AI DRIVEN SENSOR DRIVEN SYSTEM FOR IRRIGATION AND WATER WASTE MINIMIZATION

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Abstract

The advent of Artificial Intelligence in agriculture has paved the way for innovative solutions to age-old challenge. AI Sensor based system aims to revolutionize water management in agriculture by integrating Artificial Intelligence (AI) into piped and micro irrigation systems. By leveraging AI algorithms to predict crop water needs, automate valve controls, and optimize irrigation schedules, we seek to minimize water waste and maximize yields. The AI driven sensor driven system employs a network of advanced sensors to monitor various environmental parameters and soil conditions. Utilizing real-time data, it ensures the water is distributed efficiently and precisely where and when it needed. Our system is designed to adapt to changing weather patterns and soil moisture levels, thereby reducing the likelihood of water wastage through runoff. It impacts on resource conversation, offering a scalable solution to the global water crisis. It also includes a real time monitoring system which equipped with a camera module for capturing the image processing. Upon detection, the system activates an alarm, providing immediate notification to the user. Additionally, a manual off button is implemented to allow users to de-active alarm manually, promoting user control and minimizing disturbances. Our project serves as a comprehensive solution for wildlife monitoring, security applications, water minimization, soil moisture. It demonstrates the synergy between computer vision, embedded systems, human-machine interaction for future development in smart surveillance and monitoring systems.

Keywords:

Water minimization, Artificial Intelligence, Smart Irrigation, Computer vision, Image processing, IoT devices.

1.INTRODUCTION

Precision farming is one of the most important features in agriculture in a country with a large population, fertile soil and abundant water . This system is suitable for different types of water use such as interpretation water , river water and water discharge[1]. In agricultural situations, water quality management is important due to limited water resource and agriculture dependence on irrigation .It solves the waste water problem by optimizing irrigation based on soil moisture content and ambient temperature to reduce waste water and promotes plant growth using on-site sensors and data analysis[2].

Banning water is a good price to pay. It works in two places, one is to make the sensor of the microcontroller, the other is to start the water flow[3]. In other countries such as Bangladesh, solar panels have been used to provide environmentally friendly energy[4]. This system uses sensor nodes and wireless communication to provide real- time monitoring and automatic water management and solve water constraints [5]. To achieve water quality, we can also use batteries produced by Photovoltaic (PV) to minimize the water and data analysis[6].

The integration Artificial Intelligence(AI) with sensor-driven frameworks offers a promising arrangement for the challenges that framing faces due to water shortage. This inventive approach revolution's conventional water system hones by optimizing water utilization and minimizing wastage through sensors, showing the clients almost the precise edit water needs.

The primary objective of AI driven sensor system is to enhance the smart irrigation and the waste water minimization. Specially, the objectives include:

- Real-time monitoring: Utilizing a arrange of sensors to assemble significant natural and soil information, counting dampness levels, temperature and climate conditions
- AI-powered water forecasting: Utilizing machine learning, analyze sensor information and anticipate the exact water pre-requisites for particular crops at distinctive development stages.
- Data-driven choice making: Giving ranchers with profitable information and to optimize water system methodologies, make strides asset administration and improve wellbeing.

This research aims to the talk on accuracy of water minimization within the challenge of mounting the natural contests. The contributions of this research include:

- Progressing Accuracy: AI-driven sensor optimizes water system, upgrading exactness and asset efficiency. It also proves water investment funds and advances over different contexts.
- Promoting Sustainability: Inquire about adjusts with maintainability goals, advertising arrangements for water wastage reduction. Commitments back nourishment security, asset preservation and climate versatility in agriculture
- Facilitating transfer: Information sharing illuminates' dialogs for feasible water administration.

2.RELATED WORKS

The development of a system using the cost- effective solar energy system for open wells that meets the urgent need for clean drinking water in rural areas. Realizing the problems of electricity usage in these areas, the system uses solar energy to work efficiently. By using glass to optimize the exchange of sunlight, the efficiency of the system is increased and to reduce energy costs and promote environmentally friendly practices. This solar water pump has many applications such as open well water extraction [7].

A new way to manage water in pipes that could be used in

gardens by replacing human interaction with a network of wireless sensors. This also saves the water up to 34 % by using temperature, humidity and its data, and up to 26% by using temperature alone. It also includes the use of real cases and discussed. [8].

The implementation of intelligent irrigation and adjusting the irrigation system is essential in today's agricultural System that control the value of water that is required for the plant. Two models were used to analyze the data: the regression model in SPSS software and the genetic function model in the software. Among the developed countries, India is one of the largest countries in the world today, with a large part of its economy is based on agriculture. The country also has the traditional methods have been used for irrigation of farm also requires automation to reduce the time and effort required for manual reviews. It also uses deep learning models to classify the captured images into saggy and healthy classes. The fuzzy logic algorithm brings all the parameters together and controls the operating time of the irrigation system.

Drip irrigation with the help of IoT and soil moisture sensors has many advantages over traditional irrigation methods . By transmitting water directly to the roots, it helps reduce water waste and improve crop quality . Using IoT technology and soil moisture sensors can make more efficient and cleaner water planning , help save water and reduce energy costs . It provides instant information about soil moisture that can be used for irrigation purposes. Sensors can be connected to the central control system and the engine can be turned on and off according to the data collected by the sensors .

While each of these approaches offers unique advantages in addressing the challenges of sensors and water minimization, they also have limitations in terms of efficiency, scalability, and reliability. Therefore, it is essential to compare and evaluate these approaches comprehensively using simulation-based experiments to identify their strengths and weaknesses accurately.

The Wireless Sensor Network for Smart Irrigation (WISENT) project uses the wireless soil moisture sensors and machine learning to adapt irrigation activities based on crop water needs and the environment.

CropX uses Artificial Intelligence and sensors to improve water quality, provide optimal moisture for crop growth, and improve agricultural irrigation. These activities demonstrate the potential of AI-enabled sensor technology to transform the irrigation process and practice the crop growth for promoting sustainable water management in agriculture.

Additionally, future research directions may involve exploring techniques such as Artificial Intelligence, IoT devices is based on trust management for further improving services in minimization.

3.EXISTING SYSTEM

The existing irrigation systems lack the real-time sensor data for precise water waste management. The traditional irrigation systems approach is based on the following criteria:

- Timers or Fixed Schedules: Fixed timers or pre-set schedules-based irrigation may be difficult since the farmers has to check for soil moisture levels based on real-time varying weather conditions in person. The variation in weather conditions results in a change in crop water needs which are pre-defined.
- Manual Monitoring: Manual monitoring may result in underwatering or overwatering to the crops in case of any situation where the farmer is unable to visit them.
- Notify about weather conditions: A notification to the farmer on changing weather conditions will be sent which helps them to know about the current weather of their farm from a specific distance. This is difficult in some cases where the farmer in unable to reach the location based on different weather conditions.

Water management in agriculture relies heavily on manual observation and traditional irrigation schedules. In this system, farmers often face challenges in accurately assessing crop water needs, resulting in over-or under-irrigation, which can lead to water waste, decreased productivity, and environmental damage.

Descion-making in the system is based on the analysis of the information provide by the user and it is predefined with optimized actuators or control systems to adjust the water supply in response to AI. It provides the addition aim of using water efficiency, increasing crop yields and reducing the environmental impacts of agricultural interventions, compatibility with existing water infrastructure, energy efficiency and productivity

4.PROPOSED METHOD

The AI-Driven system will integrate AI-driven technology with sensor networks to create a smart irrigation system capable of optimizing water management in piped and micro irrigation setups. Sensors will analyze data , including soil moisture, weather conditions and adjust irrigation schedules and flow rates in real time to ensure optimal moisture levels in the soil while minimizing water waste.

This system aims in making the irrigation system smarter by implementing sensors which helps in gathering the real-time weather conditions and notify the farmers regarding it. Our project possesses the following functionalities:

- Real-time Data Collection: Continuous monitoring on soil moisture, temperature, humidity and even weather forecasts will be done
- AI-powered physical presence monitoring: AI analyzes the person or animal that enter into the crops and indicate to the farmer may find it easier to protect the crops which is an added advantage. This process is done using the image processing technique where a camera will be continuously monitoring the field.
- Automated Irrigation Control: The sensor-based system controls valves or sprinklers, delivering the precise amount of water needed at the right time by indicating the state of the soil moisture content by which the farmer may control turning on or off the motor using the application.
- Minimized Water Waste: Water will be consumed precisely by providing only the required amount of water to the crops.
- Improved Crop Yields: Healthier growth and potentially higher yields are achieved when crops receive the ideal amount of water.
- Efficiency and Resource Management: Farmers save time and labor by automating irrigation control.
- Smart Irrigation Controllers: These controllers use basic sensors and pre-programmed settings to adjust watering based on weather data.
- Soil Moisture Sensors: These sensors provide data on soil moisture levels.

5.FLOWCHART

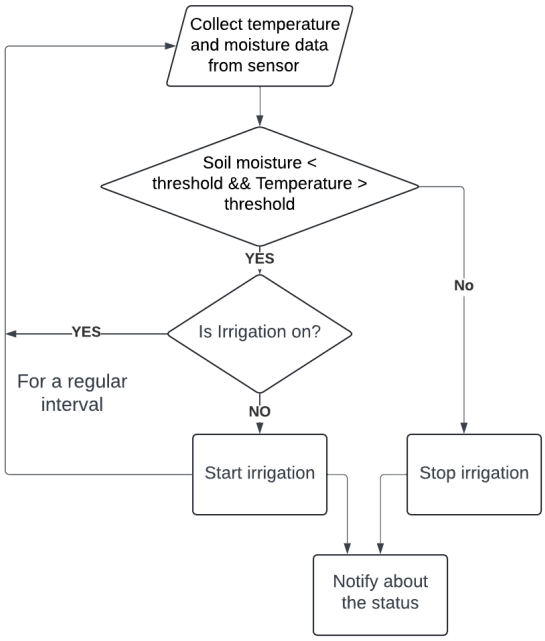

Fig:1 Block Diagram of Smart Irrigation

7.IMPLEMENTATION

7.1 HISTOGRAM EQUALIZATION

In recent years, the integration of computer vision technology and embedded systems has let to developments in many areas. An important application is the deployment of intelligent systems for the detection, monitoring and alerting of animals. This project addresses the need for real-time animal detection by using Open CV functionality in python integration into the system. Development needs and the traditional methods often do not provide timely alerts and rapid insights into a dynamic environment. Therefore, the integration of computer vision and machine learning offers effective an efficient solution to these challenges. Using OpenCV, a powerful open-source computer vision, enables the use of powerful animal detection tools. Whether pre-trained models such as HAAR digits or deep learning models are used, the goal is to identified and locate the animals in the observation area. View to submit information about detected animals or physical conditions. Additionally, the Bluetooth module provides efficient communication with external devices, allowing remote monitoring and integration with other smart systems and audible alarm. The manual off button allows the user to turn off the alarm, emphasizing the importance of user control in this type of surveillance. Integrating into OpenCV into a embedded system not only demonstrates the power of consumption, but also demonstrates the flexibility and capabilities of these systems in many ways.

- Image capture module: Using the frames from cameras connected to the system using Raspberry Pi's Camera interface. It send the captured image to the animal detection module for processing.
- Open CV: Using OpenCV in python to process incoming images and identify and locate animals in the imaging area. It can use pre-trained such as Haar cascade or deep learning models for accurate detection. Publish information about identified species, including habitat and likely distribution.
- User interface Module: Interact with the LCD screen to view real-time information about observed animals or physical conditions. It provides a user-friendly interface for monitoring these activities by sending formatted information to the screen that is dynamically updated based on the output of the animal detection module.

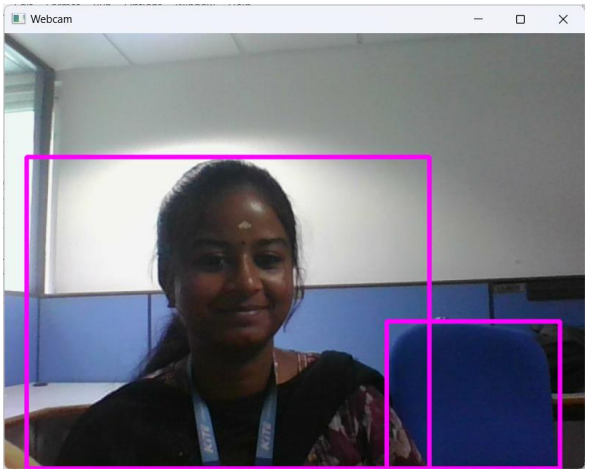

Fig 12:Hiatogram equalization

- Audio Alarm module: Monitor the output of detected animals to activate the alarm when the animal is detected. Used with manual lock button module for alarm control to provide immediate alert to nearby users.

7.2 HARDWARE ASSEMBLY AND IMPLEMENTATION

The components include Node MCU ,LCD display, relay, motor, DH-11 sensor for temperature check, soil moisture sensor and a rain detection sensor in which the node MCU(ESP8266) plays a major role since the communication between hardware and software is handled by it.

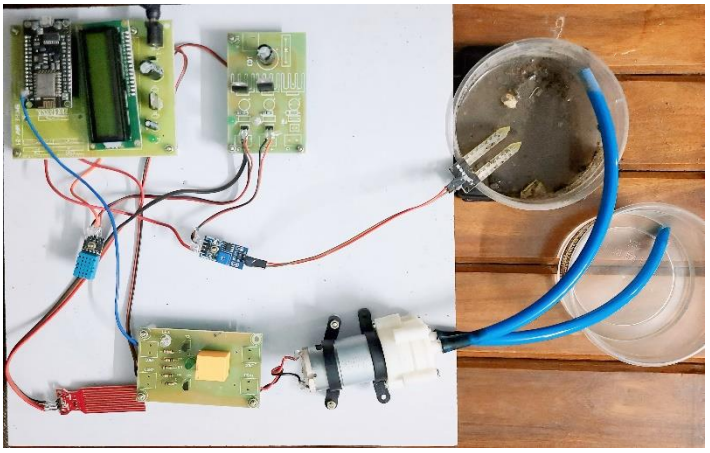

Fig 13: Hardware assembly

The data from sensors are detected and the motor is turned on or off according to the weather and the moisture conditions. Node MCU gets the status of the motor whether it has to be turned on or off and this process is done with a wifi connection through the BLYNK application. Node MCU passes a 12 voltage power which will be sent to a regulator for a 5 voltage conversion. The regulator is connected with the temperature sensor and rain detection sensor. The soil moisture sensor checks continuously for moisture level of the soil and the status is sent to ESP8266 which will be indicated to

the user through a notification in Blynk application.

The temperature sensor collects the current temperature and passes it to node MCU which will be then sent to the user through Blynk application. Humidity check is done paralelly.A motor is connected with a relay for direct connection from the ESP8266 which no need to be converted to 5 voltage. The motor has input and output spaces for getting water from the tank and passing it to the soil.

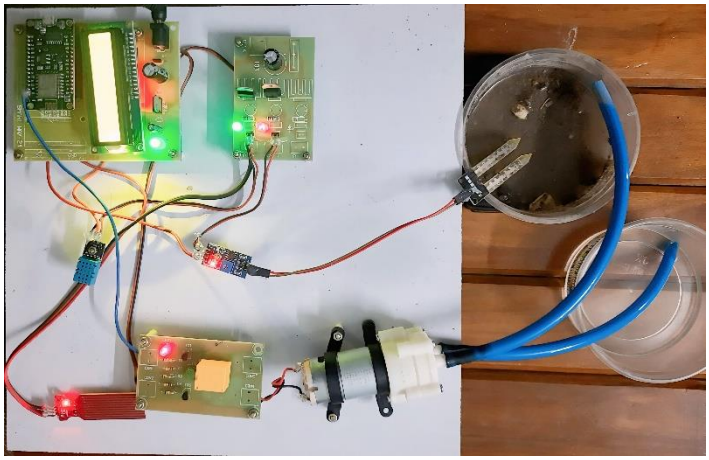

Fig 14: Hardware implementation

The weather and soil moisture status are continuously monitored and sent as notifications to the user where the user operates the motor by passing water to the field.

8.ADVANTAGES

Artificial Intelligence is a sensor-based agricultural water management has many over traditional methods. It improve accuracy and efficiency through continuous and real-time monitoring of environmental conditions and real-time monitoring of environmental conditions and soil. Using advanced sensors and smart algorithms, the system can predict crop water needs and adjust irrigation plans accordingly, reducing water wastage and maximizing water usage.

The best approach to farm management helps reduce losses and increase productivity. The advantages of AI-Driven includes:

- Precise irrigation: The electronic sensor-supported system obtains clean water by constantly monitoring the environment and soil in real time. This allows crop water requirement to be accurately predicted and irrigation schedules adjusted accordingly, reducing water waste and maximizing usage.
- Sustainability: The system promotes sustainable agriculture by reducing water waste and environmental impact. Irrigation systems are often above or below water, causing runoff, soil erosion, nutrient leaching.
- Real-time Monitoring and Alarm Systems: The system is the addition of real-time monitoring and alerts improves farm management and decision-making. The system has the ability to detect anomalies and trigger alerts, allowing farmers to quickly react to changes such as unsustainable water or weather conditions, reducing and increasing productivity.

9.RESULT

Integrating Artificial Intelligence (AI) into agriculture through sensor-driven systems provides solutions for water management. This AI-powered system optimizes water flow and valve management based on real-time data from advanced sensors, reducing water waste and optimizing crop production. The system constantly monitors the environment and the surrounding soil, adapts to changing weather conditions and soil moisture, and ensures that water is delivered directly to where and when it is needed. Real-time monitoring and image processing capabilities can detect abnormal conditions and trigger timely intervention alarms. The manual shutdown button allows the user to take control of consumption while promoting sustainable irrigation and increasing crop yields.

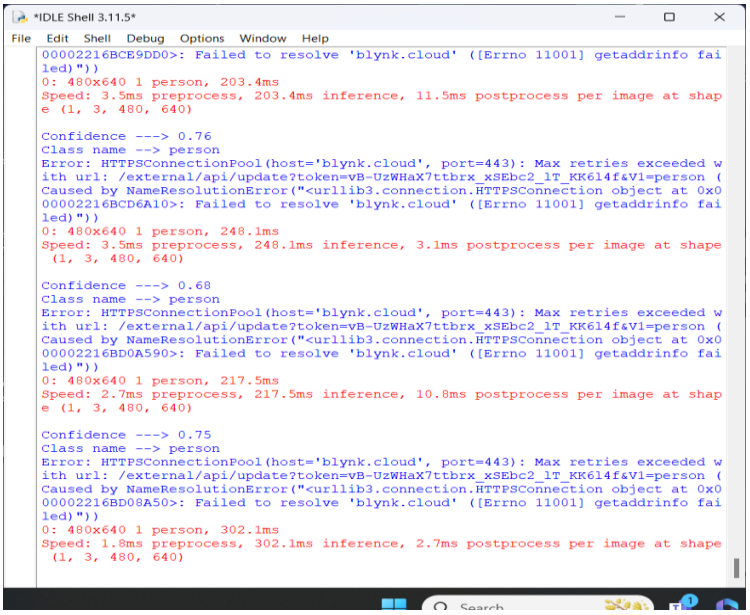

Fig 15: Histogram equalization result

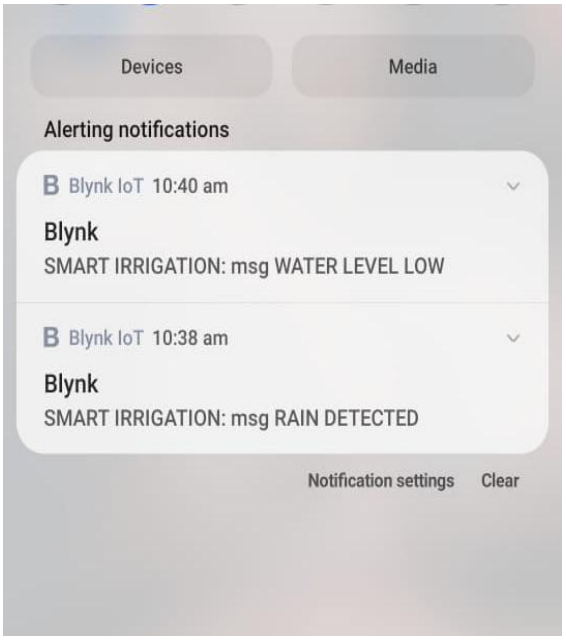

Fig 16: Mobile notifications on moisture status

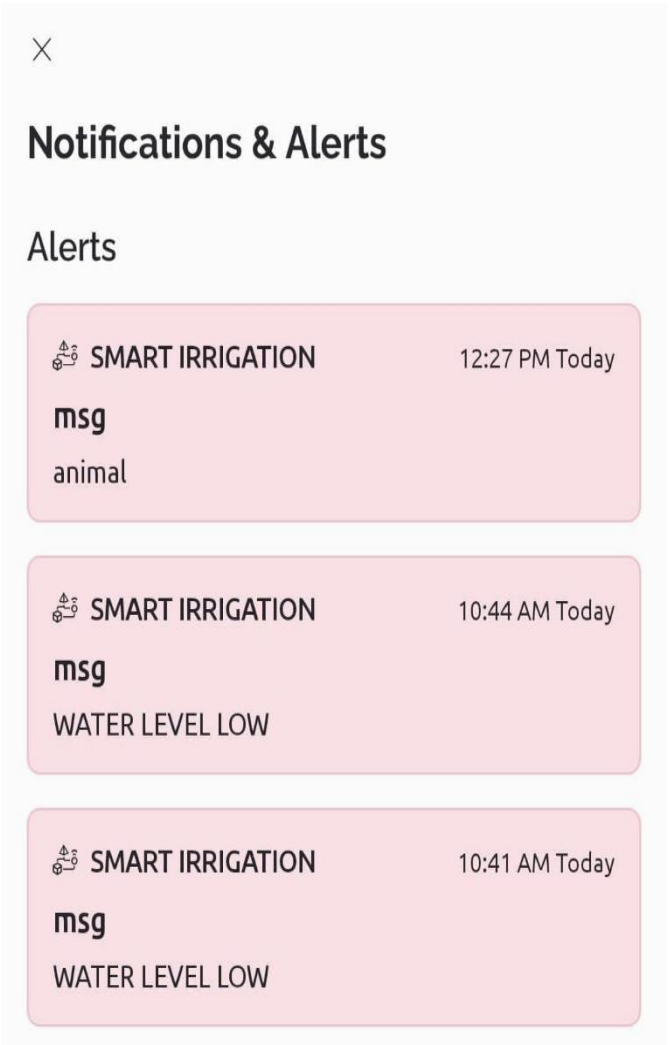

Fig 17: Notification history in BLYNK app

10. CONCLUSION

Integrating into water management at scale represents a revolutionary step in permaculture . Leveraging the power of smart algorithms and advanced technology , this innovation provides accurate water, stability, real-time monitoring and decision-making information and improves efficiency. It is and AI-powered sensor-based system that purifies water according to the specific needs of crops. This optimization reduces water waste, improves resource use, and maximizes crop yields, helping to improve agriculture and food security. Waste materials and environmental impacts to promote sustainable development. By using water efficiency according to the actual needs of crops, and save water, reduce soil erosion, rescue nutrient leaching, thereby protecting the long-term health of the agricultural ecosystem for production purposes or weather events respond quickly to improve farm management. This proactive approach reduces lose and optimize productivity and ensures the quality service and farm profitability. By analyzing large amounts of data collected by sensors, the system can identify trends, patterns and relationships to inform strategic decisions that will improve overall agricultural and manufacturing performance. Sensor-based systems represent an agricultural water productivity and data-driven decision-making to solve problems of water scarcity and environmental degradation. As global population increases and climate change worsens, such new technologies will play a key role ensures the sustainability and productivity.

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