart irrigation system for the sustainable use of water was the topic of this essay, which was created to help stakeholders understand the concept. Examining the development of intelligent irrigation systems from the perspective of Industry 4.0 (big data and internet of things), highlighting how data science, innovation, and IoT-based information systems can transform businesses, and analyzing the development of intelligent irrigation facilities are the evaluation and approach methods used [18]. Data is collected at each stage of the production and supply chains for agriculture, such as information on soil moisture, weather, and environmental conditions, crop yield and harvest, information on demand and supply from the supply chain, details on food processing from the food processing industry, and information on pesticides used by the farmer. The relevant information about soil quality, such as nutrient level and pH, can be determined nonfigurative by connecting biotic or abiotic data with the evolution and probabilistic existence of bacteria, insects, and substances. It is also possible to analyze seed characteristics, sort food based on weather patterns, manage markets and trade, and detect food contamination. Big data analytics advise agricultural professionals to choose the best produce [19].

The effect of an unmanned aerial precision irrigation model is to reduce the longest flight path with the least energy and traces of pesticides and propose an adaptable and quick Dynamic Ant Colony Optimization (AFD-ACO) method. Researchers use the neighborhood adaptive search policy to carry out planning tasks and use the fragrance pervasion rule to pre-process the world map to maximize effectiveness and optimization. Last but not least, in comparison to the other two ACO-based algorithms [20].

The ambient temperature pump's flow rate must be adjusted according to the soil's humidity and ambient temperature since the soil will lose water through evaporation. A fuzzy logic system with multiple inputs can accomplish this. Two input sets are established for the fuzzy logic controller in this instance, they are the soil's humidity and temperature. Both values are from the sensors, moisture sensor and LM35, which measure the soil's temperature and moisture content, were obtained. Data from the sensors will be obtained by the computer using data-collecting techniques [21].

The synergy between the working hardware and the soil particles, these sensors work by scaling the degree of noise, which effectively measures the soil permeability. The capacitive soil moisture sensors are dielectric sensors that determine the soil's moisture content and are next to be discussed. These use capacitance to determine the permittivity of the surrounding material. Due to the soil's moisture content, the sensor outputs the frequency response of the capacitance of the soil. With widely available IoT sensors, IoT now satisfies the demand for a more practical technique of gathering real-time data on the moisture content of the soil and the height of the crops [22].

Identified Crop watering schedules, other recommendations, and supervision are collectively provided by the Processing and Transport layers. There are layers on behalf of sensing, applications, processing, and transport in the IoT framework that has been provided. The physical layer designation of the perception layer suggests that it might be a sensor for data assembling. It detects air humidity, soil moisture, and temperature. A significant percentage of data that enters the transport layer is analyzed, recorded, and developed by the processing layer. It makes use of edge computing, databases, and CC methods, and the application layer provides applications [23].

Real-time systems determine if a physical sensor is transmitting precise readings or is failing as a result of outside influences on the system, such as noise. To address this problem, Long Short-Term Memory (LSTM)-based neural networks are proposed as a potential alternative technique. The proposed method, which substitutes a neural sensor for a physical sensor in an intelligent irrigation system, is tested. Several physical sensors are part of the Smart Irrigation System (SIS), which transmits temperature, humidity, and soil moisture data [24].

Water resources have prompted the necessity for optimal usage. Evaporation is one such parameter that assists in driving this application in identifying the soil moisture level and its retention ability with real-time data from sensors and weather forecasts. The method of nonlinear features concerning kernel canonical correlation analysis. By making this effort, the kernel functions are used to condense the input vectors of the prediction model. To calculate the soil moisture content and determine the rate of evaporation, the prediction method uses kernel functions based on support vector machines [25].

For sensing components, such as temperature and soil moisture sensors, which measure, respectively, the temperature of the atmosphere and the water content of the soil, and a Wi-Fi module, which is used in the transmission and reception process to transmit data from sensors to mobile phones and receive commands from a mobile phone. A list of the most appropriate crops is chosen from all crop databases based on the soil PH value. Mobile apps display values for monitoring metrics, including temperature, humidity, moisture, and pH [26].

Various methods and technologies for analyzing hyper spectral and multi spectral data have proven useful in enhancing agricultural practices and output. These technologies are widely used in a variety of agricultural applications, including crop management, crop yield projections, crop disease diagnosis, and the monitoring of soil, water, and land usage. Using hyper spectral information sensing, hundreds of spectral bands that cover the whole electromagnetic spectrum of an observational scene may be gathered in a single collection [27].

The research further examines the spatial and spectral elements of big data in agriculture. First, a complete examination of fair representation studies is provided before providing insights into sound research projects in agriculture employing big data, machine learning, and supervised learning with an emphasis on structures or architectures, information processing, and analytics with hyper spectral and multi spectral data. The use of hyper spectral and multi spectral data in agriculture has great potential for the future of big data, machine learning, and deep learning [28].

In this method, satellite images and meteorological data, Gaussian Processes (GPs) are used to estimate and analyze crop development and yield. The recommended technique integrates optical and microwave sensor-based data on canopy greenness, biomass, soil, and plant water content with atmospheric variables typically measured at meteorological stations. The GP model takes into account processes with various sizes and non-stationary and nonlinear behavior using a composite covariance. Compared to existing machine learning methods for estimating corn, the GP model claims considerable improvements in accuracy. Using sensitivity analysis, investigate the GP interpretability further and find that remote sensing [29].

Solar panel powers the central control system and motor. Humans are already aware of the system that uses a PIC controller to regulate the motor when it is mobile. In these systems, the power produced by the solar panels is used to run the entire system. Time is wasted since the ON/OFF system is manually operated. Using a solenoid valve that runs on a 12-volt DC source, this process is automated in this project by verifying the soil sensor's state. The valve is open if the soil sensor's signal waits; else, it is closed. Additionally, by monitoring the dry run circumstances, managing the primary motor via mobile through messaging. GSM model is used for message transmission [30]. It is shown in Fig 2

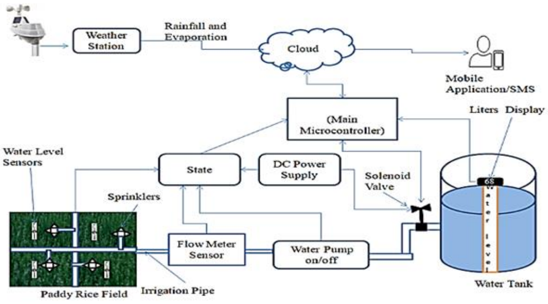


Fig 2. An irrigation system design that displays the whole irrigation system based on the emergency data set.

2.3.1Summary

The above author’s review and discussion about irrigation systems data derived based emergency autonomous of the network during preparation in supervised learning. Readings of the temperature and humidity make up the majority of the data beliefs. The sensor data in the test mode will then be predicted using the trained neural network. From that proposed neural sensor can replicate the behaviour of a physical sensor node.

2.2 Wireless Communication and Network using Irrigation

The total parameters of soil moisture of potted wheat plants within a predetermined range are measured. It makes it possible to calculate how much water is needed for irrigation at different stages of wheat growth. Each water pump's irrigation tubing has a different diameter. It was positioned all around the soil moisture sensor in a circular pattern. To mimic drip irrigation, humans caught holes into the portion of the tube that surrounds the sensor. Plant scientists will be able to experiment on wheat using this method by replicating drought stress in a greenhouse environment [31]

The crown temperature, solar irradiance, and humidity deficit are used to calculate the theoretical Crop Water Stress Index (CWSI), which indicates plant water status. A capacitive soil moisture sensor's measurement of the soil's moisture content is also used to evaluate the soil's water status. To obtain information on the effectiveness and functionality of the design, the prototype of the suggested system is built and tested. Practical testing is done on the suggested irrigation scheduling system to determine effectiveness [32]

Wireless Sensor Networks (WSNs) are employed as sensor nodes that interact with the physical environment directly and provide real-time data that are useful in locating areas that require assistance. These results offer a useful way for employing WSN as a tool for data gathering and a Decision Support System (DSS). Farmers can employ either automated irrigation systems or manual irrigation methods with the suggested DSS. Since these algorithms continuously search the whole dataset for each packet, they also lower the overall performance of a real-time system [33].

In this work, authors discussed about the different methods of specific remote device association for an agricultural setting. It is frequently essential to check the changing climate for different sections, such as soil moisture, leaf health, and diligence adjacent to completely different portions. To determine the level of soil sponginess content, soil wetness detecting equipment is employed. Additionally, wet sensing element data are managed by the controller because the camera will not be able to comprehend and monitor the leaf conditions. The management calculation indicates a high probability that the controller will fail. In nature, sensing element yield is crucial between 0 and 5 volts. Clear data are converted to automated information via a device [34]

The Wireless Chip sensor tag uses back scattering methods to monitor the Volumetric Water Content (VWC) of the soil wirelessly. The effective permittivity of the VWC of the sensor file's surrounding soil determines the resonant frequencies of its shorted dipole resonators, which make up the sensor tag. The frequency response of the sensor tag is found using an orthogonally oriented reader antenna that locates the peak in the back scattered spectrum. Interrogator/reader is the term used to describe the RF source that sends the interrogation signal to the ground. The signal is received by the sensor and back scatters off its surface. The reader collects the back scattered signal, which carries information about the local soil [35]-[36].

The conclusion is that traditional wireless sensing technologies like ZigBee, Wi-Fi, and GPRS have short transmission ranges and signal interference in large-scale farms and greenhouse environment monitoring systems. To overcome the flaws like complicated network design, in this work, a LoRa wireless technology-based low-power farm environment detecting system is proposed. This model may employ a variety of sensors in the lab to fully identify soil, simulate environmental factors, and apply lighting, irrigation, cooling, and man-machine management [37].

This work analyzed the water facilities' impact on the productivity of irrigation. Different techniques are developed to give the right amount of water to the agricultural regions to reduce this water deficit. The ideal water supply is maintained here using a precision irrigation system, reducing water waste. This method allows us to get better harvesting results. The PH value can determine how much water is needed overall for the soil and plants. An algorithm called random forest is utilized to determine the PH level. The reference, therefore, follows that preprocessing for statements about water delivery is carried out using evapotranspiration-based preprocessing (REP). The weather-based approach uses inputs including information on the following variables: air temperature, humidity, solar radiation, wind speed, soil texture, root zone depth, crop coefficient (Kc), and rainfall [38].

The Internet of Things (IOT) is an original idea trend in technology that offers solutions to problems with our level of living. IOT is being used to enhance a variety of living settings. IOT may also be used to address problems in conventional agricultural methods and the agribusiness sector to organically maintain and monitor rural homesteads with minimal human interaction. The covers a variety of IOT-related developments that have been made in the farming and agriculture sectors. Sensors, actuators, network engineering, wireless technologies and architectural layers, network geographies in use, and norms have all been mentioned as having an influence on IOT incorporation in institutional improvements in IOT-based agriculture [39]

Deep spatial-spectral belongings from multispectral photos, a complete 3-D convolutional neural network is first built. Then, a Multi-Kernel Learning (MKL) method is suggested for the fusion of deep spatial-spectral characteristics in intro images. The initial use of A3 DCNN is for assessing spatial-spectral features in agricultural yield prediction. Robust spatial-spectral information can be concurrently retrieved by using 3-D convolutions. On top of the 3-D CNN, an MKGP is concatenated with a new "spatial-spectral-spatial" composite Gaussian kernel. The new kernel can flexibly encapsulate deep feature properties and spatial consistency because it is developed from in-depth features and location data [40]

IoT architecture and artificial neural network solutions for greenhouse irrigation are discussed in this work. To forecast future moisture, our method places four sensors in various soil strata. Using a dataset they acquired by doing experiments on various soils, they show the improved performance of neural networks in comparison to the existing alternative approach of support vector regression. They suggest employing transfer learning to lower the neural network's required processing power for IoT edge devices. The other two problems of smart irrigation of greenhouses are accelerated training performance with minimal training data and integration of climate sensors to a pre-trained model [41].

The Dynamic Work lightweight model added dense connection functionalities and changed the non-linear transformation within the dense configurations to integrate low-level semantic elements with high-level multiplexing semantic features to identify the growing points of the main cotton stem. Deep separable convolution was used in this model to drastically reduce the number of model parameters. The hierarchical multi-scale approach was used to enhance the knowledge capacity of multi-scale features. Integration of elements from many layers to minimize the number of parameters and, to a certain extent, solve the issue of gradient disappearance by taking full advantage of the features of each layer [42].

Categorized as favorable or uncomplimentary for the administration of water, as well as whether the land needs water or not, whether the optimum time to irrigate is now ("Is favorable," "Need," "Had Irrigation," and "Suggested Irrigation," Hour," respectively). In a subsequent phase, using the finished dataset and before evaluating the various procedures, a test was conducted to determine the relative importance of all features, allowing for the understanding of which features are the most crucial and which should not be taken into account during training, leading to the optimization of the dataset and the elimination of noise[43].

System

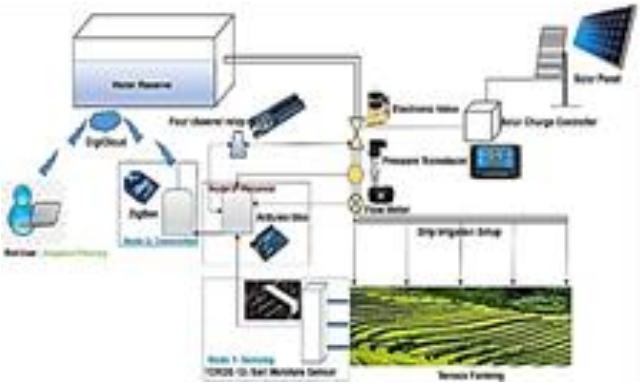


Fig 3. The architecture of Network Application Base Irrigation data set.

The user receives an SMS notification whenever the water level falls below the threshold thanks to an ultrasonic sensor in the tank that continually checks the water level. The GSM module then receives the user's SMS and turns on the relay to turn on the tube well after receiving it. When the subsurface tank is filled, a microcontroller shuts the pump off [44].

Check out the Voltage Source Inverter (VSI)-delivered electricity from the PV array that powers the Syr motor. The bidirectional power transfer between the grid and the PV array is facilitated at the grid side by a Front-End Converter (FEC). Regardless of changes in solar insolation, this PVWPS delivers a continuous water supply throughout the day for residential and irrigation use. With the help of this regulation, the grid can operate at Unity Power Factor (UPF) and benefit from improved power quality. MPPT and Syr motor control use the same power converter. So, complexity, size, and expense are all decreased. The Syr motor drive's status sensor less operation adds to the PVWPS's simplicity. This control algorithm also manages the power flow from the solar generator to the grid described by the [45] based on the above author's review Fig 3 review shown below.

2.3.1 Summary

The above literature survey has some discussion and algorithm techniques of the 2. Wireless communication and Network using Irrigation System. The above discussion is based on the soil's volumetric moisture content (optimum moisture content). The threshold value is established, and above and below levels are determined by measuring the soil moisture value level and comparing it to the threshold. The humidity sensors assist in determining the temperature and relative humidity of the surroundings. From that, we developed wireless moisture sensors that connect with these intelligent irrigation controls and support the system in determining whether or not the landscape required irrigation**,**

2.4. Various Autonomous Application- Based Irrigation System

Solar panel and Programmable Logic Controller (PLC), automatically manages the entire system. If there is enough sunlight during the day, the solar panel generates power, and water is sucked up from the well and stored in a tank. This water is then used anytime irrigated land needs water. It is an independent system that does not require any other power sources. A flow detector is used to monitor the water flow in the pipe once the motor has been turned ON using a PLC. The motor will be turned off automatically by the PLC if the flow detector did not detect the water flow within two seconds of the ON time, preventing [46]

The agri-food industry may produce a sizable number of different datasets in terms of their content, format, and storage type. Heterogeneity, diversity, unstructuredness, noise, and excessive redundancy are typically seen in big data. Such enormous data sets require complex methods for data curation and storage, as well as time-consuming statistical methods and programming models to extract relevant data. The conditioning and pre-processing of primary data yield the knowledge required to grasp the state of the (large-food) system [47].

Air moisture, air temperature, and soil moisture elements may have an impact on plant growth through a mobile application. Furthermore, it's not always feasible in real-world situations to employ timers to operate the pumps used in traditional irrigation systems. In this work, a methodology for controlling a pump's switching time using advanced fuzzy logic and user-defined variables is proposed. Sensors serve as the system's main component and input. Our suggestion has the potential to operate superbly as a connection point between sensors acting as the input and the Internet of Things acting as the medium for output [48].

IoT-based smart irrigation systems boost crop productivity. Multi-cropping is a fantastic strategy to increase earnings or crop output in less time if there is limited available land.

This essay puts forth the concept of a smart irrigation system with smart decision-making that relies on real-time data collected from the land. Based on the soil's moisture content, the pumping motor in this automatic irrigation system turns ON and OFF. An operating amplifier will control the pump by receiving information from a soil moisture sensor. A sensor that measures the precise moisture content of the soil is called a soil moisture sensor [49].

Present that the most crucial necessity for any crop is water. While certain crops require more water than others, some crops require less water. Another critical element that is necessary for the growth of a crop is temperature. While certain crops need high temperatures to develop, others suffer damage when exposed to them. The most used protocol for communication is Wi-Fi. This benefit of the Wi-Fi system can be applied to track and monitor the current status. The motor is turned ON for a set period if the soil is dry. A warning message urging the user to manually turn the motor off is issued when the sub-threshold time is reached and the motor is still in the ON position [50].

A distinctive visual method for controlling and monitoring water flow, although water is a need for life, it has been found that individuals prefer to turn on the motor when their faucets run dry and turn it off when the overhead tank begins to overflow when it comes to wisely managing water. This causes wasteful water waste and, occasionally, a lack of water during emergencies. Therefore, the main goal of the suggested model is to visually monitor the water level in the tank and sump. When the water level rises or falls below the user-set threshold, the corresponding LED lights to indicate that it is time to switch on or off the motor [51].

Crops require humidity monitoring to determine water losses by evaporation, which is important for the photosynthetic process. SAS analyzes factors including pH and conductivity using a range of soil moisture sensors. Soil conductivity maps can be used to forecast crop yield because they provide an indirect estimate of soil organic matter and soil texture. This technique is appropriate for wireless sensor nodes where faster data transfer speeds are needed but power consumption is not a concern [52].

GSM Based irrigation system with the Arduino receiver connected to the GSM modem's emitter and the Arduino transmitter connected to the GSM modem receiving. Temperature and soil moisture sensors are sent to the microcontroller. In the initial programming of the threshold, settings take place on an Arduino board. As a result, the readings obtained from the sensors are compared to the threshold values. When the temperature sensor readings exceed the threshold value but the soil moisture readings are below the threshold value. The GSM/GPRS module then notifies the user through SMS. When the message ON is received, the user then turns the motor pump ON [53].

Utilizing this advancement in an era of contaminated environments and vanishing agriculture, a system was created to track the condition of soil using sensors attached to a Node MCU, evaluate and anticipate the data using the WEKA tool, and use a Raspberry Pi 3 as a broker for the MQTT protocol. Moisture sensor and DHT-11 to Node MCU, a client/subscriber for MQTT. The Raspberry Pi employed in our system serves as an MQTT broker, allowing the motor to be turned on and off following the estimates made by our data analysis tool. Our suggested system uses a tool called WEKA that collects data from numerous sensors as training data to create a model that is then used to predict future data [54].

Developed the GSM component of the proposed design renders this working remotely. The water content is constantly monitored, and when the soil's level of moisture drops too low values, the work sends a signal to the engines asking them to start. Once the dirt reaches the client-selected highest upper limit esteem, the engines will shut off on their own. The client will get an SMS with information about the status of the activity each time the engine starts up or stops on its own. Additionally, this study includes the development of a sensor system using a Node MCU that can monitor even the movement of creatures that could destroy the harvests in horticulture fields [55] – [56].

A solar tracking system and SPV DC irrigation pumps are discussed in this work. Simulation is carried out using HOMER software. A 5 HP DC irrigation pump load is integrated into the simulation model. For the study, local sun radiation measurements from the developed HOMER model are a battery-powered standalone system. For the analysis, a constant DC load profile for seven hours per day is used. Additionally, simulations are run using various sun-tracking technologies. The simulation results are attained using SPV panel tracking with Monthly, Weekly, Daily, and Continuous Horizontal Axis, Continuous Vertical Axis, and Two-Axis Adjustment. The best SPV panel and battery configurations for each monitoring technique are mentioned, along with varied prices for original capital, operational [57].

Developed the Agri-Sens system, a dynamic irrigation scheduling system powered by the Internet of Things (IoT) is a good solution for efficient agricultural irrigation. The Agri-Sens uses IoT to provide remote manual irrigation treatment that is autonomous, dynamic, and available in real-time for different growth phases of a crop's life cycle. A low-cost water-level sensor is used to determine how much water is there in a field. Give a farmer an algorithm for autonomous dynamic-cum-manual watering based on his or her demands. Farmers may retrieve field data from the Agri-Sens through a visual display, a mobile device, or a web portal, and it provides a user interface that is friendly to them. It operates wonderfully in a variety of climatic conditions and concerns a wide range of performance metrics, including data validation, packet delivery ratio, energy consumption, and failure rate [58].

Fuzzy logic is used to determine how “Panchagavya,” an organic mixture, affects tomato productivity. A “grow bag” study has been conducted using Panchagavya's foliar nosegay and seed treatment on organically grown tomato plants to assess the “true aura” of the herb as a potent nutrient and immune protection tonic for plants, particularly tomatoes. By transforming the hard data into fuzzy data and then de-fuzzifying it to get results for tomato yield, the findings of the aforementioned study are used to derive five fuzzy logic functions. The hazy data support that Panchagavya is best used when young people have a strong level of illness resistance [59].

Through a proprietary gateway, the system will create a link to the internet, where a cloud platform will give farmers and end users clear alarms to estimate the conditions on the farm in real-time. It will feature a wireless underground sensor network (WUSN) underground made up of several cheap sensors [60].

This technique is the foundation of the suggested algorithm. Therefore, in this section, the alterations are highlighted while the other algorithmic components are briefly debated. The primary goal of the upgrades is to take into account how precipitation may affect the mounted PV system and water tank. The hydraulic component of the irrigation system is sized according to the features of the installation site [61].

Groundwater’s storage capacity, and the size of the lines that link the water tank and pump. The reductions in height are shown in meters. The minimum operation height of the pump is calculated by multiplying such losses by the height of the groundwater level and the height of the tank above the ground. The selection of a suitable pump and related power converter for its power source is made possible by this parameter and the maximum debit [62].

Field corners, High-strength steel wire ropes or fiber ropes are used to suspend the water showering apparatus or shower. Each pole has a pulley configuration installed on top of it for the simpler movement of the rope. If the z-axis of a 3D coordinate system is considered to indicate the location of the pole, the pulley setup can move an angle that is restricted in the x and y planes. This will guarantee that nearly every spot in the field is watered [63].

The field's form affects the angle's value. Because a rectangular field is taken into account in this work, the angle value will be smaller, with the precaution that the rope won't sag Stated that a smart system uses weather forecast data from the Internet and the measurement of ground data to determine a field's irrigation demands, such as soil moisture, soil temperature, and environmental conditions, the recommended system's intelligence is built on a clever algorithm. The motor is turned ON if the soil moisture is below the threshold value and turned OFF if the soil moisture is above the threshold value. The Arduino is connected to the sensor's equipment and interacts via a Wi-Fi module so that the user may get the data using an Android app on his mobile device, which can obtain sensor data from the Arduino via a Wi-Fi module [64] -[65].

It is important for students to determine which learning styles best fit their individual needs. A crucial component of engineering education success is using the right teaching technique. A teaching strategy called Tool Based Technical Activity (TBTA), which combines traditional teaching techniques to increase students' focus as they study [66]. Feedback from students using TBTA enhances their knowledge, learning, and communication abilities. Path agents, Network control agents, Multicast controlling agents, Network launch substances, and Multicast control agents are the five types of agents that make up the MAZR protocols. While network launch agents and multicast command agents are movable, path, network, and multimedia control agencies are immobile [67].

2.5. Summary of various autonomous application-based irrigation systems

The above authors discussed the application-based irrigation system based on a soil moisture sensor, water level sensor, and controller unit, and the output result gave networking and wireless communication. The review of the literature indicates that a certain effort has been taken to study the growth, Weather environment, and productivity issues in Indian agriculture at the level of individual crops. Therefore, both from data management and a policy standpoint, it is essential to evaluate the agricultural sector at the state level as well as the level of the crops.

3. Materials and Methods

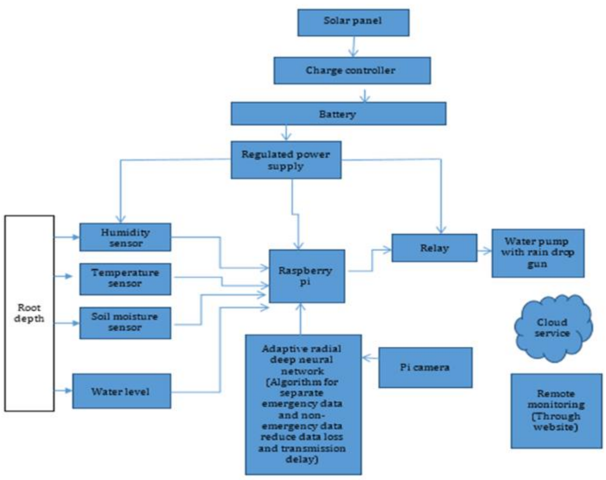


Fig 4. Overall system Architecture of the proposed system

Obtain sensor readings for the irrigation system from WSN nodes that are present. With the aid of the neural network algorithm, collected values were divided into emergency and non-emergency data to start irrigation. The suggested neural network approach increase accuracy and dependability. The security of data transmission is crucial when utilizing the Internet of Things to transport data to the cloud, and is achieved by employing neural network algorithms.

Fig 4 shows the working operation of the weather monitoring system that looks for rain during the autonomous irrigation system's operation. The soil moisture sensor evaluates the state of the soil in the absence of rain. The pump will open for 10 seconds if the soil is dry. Moisture release has an analogous form. The sensor's output is converted into a digital representation by the integrated Moisture. The Raspberry Pi uses the digital value to calculate whether the soil is moist or dry and how much water the plant needs. The Raspberry Pi relay operates a water pump when the ground is dry. This process is carried out over and over again until the soil achieves the desired humidity.

3.1 Soil moisture sensor

Here, the obtained value variable is given the value that was received from the sensor analogue pin value in analogue format. Fig 5 shows the value of pin1 will be recorded while readings from the dry soil are being monitored, and pin2 will be used to input the sensor value from the wet soil. The value for pins 3 and 4 would fluctuate between 0 and 100 as a result of which the percentage of soil is measured.

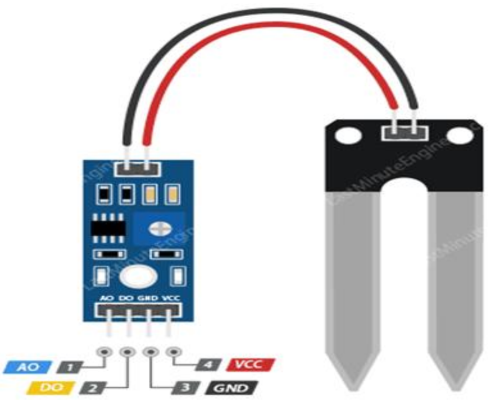


Fig 5. Pin configuration of soil moisture sensor

3.2 Humidity Sensor

The relative humidity of the air is used to estimate how much water vapor is present in the atmosphere. Fig 6 depicts the pin layout of the humidity sensor. A calibrated digital output is produced by the DHT11 temperature and humidity sensor.

The DHT11 may be connected to any controller, including Raspberry Pi and others, to deliver results right away. The DHT11 is a trustworthy humidity and

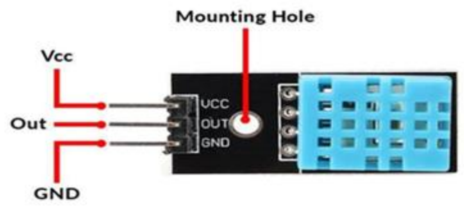


Fig 6. Pin configuration of Humidity sensor.

3.3 Temperature Sensor

With its sturdy construction and respectable accuracy, the LM35 sensor excels in a range of environmental conditions. Additionally, this circuit is simple to calibrate and generally has an accuracy of 0.5° at ambient temperature and 1°C across the whole temperature range of 55°C to +155°C. Fig 7. Sensor pin description. Since it runs between 4V to 30V and consumes 60 uA of electricity when in operation, it is perfect for battery-powered applications.

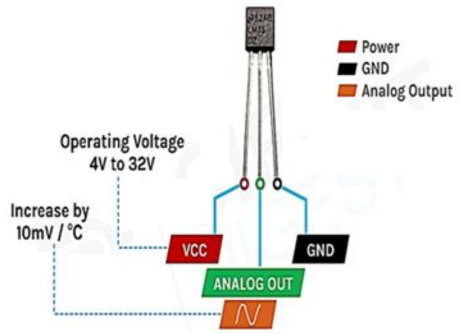


Fig 7. Circuit diagram of Temperature Sensor

3.4 Water Level Sensor

The required amount for measuring the water level with an upper limit showing the maximum quantity of water that may be filled in the container is uploaded to the Raspberry Pi. A container is taken that has been filled with water and marked with a scale. The container is attached to Remote monitoring (Through the website), which records the water level. Table 3.1 Tabulation gives the working operation of the water level sensor. The Raspberry Pi is connected through Relay for ON and OFF conditions. The water sensor turns on and flashes red when water is close to spilling out of the container. This indicator serves as an alert to preserve both water and hydropower.

Table 1. Tabulation of ON and OFF conditions from getting the value of the above sensors

SURFACE	***MOISTURE CONTENT***	***TEMPERATURE***	***HUMIDITY***	***MOTOR/FAN***
Wet surface with low-temperature surroundings	70%,	20 °C	43%	OFF state.
Dry surface with low-temperature surroundings	20%	20 °C	43%	The fan is in the OFF state and the Motor is in the ON state.
Dry surface with high-temperature surroundings	40%	31 °C	43%	Both motor and fan are in the ON state.
Wet surface with high-temperature surroundings	80%	31 °C	43%	The fan is in the ON state and the motor is in the OFF state.
Highly humid conditions	60%,	31 °C	70%	The fan is in the ON state and the motor is in the OFF state.

3.5 Adaptive radial deep neural network

To operate the smart irrigation system and reduce errors from sensors, three processing levels combine Adaptive radial deep neural networks have different types of layers i) Input Layer) ii) Hidden Layer iii) Output Layer. The neural network application layer closing each of these three levels consists of a unique combination of elements and features. Following that, initial

Predictions and computations are made in the specific interval, and the necessary water is pushed utilizing pumping motors. All of the settings are initially set to zero Input Layers are Data transmission and collection from the initial stage from the sensor unit. Hidden Layers are used to collect data from agricultural areas and send it for further data processing. The Output Layer parameters are continually gathered and sent to the processing unit. Using Pearson correlations, the total values are compiled and the Fig 8 shows the architecture.

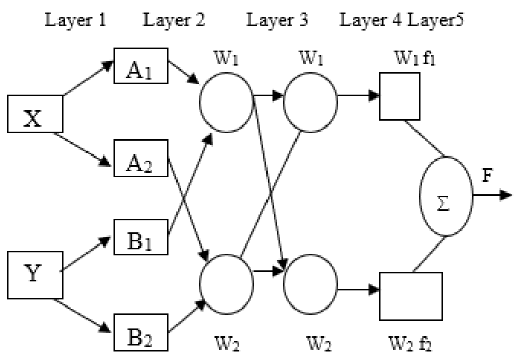


Fig 8. The architecture of Adaptive radial deep neural network

3.5.1 Algorithm Steps

Step 1: Input value from getting the sensor.

Step 2**:** Read all sensor values must add 0 to 1, typically the multidimensional (z_j) function soft-max is employed.

$$Softmax\ (z)_i = \frac{\exp(z_i)}{\sum_i \exp\ (z_j)} \qquad (1)$$

*Step 3***:** In the irrigation, data set $E_{(x,y)}$ sensor node and this control unit work together then because the use of the logarithmic prevents the $\log(\ \rho\theta\ \left(\frac{Y}{X}\right))$ gradient from having relatively minute values.

$$L\ (\theta) = -E_{(x,y)} \sim p^{\left(\log\left(\ \rho\theta\ \left(\frac{Y}{X}\right)\right)\right)} \qquad (2)$$

*Step 4***:** The training procedure was carried out using experimental data obtained throughout the soil moisture level and the order of water durations and hard threshold function.

$$\theta_\beta\ (X) = max\ (0, x) \qquad (3)$$

Step 5: The aggregate data point x, y's error should be calculated for each training batch.

$$\varepsilon_t = \frac{\sum_{i=1}^{n} \omega_n^t * I(w_n \neq h_t(x_n))}{\sum_{i=1}^{n} \omega_n^{(t)}} \qquad (4)$$

The similarity between two or more using the sum of the digital values, and subsets are determined.

4. Result and Discussion

To analyse drip irrigation, an adaptive radial deep neural network inference method is used. The ARDNN makes use of the MATLAB version 2017b implementation tool, which is a programming technique for conveying digital mathematical concepts.

Table 2. Simulation Parameters Details

PARAMETER	VALUE
Data set	Irrigation Dataset
Number of Data	500
Trained data	400
Test data	100
Tool	Mat Lab

The main factors that affect the irrigation process are the kind of growth, growth state (height, depth of roots), leaf coverage, soil type, salinity, and water budget (economy or regular watering). Consequently, the following values are used as the system's input parameters: sensors for soil temperature and moisture Humidity detector Adaptive radial deep neural network.

- Recurrent Neural Network.
- Modular Neural Network.
- Sequence-To-Sequence Models.

4.1 Performance Analysis of Matrix

In the derivations that came before, "(x i)" stands for the achieved value and "x i" for the genuine value. The mean absolute error, which may be used to predict errors given the real and attained rates, is the average of accomplished errors. Additionally, this model classifies soil samples into two categories: soil with a high moisture level (HML) and soil with a low moisture level (SML) (LML). Results are assessed using the True Positive (TP), True Negative (TN), False Positive (FP), and False Negative (FN) classification rates. This leads to the calculation of important analytical metrics including Precision, Recall, and F-Measure. Also provided below are the computations.

- The sensitivity rate (recall), which is calculated using the method provided, is the frequency with which the model accurately predicts positive classifications,

$$Sensitivity = \frac{TP}{TP+FN} \quad (5)$$

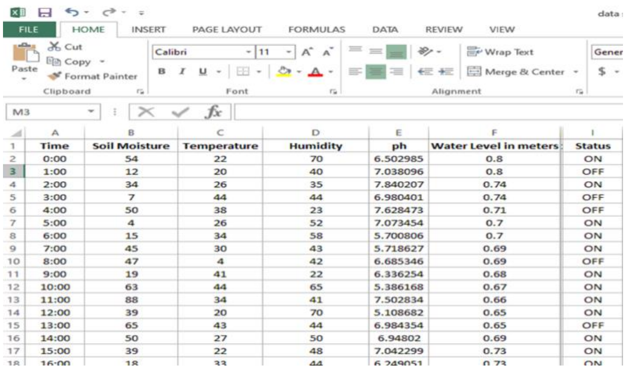
- The proportion of accurately recognized soil samples to all samples submitted for testing is known as the precision value. It might be computed as

$$Precision\ Value = \frac{TP+TN}{(TP+FN)+(FN+TN)} \times 100 \quad (6)$$

- The accuracy value is determined by how many accurate predictions it makes designed for the entire test dataset. Accuracy is a useful fundamental metric to evaluate the model's effectiveness. Accuracy deteriorates as a measure with imbalanced datasets.

Accuracy = (TP + TN) / (TP + TN + FP + FN (7)

4.2 Data set calculation from sensors through controller-based Adaptive Radial Deep Neural Network



	Time	Soil Moisture	Temperature	Humidity	ph	Water Level in meters	Status
2	0:00	54	22	70	6.502985	0.8	ON
3	1:00	12	20	40	7.038096	0.8	OFF
4	2:00	34	26	35	7.840207	0.74	ON
5	3:00	7	44	44	6.980401	0.74	OFF
6	4:00	50	38	23	7.628473	0.71	OFF
7	5:00	4	26	52	7.073454	0.7	ON
8	6:00	15	34	58	5.700806	0.7	ON
9	7:00	45	30	43	5.718627	0.69	ON
10	8:00	47	4	42	6.685346	0.69	OFF
11	9:00	19	41	22	6.336254	0.68	ON
12	10:00	63	44	65	5.386168	0.67	ON
13	11:00	88	34	41	7.502834	0.66	ON
14	12:00	39	20	70	5.108682	0.65	ON
15	13:00	65	43	44	6.984354	0.65	OFF
16	14:00	50	27	50	6.94802	0.69	ON
17	15:00	39	22	48	7.042299	0.73	ON
18	16:00	18	33	44	6.249051	0.73	ON

Fig 9. Data set evaluation for evaluation of Matrix method

Fig 9 Displays the Excel data sheet from Visual Studio web page-based smart agricultural irrigation data set's IoT (Internet of Things) implementation interface.

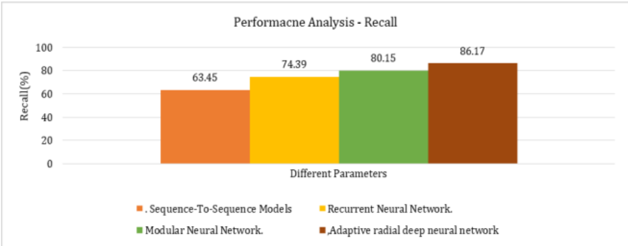


Fig 10. Analysis of Recall

Fig 10. Discusses the performance analysis of recall. This comparison clearly shows proposed Recall (86.17%), Recurrent Neural Networks (74.39%), Modular Neural Networks (80.15%), and sequence-to-sequence models (63.45%).

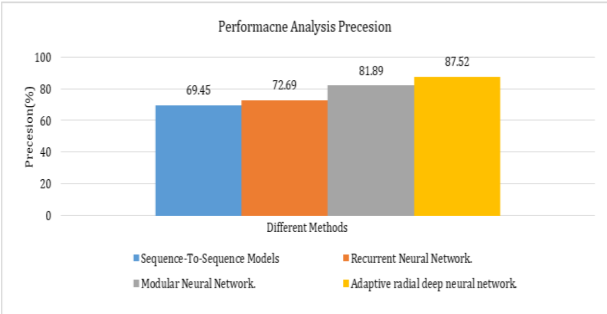


Fig 11. Performance Analysis of Precision

Fig 11. Examines the recall performance analysis. This result indicates reliably that the adaptive radial deep neural network approach calculation Adaptive Radial Deep Neural Network method gives a Precision Value (of 87.52%). The Precision Value comparison of Recurrent Neural Networks (72.69%), Modular Neural Networks (81.89%), and Sequence-To-Sequence Models (69.45%).

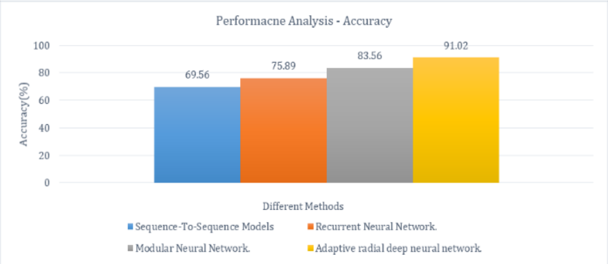


Fig 12. Accuracy Analysis of different irrigation data sets

Fig 12**.** Examines the accuracy of performance analysis. This result indicates that the suggested Adaptive Radial Deep Neural Network approach Adaptive Radial Deep Neural Network method gives an accuracy Value (91.02.%). The accuracy Value comparison of Recurrent Neural Networks (75.89%), Modular Neural Networks (83.56%), and Sequence-To-Sequence Models (69.56%).

4.3 Summary

The Adaptive Radial Deep Neural Network approaches based on Neural Networks have calculated Precision, Recall, Accuracy, and False Rate are examples of value analysis. In order to fix these inadequacies, sensor nodes are employed to develop smart irrigation systems (Internet of Things). Soil moisture and temperature sensors are used to continually monitor the environment and collect information on soil temperature and condition. Only the data requested should be collected; the remainder should be discarded. The IoT (Internet of Things) transmits data to devices such as wireless communications. The major purpose of evaluating and calculating vast amounts of data in databases is to discover new relevant connections, trends, and input data from soil moisture and temperature sensors. The given graph shows the recall ratio and accuracy.

5. Conclusion

Large amounts of water are used in conventional agricultural activities, which leads to water waste and plant monitoring. To reduce water wastage during this repeating process and immediately monitor plants using sensors, an intelligent irrigation system is being improved. The effectiveness of implemented strategies in various agricultural fields is calculated using this method. The key component that collects data from three sensors—a soil moisture sensor, and a temperature humidity sensor is the controller unit. Additionally, it offers a capability for scheduling watering. When the soil moisture extends to a specific level, the user can schedule watering. Based on information about the projected pattern of soil moisture and precipitation, the method directs users to retain the threshold value. The irrigation can be started automatically by the system, and it can end if the soil moisture reaches the predetermined threshold value. In this module, the connection of a water pump is accomplished by a relay switch that is managed by a node with Wi-Fi capabilities.

It becomes essential for the efficient and optimum use of fresh water in irrigation to create intelligent irrigation systems based on a dynamic forecast of the soil moisture pattern of the field and precipitation information for upcoming days. This analysis develops an intelligent system that forecasts soil moisture using data gathered from sensors placed in the field and Internet-based weather forecasts. Through a sensor node that was independently created, field data was collected.

The Adaptive Radial Deep Neural Network approach gives The DBN-PPCA provides an Accuracy Rate of (91.02%), a Precision of 87.52%, and a recall of 86.17%, and the overall review analysis performance analysis are given better output result.

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