**MAJOR PROJECT**

**Literature survey**

**Smart irrigation management system**

Traditional agriculture has been the pillar of development on the planet for centuries. But with exponential population growth and increasing demand, farmers will need water to irrigate the land to meet this demand. Because of the scarcity of this resource, farmers need a solution that changes the way they operate. With the advent of new technologies, the notion of Agriculture 4.0 has become a reality to keep up with and meet the demand. With the addition of artificial intelligence and IoT through the collection and processing of agricultural data, decisions have become more and more precise to facilitate decision-making. This paper proposes an intelligent and flexible irrigation approach with low consumption and cost that can be deployed in different contexts. This approach is based on machine learning algorithms for smart agriculture. For this, we used a set of sensors (soil humidity, temperature, and rain) in an environment that ensures better plant growth for months, from which we collected data based on an acquisition map using the Node-RED platform and MongoDB. We used many different models based on the collected data: KNN, Logistic Regression, Neural Networks, SVM, and Naïve Bayes. The results showed that K-Nearest Neighbors is better with a recognition rate of 98.3% and a root mean square error (RMSE) of 0.12, compared to other models (LR, NN, SVM, NB). and towards the end, we provided a web application that brings together the various data emitted by the sensors as well as the prediction of our models to allow better visualization and supervision of our environment.

A smart irrigation management system is an innovative solution that leverages technology to efficiently and effectively manage the irrigation of agricultural fields, gardens, and landscapes. By integrating sensors, weather data, and automation, this system optimizes water usage, reduces waste, and enhances crop or plant growth. It allows for remote monitoring and control, helping users make data-driven decisions to conserve resources and promote sustainability in irrigation practices.

**Scope of the project**:

**1.IoT Sensor Technologies:** Investigating the types of IoT sensors used in smart irrigation systems, their functionality, and their contribution to data collection regarding soil moisture, weather conditions, and plant health.

**2.Machine Learning Algorithms:** Analyzing the machine learning algorithms employed to process the data collected by IoT sensors, with a focus on their role in optimizing irrigation schedules, predicting water requirements, and adapting to changing conditions.

**3.Water Conservation and Sustainability:** Examining the environmental and resource conservation benefits of smart irrigation systems, including reduced water usage, improved crop or plant health, and overall sustainability.

**4.Challenges and Limitations:** Identifying the challenges and limitations associated with implementing IoT and machine learning in irrigation management, such as cost, connectivity issues, and data accuracy.

**5.Real-World Implementations:** Reviewing case studies and practical examples of smart irrigation systems that successfully integrate IoT and machine learning, highlighting their impact on agriculture and landscaping.

**6.Future Trends and Research Gaps:** Exploring emerging trends and potential areas for further research, including innovations, scalability, and the integration of smart irrigation systems with other agricultural technologies.

**Search strategy:**

**1.Keywords Related to Smart Irrigation Management:**

* Smart irrigation
* Precision irrigation
* Irrigation automation
* Efficient irrigation
* Water management in agriculture

**2.Keywords Related to IoT (Internet of Things):**

* IoT in agriculture
* Agricultural IoT
* Sensor networks in agriculture
* IoT-based irrigation
* Smart agriculture

**3.Keywords Related to Machine Learning:**

* Machine learning in agriculture
* ML algorithms for irrigation
* Predictive analytics in irrigation
* Data-driven irrigation
* AI in agriculture

**4.Combination Keywords:**

* "Smart irrigation IoT"
* "Machine learning for irrigation"
* "IoT-based water management"
* "Sustainable agriculture and IoT"
* "Smart farming and ML"

**5.Specific Databases and Resources:**

* IEEE Xplore
* Pub Med (for health and agriculture-related research)
* Google Scholar
* Science Direct
* ACM Digital Library
* Agricultural and Environmental Science databases

**6.Filters and Date Range:** Apply filters to narrow down the search to peer-reviewed articles, conference papers, and publications from the last 5-10 years to ensure the information is current.

**7.Search Strings:** Construct search strings using combinations of the above keywords and phrases. For example:

* "Smart irrigation IoT AND machine learning"
* "Precision agriculture AND IoT sensors"
* "IoT-based water management systems

**Selection criteria:**

To ensure the quality and relevance of sources for smart irrigation management systems using IoT and machine learning, it's important to establish clear selection criteria. Here are some criteria:

**1.Relevance to the Research Question:** Sources must directly address the integration of IoT and machine learning in smart irrigation management systems.

Ensure that the content aligns with the specific areas of focus identified in your research question (e.g., IoT sensors, machine learning algorithms, water conservation).

**2.Publication Date:** Include sources published within the last 10 years to ensure that the information is current and reflects recent advancements in the field. However, older sources may be included if they provide valuable historical context.

**3.Credibility and Authorship:** Prioritize peer-reviewed journals, reputable conferences, and publications from recognized research institutions and experts in the field.

Be cautious with non-peer-reviewed sources and ensure the credibility of the publication or platform.

**4.Type of Research:** Include a variety of source types, such as empirical studies, theoretical papers, case studies, and reviews, to obtain a comprehensive view of the topic.

**5.Geographical Relevance:** Consider the geographical context if your research question pertains to specific regions or climate conditions. Include studies that are applicable to your area of interest.

**6.Methodological Soundness:** For empirical studies, assess the research methodology and data collection techniques to ensure they are robust and well-documented.

**7.Language and Accessibility:** Focus on sources written in languages you can understand and access. Translate sources if necessary to extract relevant information.

**Data extraction:**

**1.Source Information:** Provide the full citation for each source, including the title, authors, publication date, and source type (journal article, conference paper, etc.).

**2.Key Findings:** Summarize the primary findings or outcomes of the source related to smart irrigation management systems, IoT, and machine learning. What were the main takeaways or results?

**3.Methodologies:** Describe the research methods used in the source. This could include the type of data collected, data collection tools (e.g., IoT sensors), and the machine learning algorithms employed.

**4.Theoretical Frameworks:** Identify any theoretical frameworks or models that the source references or utilizes in the context of smart irrigation with IoT and machine learning.

**5.Relevance to Research Question:** Explain how the information from the source directly relates to your research question and the specific areas of focus you defined.

**Organization:**

**1.Chronological Organization:** Arrange the sources in chronological order based on their publication date. This approach provides an overview of how the research in the field has evolved over time.

It helps in identifying the historical development of smart irrigation systems and tracking the progression of IoT and machine learning technologies in this context.

**2.Thematic Organization:** Categorize the sources based on common themes or topics. Each category represents a specific aspect of smart irrigation, IoT, or machine learning.

This approach allows you to delve deep into specific subtopics, such as IoT sensor technologies, machine learning algorithms, water conservation practices, and challenges.

**3.Trends and Gaps Analysis:** Organize the sources by identifying trends, patterns, and gaps in the existing research. This method involves grouping sources based on common trends and research gaps you've observed.

It helps you synthesize the information and present a comprehensive analysis of the current state of knowledge in the field.

**Synthesis:**

In the synthesis phase using IoT and machine learning, analyze and synthesize information from different sources to create a coherent narrative. Here's a step-by-step approach:

**1.Identify Common Themes and Patterns:**

Begin by identifying common themes, findings, and patterns across the selected sources. What recurring ideas or concepts emerge from the literature?

**2.Compare and Contrast Findings:**

Analyze and compare the key findings of different studies. Are there consistent results or discrepancies among the sources? Note any areas of agreement or contention.

**3.Methodological Comparison:**

Compare the methodologies used in the sources. Are there common approaches to integrating IoT and machine learning in smart irrigation systems? How do different methodologies affect the results?

**4.Theoretical Frameworks:**

Explore the theoretical frameworks or models that sources reference. Are there overarching theories that guide research in this field, and how do they influence the outcomes?

**5.Identify Disagreements and Contradictions:**

Highlight any disagreements or contradictions between sources. These discrepancies can provide valuable insights into areas where more research is needed.

**6.Emerging Trends and Research Gaps:**

Synthesize the sources to identify emerging trends and potential research gaps. Are there areas where the literature is lacking or where further investigation is required?

**7.Theoretical and Practical Implications:**

Discuss the theoretical and practical implications of the synthesized information. What do these findings mean for the field of smart irrigation management using IoT and machine learning?

**Identification of Gaps:**

**1.Integration of IoT and Machine Learning in Small-Scale Agriculture:**

Much of the existing literature focuses on large-scale agricultural operations. Further research is needed to adapt and assess the feasibility of smart irrigation systems in small-scale or subsistence farming.

**2.Cost-Benefit Analysis:**

There is a need for more in-depth cost-benefit analyses to determine the economic viability of implementing smart irrigation systems for various types of crops and regions.

**3.Data Privacy and Security:**

As IoT sensors collect sensitive data, research should explore the privacy and security implications of these systems, including data protection measures and potential vulnerabilities.

**4.User Adoption and Training:**

Investigate the factors influencing user adoption and the effectiveness of training programs for farmers and irrigation system operators in using these technologies.

**5.Machine Learning Algorithms Optimization:**

Explore ways to optimize and adapt machine learning algorithms for specific crops and regions to enhance the precision of irrigation recommendations.

**6.Multi-Criteria Decision-Making:**

Research multi-criteria decision-making approaches that integrate water conservation, crop yield, and economic factors to provide comprehensive irrigation management strategies.

**Critical evaluation:**

**1.Author's Qualifications:**

Look at the author's background and expertise. Authors with relevant qualifications in agriculture, agronomy, technology, or related fields are more credible.

Check for the author's research experience and any prior work in precision agriculture.

**2.Publication Venue:**

Consider the source's publication venue. Peer-reviewed journals, reputable conferences, and academic publishers tend to be more reliable.

Assess whether the source is published in a respected platform dedicated to precision agriculture.

**3.Research Methodology:**

Examine the research methodology used in the source. Is it based on sound scientific methods and data collection techniques?

Evaluate whether the methodology is appropriate for the research question being addressed.

**4.Potential Biases:**

Investigate any potential biases in the source. Authors should transparently disclose conflicts of interest, funding sources, or any affiliations that might introduce bias.

Be critical of any apparent industry bias in sources affiliated with specific technology providers.

**Discussion:**

**1.Significance of the Research:**

Begin by emphasizing the significance of the existing research in the context of smart irrigation management using IoT and machine learning. Explain why this field is important for addressing water conservation, sustainable agriculture, and resource efficiency.

**2.Contributions to Sustainable Agriculture:**

Discuss how the literature review's findings contribute to the promotion of sustainable agriculture. Highlight the role of smart irrigation systems in reducing water usage and improving crop yields, which is critical for food security.

**3.Advancements in IoT and Machine Learning:**

Describe how the integration of IoT and machine learning has advanced the field of irrigation management. This technology is transforming traditional practices and enabling more precise and data-driven decision-making.

**4.Water Resource Conservation:**

Address the implications of the research for water resource conservation. Emphasize how smart irrigation systems can help mitigate the challenges of water scarcity and contribute to responsible water usage.

**5.Policy and Industry Implications:**

Discuss how the findings may have implications for agricultural policies, regulations, and industry practices. Consider how governments, farmers, and technology providers might adapt to this evolving landscape.

**6.Trans-disciplinary Nature:**

Recognize the trans-disciplinary nature of the topic, as it combines agriculture, technology, environmental science, and data analysis. Discuss how this interdisciplinary approach contributes to a holistic understanding of smart irrigation management.

**7.Potential Benefits and Challenges for Farmers:**

Explore the implications for farmers and agricultural stakeholders, including potential benefits such as increased efficiency and yield, as well as challenges like initial investment costs and training needs.

**8.Global Relevance:**

Discuss the global relevance of the research, emphasizing that smart irrigation is not confined to specific regions but has applications worldwide, particularly in addressing climate change and water resource management.

**Conclusion:**

In conclusion, the integration of IoT and machine learning in irrigation management represents a transformation approach to sustainable agriculture and water resource management. The importance of advancing research in this field cannot be overstated, as it holds the key to more efficient, environmentally friendly, and economically viable irrigation practices that are essential in a world where water resources are increasingly strained. Future research endeavors will play a pivotal role in realizing the full potential of smart irrigation management systems.

Intelligent irrigation is an important step to increasing production to meet the world’s food needs, which are expected to increase by more than 70% by the year 2050. It is also about managing the use of water for irrigation. In this paper, we propose an irrigation prediction that starts with the creation of a database using a data acquisition card with multiple sensors (Soil humidity sensor, temperature and humidity sensor, rain sensors) and the Node-RED platform. This allowed us to collect multiple data to be able to use it in our decision support models using machine learning. The results showed that K-Nearest Neighbors has a recognition rate of 98.3% compared to other models, and finally present a web application to group all functions carried out throughout this course to facilitate the visualization and supervision of the environment through a simple telephone or laptop.