Smart-Agriculture-Irrigation-Monitoring-System-Using-Internet-of-Things

Chapter · August 2023

DOI: 10.4018/978-1-6684-7879-0.ch006

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Chapter 6
Smart Agriculture Irrigation Monitoring System Using Internet of Things

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ABSTRACT

In this chapter, smart agriculture irrigation monitoring systems using IoT principles are described. The general information for precision agriculture systems, the integration of the internet of things with irrigation systems, and measuring parameters have been illustrated. Two framework models, such as Agriculture Factor-Based Relevance Vector Analysis (ARV) and advanced irrigation systems for soil moisture prediction systems for smart agriculture irrigation, have been illustrated in this chapter. The environmental factors for the irrigation system have also been monitored and controlled to improve the production rate. The framework model for an advanced irrigation system and the ARV model for prediction and control of water supply to the land based on soil moisture has also been illustrated.

INTRODUCTION

In order to increase output while having the least negative impact on the environment and to better prepare agricultural land for climate change adaptation, the United Nations has established the goal of implementing sustainable food production techniques in agriculture. Precision agriculture is a revolutionary agricultural method that has emerged in agriculture as a means of achieving the UN's goals.

DOI: 10.4018/978-1-6684-7879-0.ch006

This is a method of modern agriculture that makes use of information and communication technologies to boost the efficiency of agritourism. Farmers are utilising sensors more frequently to track the health and productivity of their crops by keeping an eye on factors including plant health, irrigation, crop output, soil health, and the impact of fertiliser and pesticides. Farmers are encouraged to monitor their crops remotely thanks to information and communication technology like wireless sensor networks and internet of things in agriculture.

For real-time monitoring of the agricultural field, an architecture that integrates several systems such as sensor motes, gateways, and handheld devices is presented. The design and creation of a precise, effective, and dependable system with minimal expense and complexity for the farmers is the main objective. The importance of implementing customization in the hardware and firmware design and development is discussed. The sensor mote and gateway process long-range communications to start the data transmission from the agricultural field to the cloud server. Long-range communications and Wireless Fidelity (Wi-Fi) are built into a hand-held IoT device, which gets sensor data from the agricultural field from the cloud server and through long-range communications. Machine learning algorithms are used to anticipate the best harvests using the sensor data collected by the handheld device(Boopathi, Siva Kumar, et al., 2023; Kumara et al., 2023).

The findings point to a promising future for precise, low-cost, and complicated systems that primarily help farmers keep an eye on their fields. Ager, sometimes known as Agri, is a Latin term that means "soil," and "culture" is the act of cultivating soil. The term "agriculture" has evolved in the contemporary era to encompass a variety of activities such as arboriculture, horticulture, domestication, and vegeculture. The 80 percent of the world's population who live in poverty might benefit from increased income, reduced poverty, and improved food security thanks to agriculture. Given that it contributes 4% of the world's GNP in 2018, agriculture is also crucial to economic growth (GDP).

For the purpose of supplying the growing global population with food, conventional agricultural methods are changing. We have developed numerous forms of agriculture during the last few centuries, including 1, 2, and 3.0, as well as 4.0 in the present and coming decades. The first agricultural revolution took place between antiquity and 1920, a time period during which most farming was done manually and relied on methods like tillage and pollination. Agriculture uses 70 percent of the world's freshwater and occupies 23% (11 million KM 2) of the livable space. Thanks to green revolution technologies, agricultural output tripled between 1960 and 2015, and more water, land, and other natural resources were used(S. et al., 2022; Vanitha et al., 2023).

Only a few numbers of species of high yielding wheat and rice variants are being grown in the early stages of the green revolution. The improvement of cultivation uniformity demonstrates that seeds are more prone to illnesses because they lack the capacity to fight off illnesses(Boopathi, 2023; Boopathi, Venkatesan, et al., 2023; Sampath et al., 2022). Due to its considerable contribution to the future potential growth of agriculture, pesticide use has grown to be a serious concern for conserving the environment and biodiversity. The phrase "transition from sustainability" in agriculture refers to the change from one agricultural framework to another that is based on a more comprehensive theory of sustainable agriculture. The third revolution in agriculture, known as precision agriculture, intends to address the sustainability issue as well as the future rise in food demand. According to the World Food Programme, the development and widespread availability of wireless sensors and communication protocols stimulate the use of precision agriculture to increase output (WFP). PA helps farmers monitor the state of their crops by using sensors and communication protocols. IoT, cloud computing, and wireless sensor networks are three of the key technologies that go into PA. PA specifically helps farmers to discover the characteristics required for a healthy crop at a specific point in time. Information gathered from many sources about soil nutrients, plant chlorophyll level, and the presence of pest weeds is combined to increase productivity and efficiency. Predictive analytics can be used to analyse the behaviour and conditions of the crops in terms of disease detection, water management, suitable crop, etc. thanks to data generated by WSN and IoT. With the use of AI, predictive analytics is made possible, and it also offers farmers valuable insights for increasing crop output(Boopathi, Siva Kumar, et al., 2023; Kumara et al., 2023; Vanitha et al., 2023).

Crop rotation, fertilisation, and irrigation are the three main concerns of agriculture. Farmer crop modification has been used since the dawn of civilization. food, raw resources, fibres, and the independent role of agriculture in the economy of the nation. Urban population growth raises the need for water, which may cause a food shortage. Over the last ten years, farmers have employed soil characteristics to comprehend seasonal fluctuations in the cultivation field for crop identification. However, this knowledge usage proved ineffective to target and optimise agricultural inputs, especially in large-scale farming, due to the lack of relevant technologies. To better address today's environmental issues, researchers have improved the farming process with "Precision Agriculture" technology. The main goal of this project is to develop a new agriculture-based decision-making system that would enable high yield production with minimal input from farmers. The series of tasks in the field, such as planting, weeding, watering, fertilising, and finally harvesting, are the responsibility of each farmer. In many wealthy nations, precision agriculture completely relies on the Internet of Things (IoT) rather than using conventional farming techniques(Bagha et al., 2022). The majority of individuals whose livelihoods depend on agriculture live in rural areas with limited access to agricultural technologies. Numerous disciplines, including corporate management, medical advice, weather forecasting, the educational system, and communication systems, have benefited from technological breakthroughs.

An irrigation system that supports decision-making to sustain high-quality crop growth and water stability has been patented by a team from the University of Michigan. It optimises the water level for irrigation. The American Society of Mechanical Engineers will grant the "Agriculture Cultivation Recommender and Smart Irrigation System" patent (ASME). The sensor is a key component of the Internet of Things (IoT), which transforms routine agriculture into precision or intelligent agriculture. Every process, including data sensing and collection, transmission, reception, storage, and decision-making, is the focus of the work mentioned. This technique helps farmers examine crop growth characteristics in relation to soil conditions and provides necessary recommendations for creating precise projections.

PRECISION AGRICULTURE

There is no data on how farmers behave in regards to how much soil is sampled. To ensure the promotion and implementation of effective irrigation systems, the farmer's decisions and insights must be carefully considered. According to equipment, crop consultants, university extensions, news media, and governmental organisations, the study examines southern states in the United States that cultivate cotton. The study advances knowledge of the farmer's perspective on the adoption and application of effective irrigation methods. The adoption of precision farming technologies is impacted in major and varied ways by the many informational sources. For instance, farmers typically combine information from precision farming with data from other sources, such as crop consultation, trade exhibits, advertisements, etc., using the extended version of the information. In order to assist farmers in boosting their profit margins, crop advisors and input suppliers are sharing their knowledge of precision farming.

Leading agricultural practises that use technology include GPS, sensors, variable rate technology (VRT), and yield monitoring (YM). Precision agriculture techniques are attractive to farmers because of their promise to increase agricultural earnings and the environment. Currently, geographic information systems (GIS) and sensors are the most commonly used technologies for this. In 14 southern U.S. states, the adoption of precision farming increased from 63 percent in 2009 to around 73 percent in 2013(Obi et al., 2016).

The soil survey maps, lime, phosphorus, and potassium treatments, and grid and zone soil sampling are the precision agricultural technologies that are most extensively used. According to the International Cotton Growers' Association (ICG), a trade organisation that represents farmers who use cotton as a raw material for animal feed and other products like paper and paperboard, the southern U.S. is the most crucial geographical cotton production region in the world. The majority of southern U.S. states view government organisations, news outlets, crop consultants, university extension agents, other farmers, and marketers of farm equipment as crucial sources of information about precision farming techniques. There is currently no method available to determine irrigation methods over vast areas(Boopathi, Khare, et al., 2023; Palaniappan et al., 2023; Senthil et al., 2023).

USAGE OF IOT IN PRECISION AGRICULTURE

Smart farming is now possible thanks to the Internet of Things. IoT sensors are able to predict climatic change, address irrigation problems, and support farmers in steadily increasing crop output. Agriculture must come up with innovative solutions due to the growing population and increased food demand. According to academics, the main issue with IoT in agriculture is obtaining a high output at a reasonable price. After the Internet of Things (IoT) is used in the farming sector, there will be a 20% boost in the growth of the agricultural industry. The agriculture sector places a strong priority on IoT technology in order to reap benefits quickly and at minimal cost, making farming high-tech and innovative. In irrigation fields, sensors track and save the information for later use. The monitoring cloud network is connected to the sensors. The use of IoT in the irrigation industry has resulted in a significant reduction in manual labour and strenuous physical labour. The Internet of Things can provide farmers a variety of advantages, including improved crop output, reduced water use, crop monitoring, and foresight of environmental effects. Because the sensors collect more precise and accurate data, the IoT cloud environment can make predictions that are more accurate (Obi et al., 2016). It assists the farmer in selecting the appropriate plant for a certain setting, from planting the seeds to choosing crops based on the environment. Water conservation for irrigation can be tracked using an intelligent irrigation planning system. To address the rising demand, machine learning helps improve and modernise the irrigation system. Using IoT and machine learning algorithms, smart decision support systems are becoming a crucial part of agricultural processes(Babu et al., 2022; Boopathi, Arigela, et al., 2022; Jeevanantham et al., 2022).

IOT MEASURES FOR MAJOR AGRICULTURAL ISSUES

Weather Condition

Agriculture is significantly impacted by changes in climate brought on by weather. Utilizing IoT to handle climate change and adapt is an immediate solution to this issue. According to experts, severe climate changes would result in a 30% decline in agricultural production by 2050.

Disease Detection and Diagnosis

IoT-enabled sensors take pictures of harmed plants and provide a suitable and timely decision to save the plant's life. Here, image pre-processing in conjunction with IoT aids plant pathologists in the accurate identification and detection of illness. A lack of effective pesticide management methods and a number of plant diseases have a significant impact on crop productivity.

Usage of Fertilizer

The amount of fertiliser used during farming operations significantly affects the harvest. Based on the requirements of the crop, each farmer should make informed judgments regarding the application of chemicals. The impact of fertiliser consumption destroys the plant's nutrient content and continues to be a major contributor to many acute ailments.

Soil Variations

Based on the needs of the crop, each farmer should choose the right chemicals to use. The use of fertilisers has the negative effect of destroying the plant's nutrient content and continues to be a major contributor to numerous acute illnesses.

Water Quality and Quantity Estimation

The crop loses water through transpiration and evaporation while it is being grown. The farmer should estimate how much water is necessary for agriculture ahead of time. The water depends on a number of variables, including the climate, season, soil type, crop varieties, and stage of growth.

Yield Production Readiness Analysis (YPRA)

Sensors are intended to evaluate how ripe the fruits are. With the aid of this technology, retailers may work with farmers to determine when fruit is ready before sending it to various business sectors. Once farmers are aware of crop price information, they decide to sell the plants when demand is at its highest.

YIELD MONITORING AND FORECAST

The production is maximised and the policy mechanisms are adjusted when the harvest season is correctly predicted. The European Commission, which makes decisions for the EU, is tasked with mapping the production variability of sugar beets(Putri et al., 2012).

The knowledge necessary for a farmer to use precision agricultural technology efficiently is above that of a conventional farmer. However, their expertise is insufficient to convert a technology for uniform crop production into a precise agriculture technology. The potential advantage of a specific precision agriculture information source depends on its ability to close the information gap that could be necessary to employ those technologies efficiently. It depends greatly on how adopting precision agriculture through an information source can increase farm earnings for this indirect advantage to materialise. People decide on information since there may be an advantage to using it. Precision agriculture enables farmers to maximise the use of their inputs by taking advantage of the spatial and temporal variability present in a field. Furthermore, choosing an information source could have a cost attached to it. Endogeneity is a major issue in precision agriculture technology, because it hinders potential end users' acceptance of new advances. The economic agent's human capital endowment and the type of firm operated have a significant impact on the choice and use of information(Comparetti, 2011).

Irrigation uses only 1% of the freshwater used in India, which supplies 4% of the world's population. Developed nations prioritise water conservation efforts and cost-effective smart irrigation systems to guarantee the security and effectiveness of their water supplies. The design of the stated smart irrigation system heavily depends on a few key variables, including rainfall, evaporation, and soil moisture. In this post, we explain how an effective approach for utilising water resources is modelled based on cutting-edge technologies. Wi-Fi sensor integration transforms agriculture in unimaginable ways with smart farming.

FARMING NEEDS FOR PRECISION AGRICULTURE

a. ***Complex technology with illogicality equipment:*** Increased awareness of the benefits of the invention was expected to increase the rate of PA adoption. Farmers should adjust to the hardware and software-related technological challenges. They should also be aware of the parts of the operating PA systems that operate irrationally.
b. ***Lack of products:*** Due to a lack of available goods, the PA combines engineering and technology to facilitate productive farming. This idea integrates the processes of data collection, data processing, and additional monitoring.
c. ***Increase in cost due to maintenance:*** The cost of installing PA equipment has not yet been widely accepted by farmers due to several networking issues.

ADVANCED AGRICULTURAL PRACTICES

By implementing these revolutionary techniques, food quantity and quality were improved. Alternative food supply methods, such as genetically and bioengineered foods, face genetic and DNA issues.The yield can be increased by traditional agricultural practises with little negative impact. Bioorganic food products are a result of similar technology being accepted by society. Numerous studies show that these foods have serious negative impacts on humans, including infertility, changes to human health, ageing, improper insulin regulation, etc. Greenhouse farming is a traditional kind of agricultural production. The 19th century saw a rise in popularity for the concept of plant cultivation(Boopathi, Siva Kumar, et al., 2023; S. et al., 2022; Vanitha et al., 2023). In nations with severe weather, the same was advertised. Moving toward cultural and urban farming necessitates the use of sophisticated and controlled procedures, which are essential. Crop production performance varies based on elements like precision, material, ventilation, decision-support systems, etc. In order to anticipate and adapt to climate change, an IoT-based prototype continuously measures environmental variables including soil temperature, humidity, water level, etc. An accurate and secure link between the participating objects is necessary for timely information transfer and reporting in precision agriculture. In the remote locations where the farmers were found, there were connected energy networks. The agricultural industry needs a robust and large design that takes energy use, dependability, cost, etc. into account(Heideker et al., 2020).

Various ecological metrics are needed to incorporate precision agriculture in the cultivation field in order to indirectly evaluate the environmental impact. Precision farming strives to boost yield and profitability, lessen the effects food production has on the environment, and maximise output at the lowest possible cost. In order to solve the issue of raising yields and profitability, this method calls for a creative strategy. It is necessary to quantify the variability in sugar beet production and quality because it is largely unknown and depends on soil characteristics and microclimate conditions. Several strategies for increasing agricultural income and ensuring efficient resource use are discussed. Here, the highly developed precision agriculture model has been applied to monitor crop growth while accounting for variations in the field, such as air temperature, soil moisture, and soil type. Precision farming reduces the impact of traditional management techniques. The suggested study is focused on identifying the factors that limit crop output. According to the soil types, precision farming has an impact on crop development that is yield-based. The possible methods of precision agriculture could increase the production of the Indian agricultural industry and make use of numerous technologies.

WSN-BASED PRECISION AGRICULTURE

The majority of southern U.S. states view government organisations, news outlets, crop consultants, university extension agents, other farmers, and marketers of farm equipment as crucial sources of information about precision farming techniques. There is currently no method available to determine irrigation methods over vast areas. The Internet of Things (IoT) is a network of internet-connected things that can gather or modify data. It primarily links a computer with an IP address into the global network. Any other device can be connected to it via the global network known as the Internet. In precision agriculture, a vast amount of data is collected and analysed. The sensor node typically runs on battery power with little energy. WSN will aid farmers in increasing crop productivity by utilising contemporary technology. It will also take the place of conventional farming methods(Dhall & Agrawal, 2018). By utilising sensors and machines to monitor and manage water usage, smart irrigation employing the Internet of Things and machine learning techniques attempts to assure optimal water resource management. With the numerous sensing parameters taken into account, this system aids in the prediction of irrigation planning based on irrigation requirements.

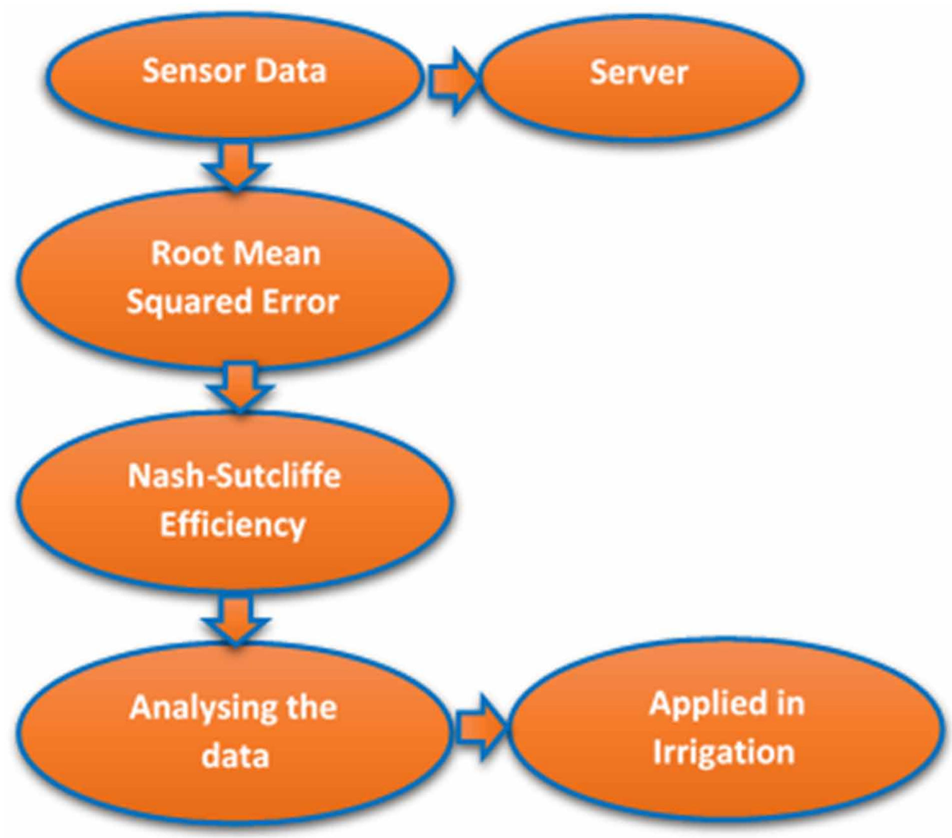
METHOD ONE: AGRICULTURE FACTOR-BASED RELEVANCE VECTOR ANALYSIS (ARV) SYSTEM

By 2050, a billion people will be supported by the production of food and fuel thanks to the Internet of Things (IoT). Farmers now gather real-time data from sensors and keep an eye on their crops in order to reap bigger yields and increase revenues. India ranks second in agricultural production due to the variety of fruits and vegetables that are produced there year-round according to different weather conditions. In the majority of developed nations, farmers install sensors in their fields to automate farming operations based on current environmental conditions. It is still difficult for farmers to find answers to problems like preventing plant diseases and reducing crop loss in order to increase productivity(Mekonnen et al., 2020). Recent technology developments like precision-based agriculture increase yields by utilising machine learning and the Internet of Things (IoT). An idea for a computer application to plan irrigation in either a scheduled or automatic manner by analysing favourable climatic parameters like temperature and humidity. Farmers will be able to determine the amount of water needed for cultivation so that healthy plants may be maintained with the least amount of water.

Experimental Setup

The shortage of food is impacted by the growth in the world population. A significant development in the agricultural sector that addresses current environmental problems is the proposed module for precision agriculture, In order to meet the site-specific requirements of the outlined modern agriculture methods, the system recognises differences in environmental elements and suggests their integration in the field. The framework of the proposed ARV recommendation system is shown in Figure 1.

Figure 1. Framework of the proposed ARV recommendation system



Sensor Data Collection: The ability to improve crop output in real time thanks to data collection is a key component of precision agriculture. Installed sensors in the field continuously collect data and transmit it to a centralised server for archival. Any cultivation must have a seedbed free of weeds in order for the seeds to sprout fast. The best low-cost, low-power sensor design for gathering field data has been developed by several researchers. The best results in the single-tier heterogeneous network with the ZigBee module and the GPRS module were achieved by the soil moisture sensor and soil temperature sensor. In this research, solar-powered irrigation was one of the main points of interest. Indian farmers use ventilation techniques to regulate the temperature and humidity of their crops. The influence of temperature, humidity, and water level on cultivation led to insights into how crucial data on these variables should be considered in this study. Farmers who are attempting to increase their yields receive real-time decision-making help from the data acquired over wireless channels for study by agriculturalists.

Relevant Vector Analysis: Utilizing the cutting-edge ARV algorithm, all data analytics for the ARV Recommendation System were performed. Based on the recorded sensor value, the computer forecasts the important variables and offers suggestions for high-yield farming(Singh et al., 2021). The residuals of errors in the estimation of the data samples used to determine an estimator's chance of success, or its confidence interval, are represented by the RMSE's deviations from the mean.

The real-time sparse dataset from the agricultural field was employed by the ARV recommendation algorithm, which also took into account the training samples and randomly selected 100 plants from 100 different types as testing samples. Temperature, humidity, and water are taken for measurement. Sensors for measuring the microclimate over the course of the full growing season are placed at a distance of 8 metres. Throughout a month, sensors were observed daily at 8 a.m., 10 a.m., 12 p.m., 2 p.m., and 4 p.m. The humidity sensors used to continuously record wetness information do so every 60 minutes. Sensors were utilised to measure the pH value, soil temperature, and soil humidity. The parameter that was sensed has a control system. As shown, an agricultural field is divided into equal tubs, each with a one-unit area and dimensions of 8 metres long by 7 metres wide.

Results and Discussions

The following are the presumptions used for the observation of crop growth under the conditions listed below: A five-minute irrigation period was used. Crops that are grown below the lowest reasonable solar temperature suffer slightly from a lack of water. Under typical lighting and weather circumstances, such as a clear or overcast/drizzly day, crops develop in a normal, healthy manner. The system's effectiveness will be shown following the crop's full growth and yield(Bagha et al., 2022). This example will be performed using the crop growth image that was photographed and kept for future use as proof. The ARV Recommendation algorithm examines the data to identify variables that are not in a satisfactory state and determines whether or not to use the field. Due to the extremely low soil moisture and humidity levels, a necessity.

The "ARV Recommendation" algorithm, which has been suggested, recognises variances in environmental factors and suggests the top farmers for each specific farming discipline. During the experimental period, data for humidity and temperature show high temperatures and low humidity during the daytime, with water evaporation also occurring at a high pace. The "ARV Recommendation" algorithm, which has been suggested, recognises variances in environmental factors and suggests the top farmers for each specific farming discipline. During the experimental period, data for humidity and temperature show high temperatures and low humidity during the daytime, with water evaporation also occurring at a high pace.

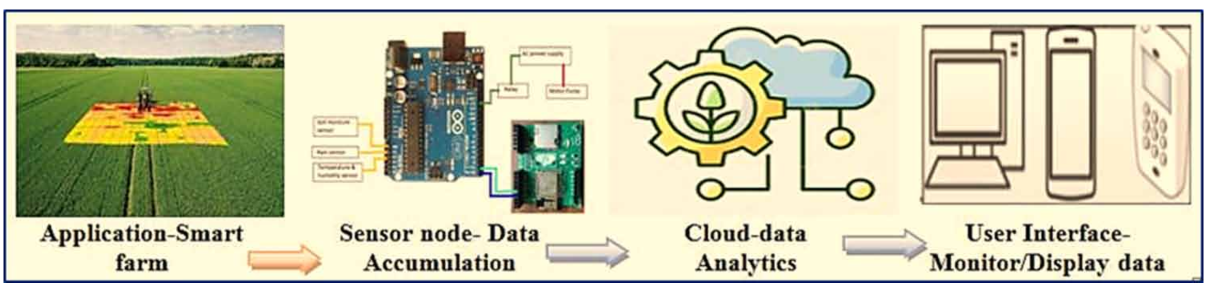
METHOD TWO: ADVANCED IRRIGATION SYSTEM FOR SOIL MOISTURE PREDICTION

The minimum water used for cultivation and boost output yield, the Indian government has proposed a water management module for precision agriculture. The "AISM System" proposed module's main goals are to support farmers who practise precision farming and maximise the use of water resources. The created AISM System is useful for keeping an eye on larger crop areas. The management of irrigation in agriculture can be supported by predictions of soil moisture. People today prefer automation over human involvement in all activities. Irrigation is the process of applying water artificially to agricultural fields; it is done by machines rather than people for a variety of reasons, including socioeconomic and environmental considerations. Reduced water use for plants and other agricultural crops is the goal of AISM. How much water is required to develop crops, flowers, and other plant-based organisms depends in part on the moisture content of the soil. A research team has created a machine learning system to forecast soil moisture and schedule irrigation in an area of agriculture. Data from the agricultural sector and web-based weather forecasting platforms like Open Weather and AccuWeather were analysed for the project. The architecture for smart forming is shown in Figure 2.

An infrastructure tool for anticipating soil moisture and intelligent irrigation scheduling in the agricultural sector is the AISM System. The main function predicts soil moisture using a unique SLR (sparse linear regression) technique. The new K SLR (K-Sparse Linear Regimental Algorithm for Smart Irrigation) algorithm is used in the secondary function. The newly created unique SLR (sparse linear regression) algorithm is contrasted with the greatest performance displayed by SVM (SVM). The popular supervised machine learning method SVM is used to solve a variety of classification and regression problems. The kernel function has been altered to accept vectors, pictures, and sequential data. A pair of data points is viewed as a similarity function by the kernel. Based on the provided input information, the AISM System forecasts the soil moisture for the following days. The water pump is connected to a relay switch with Wi-Fi capability for irrigation control. The signal for in-field real-time monitoring is triggered by the online interface.(Heideker et al., 2020).

The farmer plans the irrigation at a predetermined threshold for soil moisture. The R-Pi module notifies the Arduino-Uno and manages the relay to switch the water motor between the ON and OFF states. The mode of irrigation manual or automatic is determined by the Ground Soil Moisture (GSM) anticipated with MSE and its comparison with Tmax. Farmers that rely on the terrestrial tank due to a lack of water can use the AISM System with excellent support. the motor received the signal with the value “1” for “ON.” It sends “0” to cease irrigation. The system forecasts how much water will be needed for crops.

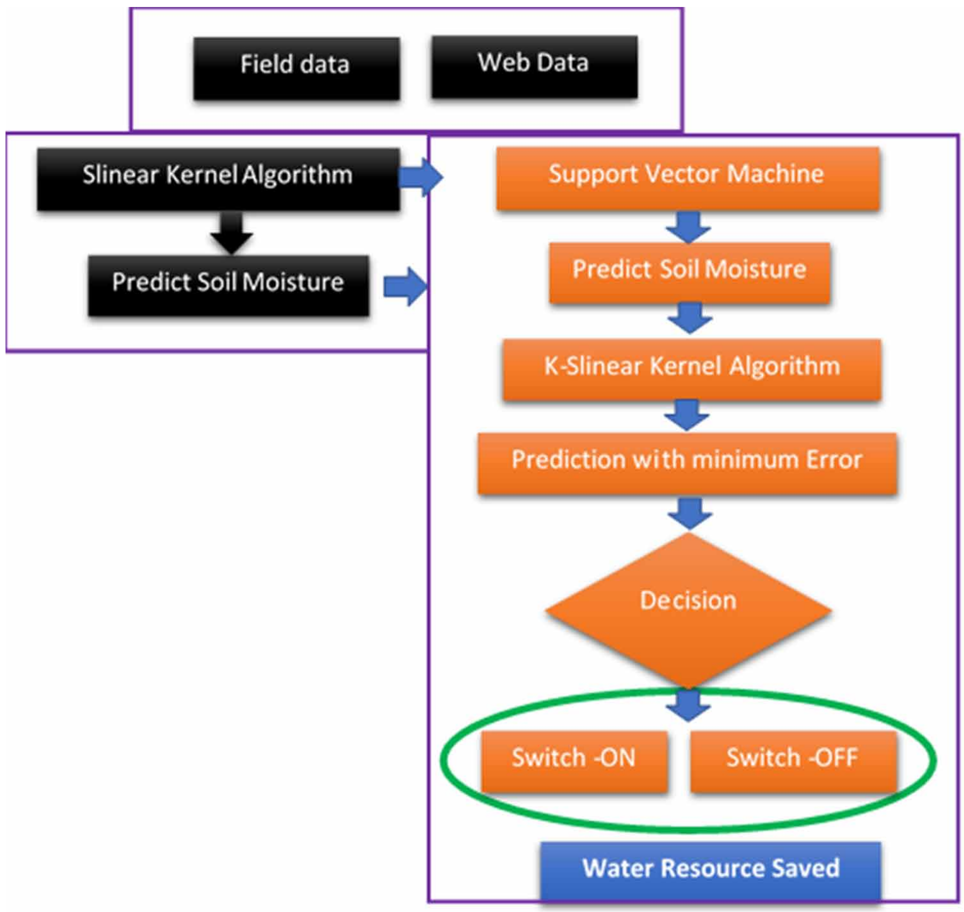
Figure 2. Architecture of smart farming



Experimental Setup

The framework of the proposed AISM system is shown in Figure 3. It functions by analysing online data from weather portals like Open Weather and AccuWeather, including temperature, humidity, and other variables related to the weather. **Arduino UNO board:** A microcontroller called Arduino is intended for interactive object-based applications. Six of the fourteen I/O pins on the ATmega328-based UNO board’s Arduino are outputs. When linked to USB, the serial setup makes transmission easy. The Atmega328 chip microcontroller is widely used because of the availability of its open-source resources(Chakravarthi et al., 2022; Saravanan et al., 2022). **Moisture Sensor:** The sensor suggests irrigation for plants in the botanical garden and agricultural fields. The operating voltage for ground moisture is 5 V, and the needed current is less than 20 mA. Capacitance is used by the soil moisture sensor to gauge the surrounding soil’s dielectric permittivity. The sensor generates a voltage that is proportional to the soil’s water content and, consequently, to the dielectric permittivity. The evaporation-related moisture loss is measured by the soil moisture sensor. The humidity sensor software and the Arduino Uno board are mostly used to control the moisture content and its irrigation. The soil moisture is linked to the VCC percent, GND soil moisture, and attached sensor on the Arduino UNO(Jeevanantham et al., 2022).

Figure 3. The framework of the Proposed AISM System



Relay: An essential component of a car's control system is a high-power electric motor relay, which needs to be pre-calibrated to withstand overloads or failures. The common, customary, and normal pins are the three options for connecting the relays. The relay module is very easy to connect to an Arduino. The Arduino digital pin is connected to all of the forwarding pin's pins. The IN1 relay port is connected to a ground, and the relay's GND is connected to the ground.

Water Pump: This is an illustration of a DC motor, a type of motor that is frequently used with DC power distribution systems. The supports are utilised to enable the rotor to continue rotate in the direction of its axis. While some rotors employ supports to hold the conductors in place, some rotors have magnets that the stator uses to grip the conductors.

Results and Discussions

To forecast the needed soil moisture for Indian agriculture, an algorithm has been created. It makes use of sensors to keep an eye on environmental factors including temperature, humidity, and soil moisture. By tracking the irrigation settings on an hourly basis for around three weeks, the programme demonstrated its effectiveness. Algorithm-predicted soil moisture (PSM) measurement instructions are provided by SLR. This method aids in forecasting the soil moisture for the following days. With the Least Mean Square Error and Correlation Coefficient, the K SLR algorithm promotes excellent accuracy. In comparison to the current SVM method, the SLR algorithm exhibits superior accuracy with a lower MSE. For the purpose of predicting the soil moisture difference for the following day, the SLR algorithm is trained using the observed sensor data and the recorded data independently(Ahmed et al., 2018; Bhat et al., 2019).

In addition, Taguchi(Boopathi et al., 2021; Boopathi, Haribalaji, et al., 2022; Boopathi, Jeyakumar, et al., 2022; Boopathi, Thillaivanan, et al., 2022; Boopathi, 2022a; Boopathi, Venkatesan, et al., 2023; Dass james & Boopathi, 2016; Haribalaji et al., 2021, 2022; Kavitha et al., 2022; Sampath & Myilsamy, 2021; Yupapin et al., 2022), and response surface methods(Boopathi & Myilsamy, 2021; Boopathi & Sivakumar, 2013, 2014; Kannan et al., 2022; Myilsamy & Sampath, 2021; Sampath & Myilsamy, 2021) can be applied to the optimization of agricultural systems. Multi-criteria optimization techniques have been applied to improve the overall performance(Boopathi, 2019, 2022b; Boopathi & Sivakumar, 2013; Kavitha et al., 2022; Myilsamy & Sampath, 2021; Yupapin et al., 2022).

The "AISM System" proposed module analyses the sensed data to forecast soil moisture and schedule irrigation effectively. In comparison to the current ANN model, in comparison to manual watering, sensor-based irrigation uses less water and takes less time. The technology uses the soil moisture as the information to prevent both insufficient and excessive irrigation. This module discusses issues with manual irrigation and shows that sensor-based irrigation uses the least amount of water. The most dependable sensor-based irrigation system is the AISM System, which operates automatically without human intervention. The research only considered small-scale agriculture; however, the technology will eventually need to be tested on a much larger scale. The MSE and R analysis demonstrates.

SUMMARY

IoT-based smart agriculture irrigation monitoring systems are discussed in this chapter. The illustration of measuring parameters, internet of things integration with irrigation systems, and general information for precision agriculture systems. In this chapter, two framework models for the irrigation system for smart agriculture have been presented. To increase productivity, the environmental elements affecting the irrigation system have been tracked and managed. With the use of appropriate flow charts, the framework model for an enhanced irrigation system for soil moisture prediction has also been described.

REFERENCES

Ahmed, N., De, D., & Hussain, I. (2018). Internet of Things (IoT) for Smart Precision Agriculture and Farming in Rural Areas. *IEEE Internet of Things Journal*, *5*(6), 4890–4899. doi:10.1109/JIOT.2018.2879579

Babu, B. S., Kamalakannan, J., Meenatchi, N., Karthik, S., & Boopathi, S. (2022). Economic impacts and reliability evaluation of battery by adopting Electric Vehicle. *IEEE Explore*, (pp. 1–6). IEEE.

Bagha, H., Yavari, A., & Georgakopoulos, D. (2022). Hybrid Sensing Platform for IoT-Based Precision Agriculture. *Future Internet*, *14*(8), 233. doi:10.3390/fi14080233

Bhat, M. A., Adil, A. W., Sikander, B. M., Lone, Y., & Malik, J. A. (2019). Waste Management Technology for Sustainable Agriculture. In *Waste Management Technology for Sustainable Agriculture* (pp. 156–176). IGI Global. doi:10.4018/978-1-7998-0031-6.ch009

Boopathi, S. (2019). Experimental investigation and parameter analysis of LPG refrigeration system using Taguchi method. *SN Applied Sciences*, *1*(8), 892. doi:10.100742452-019-0925-2

Boopathi, S. (2022a). (in press). Cryogenically treated and untreated stainless steel grade 317 in sustainable wire electrical discharge machining process: A comparative study. *Environmental Science and Pollution Research International*, 1–10. doi:10.100711356-022-22843-x PMID:36057706

Boopathi, S. (2022b). Experimental investigation and multi-objective optimization of cryogenic Friction-stir-welding of AA2014 and AZ31B alloys using MOORA technique. *Materials Today. Communications*, *33*, 104937. doi:10.1016/j.mtcomm.2022.104937

Boopathi, S. (2023). An Investigation on Friction Stir Processing of Aluminum Alloy-Boron Carbide Surface Composite. In *Materials Horizons: From Nature to Nanomaterials* (pp. 249–257). Springer. doi:10.1007/978-981-19-7146-4_14

Boopathi, S., Arigela, S. H., Raman, R., Indhumathi, C., Kavitha, V., & Bhatt, B. C. (2022). Prominent Rule Control-based Internet of Things: Poultry Farm Management System. *IEEE Explore*, (pp. 1–6). IEEE.

Boopathi, S., Haribalaji, V., Mageswari, M., & Asif, M. M. (2022). Influences of Boron Carbide Particles on the Wear Rate and Tensile Strength of Aa2014 Surface Composite Fabricated By Friction-Stir Processing. *Materiali in Tehnologije*, *56*(3), 263–270. doi:10.17222/mit.2022.409

Boopathi, S., Jeyakumar, M., Singh, G. R., King, F. L., Pandian, M., Subbiah, R., & Haribalaji, V. (2022). An experimental study on friction stir processing of aluminium alloy (AA-2024) and boron nitride (BNp) surface composite. *Materials Today: Proceedings*, *59*, 1094–1099. doi:10.1016/j.matpr.2022.02.435

Boopathi, S., & Khare, R. KG, J. C., Muni, T. V., & Khare, S. (2023). Additive Manufacturing Developments in the Medical Engineering Field. In Development, Properties, and Industrial Applications of 3D Printed Polymer Composites (pp. 86–106). IGI Global.

Boopathi, S., Lewise, K. A. S., Subbiah, R., & Sivaraman, G. (2021). Near-dry wire-cut electrical discharge machining process using water-air-mist dielectric fluid: An experimental study. *Materials Today: Proceedings*, *49*(5), 1885–1890. doi:10.1016/j.matpr.2021.08.077

Boopathi, S., & Myilsamy, S. (2021). Material removal rate and surface roughness study on Near-dry wire electrical discharge Machining process. *Materials Today: Proceedings, 45*(xxxx), 8149–8156. doi:10.1016/j.matpr.2021.02.267

Boopathi, S., Siva Kumar, P. K., & Meena, R. S. J., S. I., P., S. K., & Sudhakar, M. (2023). Sustainable Developments of Modern Soil-Less Agro-Cultivation Systems. In Human Agro-Energy Optimization for Business and Industry (pp. 69–87). IGI Global. doi:10.4018/978-1-6684-4118-3.ch004

Boopathi, S., & Sivakumar, K. (2013). Experimental investigation and parameter optimization of near-dry wire-cut electrical discharge machining using multi-objective evolutionary algorithm. *International Journal of Advanced Manufacturing Technology*, *67*(9–12), 2639–2655. doi:10.100700170-012-4680-4

Boopathi, S., & Sivakumar, K. (2014). Study of water assisted dry wire-cut electrical discharge machining. *Indian Journal of Engineering and Materials Sciences*, *21*(1), 75–82. https://doi.org/http://nopr.niscair.res.in/handle/123456789/27453

Boopathi, S., Thillaivanan, A., Azeem, M. A., Shanmugam, P., & Pramod, V. R. (2022). Experimental investigation on abrasive water jet machining of neem wood plastic composite. *Functional Composites and Structures*, *4*(2), 025001. doi:10.1088/2631-6331/ac6152

Boopathi, S., Venkatesan, G., & Anton Savio Lewise, K. (2023). Mechanical Properties Analysis of Kenaf–Grewia–Hair Fiber-Reinforced Composite. In *Lecture Notes in Mechanical Engineering* (pp. 101–110). Springer. doi:10.1007/978-981-16-9057-0_11

Chakravarthi, P. K., Yuvaraj, D., & Venkataramanan, V. (2022). IoT-based smart energy meter for smart grids. *ICDCS 2022 - 2022 6th International Conference on Devices, Circuits and Systems*, (pp. 360–363). IEEE. 10.1109/ICDCS54290.2022.9780714

Comparetti, A. (2011). Precision Agriculture: Past, Present and Future. *Agricultural Engineering and Environment*, *16*, 17.

Dass james, A., & Boopathi, S. (2016). Experimental Study of Eco-friendly Wire-Cut Electrical Discharge Machining Processes. *International Journal of Innovative Research in Science, Engineering and Technology, 5*(1), 666–675.

Dhall, R., & Agrawal, H. (2018). An improved energy efficient duty cycling algorithm for IoT based precision agriculture. *Procedia Computer Science*, *141*, 135–142. doi:10.1016/j.procs.2018.10.159

Haribalaji, V., Boopathi, S., & Asif, M. M. (2021). Optimization of friction stir welding process to join dissimilar AA2014 and AA7075 aluminum alloys. *Materials Today: Proceedings*, *50*, 2227–2234. doi:10.1016/j.matpr.2021.09.499

Haribalaji, V., Boopathi, S., Mohammed Asif, M., Yuvaraj, T., Velmurugan, D., Anton Savio Lewise, K., Sudhagar, S., & Suresh, P. (2022). Influences of Mg-Cr filler materials in Friction Stir Process of Aluminium-based dissimilar alloys. *Materials Today: Proceedings, 66*(xxxx), 948–954. doi:10.1016/j.matpr.2022.04.668

Heideker, A., Ottolini, D., Zyrianoff, I., Neto, A. T., Salmon Cinotti, T., & Kamienski, C. (2020). IoT-based Measurement for Smart Agriculture. *2020 IEEE International Workshop on Metrology for Agriculture and Forestry, MetroAgriFor 2020 - Proceedings*, (pp. 68–72). IEEE. 10.1109/MetroAgriFor50201.2020.9277546

Jeevanantham, Y. A., Saravanan, A., Vanitha, V., Boopathi, S., & Kumar, D. P. (2022). Implementation of Internet-of Things (IoT) in Soil Irrigation System. *IEEE Explore*, (pp. 1–5). IEEE.

Kannan, E., Trabelsi, Y., Boopathi, S., & Alagesan, S. (2022). Influences of cryogenically treated work material on near-dry wire-cut electrical discharge machining process. *Surface Topography : Metrology and Properties*, *10*(1), 015027. doi:10.1088/2051-672X/ac53e1

Kavitha, C., Malini, P. S. G., Charan, V., Manoj, N., Verma, A., & Boopathi, S. (2022). (in press). An experimental study on the hardness and wear rate of carbonitride coated stainless steel. *Materials Today: Proceedings*. doi:10.1016/j.matpr.2022.09.524

Kumara, V., Mohanaprakash, T. A., Fairooz, S., Jamal, K., Babu, T., & B., S. (2023). Experimental Study on a Reliable Smart Hydroponics System. In *Human Agro-Energy Optimization for Business and Industry* (pp. 27–45). IGI Global. doi:10.4018/978-1-6684-4118-3.ch002

Mekonnen, Y., Namuduri, S., Burton, L., Sarwat, A., & Bhansali, S. (2020). Review—Machine Learning Techniques in Wireless Sensor Network Based Precision Agriculture. *Journal of the Electrochemical Society*, *167*(3), 037522. doi:10.1149/2.0222003JES

Myilsamy, S., & Sampath, B. (2021). Experimental comparison of near-dry and cryogenically cooled near-dry machining in wire-cut electrical discharge machining processes. *Surface Topography : Metrology and Properties*, *9*(3), 035015. doi:10.1088/2051-672X/ac15e0

Obi, F., Ugwuishiwu, B., & Nwakaire, J. (2016). Agricultural Waste Concept, Generation, Utilization and Management. *Nigerian Journal of Technology*, *35*(4), 957. doi:10.4314/njt.v35i4.34

Palaniappan, M., Tirlangi, S., Mohamed, M. J. S., Moorthy, R. M. S., Valeti, S. V., & Boopathi, S. (2023). Fused Deposition Modelling of Polylactic Acid (PLA)-Based Polymer Composites: A Case Study. In Development, Properties, and Industrial Applications of 3D Printed Polymer Composites (pp. 66–85). IGI Global.

Putri, D. A., Saputro, R. R., & Budiyono, B. (2012). Biogas production from cow manure. *International Journal of Renewable Energy Development*, *1*(2), 61–64. doi:10.14710/ijred.1.2.61-64

S., P. K., Sampath, B., R., S. K., Babu, B. H., & N., A. (2022). Hydroponics, Aeroponics, and Aquaponics Technologies in Modern Agricultural Cultivation. In *Trends, Paradigms, and Advances in Mechatronics Engineering* (pp. 223–241). IGI Global. doi:10.4018/978-1-6684-5887-7.ch012

Sampath, B., & Myilsamy, S. (2021). Experimental investigation of a cryogenically cooled oxygen-mist near-dry wire-cut electrical discharge machining process. *Strojniski Vestnik. Jixie Gongcheng Xuebao*, *67*(6), 322–330. doi:10.5545v-jme.2021.7161

Sampath, B. C. S., & Myilsamy, S. (2022). Application of TOPSIS Optimization Technique in the Micro-Machining Process. In Trends, Paradigms, and Advances in Mechatronics Engineering (pp. 162–187). IGI Global. doi:10.4018/978-1-6684-5887-7.ch009

Saravanan, A., Venkatasubramanian, R., Khare, R., Surakasi, R., Boopathi, S., Ray, S., & Sudhakar, M. (2022). POLICY TRENDS OF RENEWABLE ENERGY AND NON. *Renewable Energy*.

Senthil, T. S., Puviyarasan, M., Babu, S. R., Surakasi, R., Sampath, B., & Associates. (2023). Industrial Robot-Integrated Fused Deposition Modelling for the 3D Printing Process. In Development, Properties, and Industrial Applications of 3D Printed Polymer Composites (pp. 188–210). IGI Global.

Singh, R. K., Berkvens, R., & Weyn, M. (2021). AgriFusion: An Architecture for IoT and Emerging Technologies Based on a Precision Agriculture Survey. *IEEE Access : Practical Innovations, Open Solutions*, *9*, 136253–136283. doi:10.1109/ACCESS.2021.3116814

Vanitha, S. K. R., & Boopathi, S. (2023). Artificial Intelligence Techniques in Water Purification and Utilization. In *Human Agro-Energy Optimization for Business and Industry* (pp. 202–218). IGI Global., doi:10.4018/978-1-6684-4118-3.ch010

Yupapin, P., Trabelsi, Y., Nattappan, A., & Boopathi, S. (2022). Performance Improvement of Wire-Cut Electrical Discharge Machining Process Using Cryogenically Treated Super-Conductive State of Monel-K500 Alloy. *Iranian Journal of Science and Technology - Transactions of Mechanical Engineering*, (pp. 1–17). Springer. doi:10.1007/s40997-022-00513-0