InterConf
Scientific Publishing Center

ISSN 2709-4685

THE ISSUE CONTAINS:

Proceedings of the 6th International Scientific and Practical Conference

SCIENTIFIC GOALS AND PURPOSES IN XXI CENTURY

Seattle, USA
19-20.03.2024

Scientific Collection
InterConf+

№ 43 (193)
March, 2024

OPEN ACCESS

ISSN 2709-4685

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ICV (Index Copernicus Value) = 88.21 / 100

UDC 001.1

S 40 *Scientific Collection «InterConf+»*, 43(193): with the Proceedings of the 6th International Scientific and Practical Conference «Scientific Goals and Purposes in XXI Century» (March 19-20, 2024; Seattle, USA) / comp. by LLC SPC «InterConf». Seattle: ProQuest LLC, 2024. 647 p.

ISSN 2709-4685
DOI 10.51582/interconf.19-20.03.2024

Please, cite as shown below:

1. Surname, N. & Surname, N. (2024). Title of an article. *Scientific Collection «InterConf+»*, 43(193), 21-27. https://doi.org/10.1080/interconf...

This issue of Scientific Collection «InterConf+» contains the materials of the International Scientific and Practical Conference. The conference provides an interdisciplinary forum for researchers, practitioners and scholars to present and discuss the most recent innovations and developments in modern science. The aim of conference is to enable academics, researchers, practitioners and college students to publish their research findings, ideas, developments, and innovations.

Scientific Collection «InterConf+» and its content are indexed in:

Index Copernicus; Google Scholar; WorldCat; OUCI (*Open Ukrainian Citation Index*); CrossRef; Semantic Scholar; Mendeley; Scilit; OpenAIRE (*pan-European research information system*), etc.

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ARCHITECTURE, CONSTRUCTION AND DESIGN

Proceedings of the 6th International
Scientific and Practical Conference
«Scientific Goals and Purposes
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INFORMATION AND WEB TECHNOLOGIES

DOI 10.51582/interconf.19-20.03.2024.047

Creation of an intelligent irrigation system based on the fuzzy Sugeno model

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Abstract.
This paper discusses the creation of an intelligent irrigation system based on the fuzzy Sugeno model. The goal of the work is to develop an effective system capable of automatically managing irrigation in agriculture, horticulture and other areas where optimal use of water resources is required. To achieve this goal, an analysis and selection of data processing methods was carried out, and the key parameters necessary for the implementation of an intelligent irrigation system were identified. The fuzzy Sugeno model was chosen as the base model, which allows taking into account the uncertainty and fuzziness of data when making decisions. The main objective of the work was to create software capable of making a decision on the need for irrigation and the optimal volume of water supply based on the collected data on soil moisture. Research has shown that the developed system is capable of effectively managing irrigation, optimizing the consumption of water resources and increasing crop yields. The results of the work can be applied in agriculture, horticulture and other areas where automated irrigation control based on soil moisture data is required.

Keywords:
intelligent irrigation system
Sugeno model
IoT technologies
K-nearest neighbors algorithm
machine learning
soil moisture

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1. Introduction.

An intelligent irrigation system is a comprehensive software solution designed to optimize and automate the process of irrigation of agricultural land. This system combines advanced automation, data analytics and artificial intelligence technologies to effectively manage resources and maximize yields. The system continuously monitors weather conditions, soil moisture, water consumption and other parameters, collecting and analyzing data using sensors and IoT technologies. Based on the collected data, the system uses machine learning and artificial intelligence algorithms to predict optimal irrigation conditions and optimize water consumption depending on crop needs and external conditions. The system controls irrigation systems, including water distribution, pressure and spray control, automatically responding to changes in the environment and plant needs. A smart irrigation system helps optimize the use of water resources, minimizing water and energy losses and reducing environmental stress. The system provides reports and analytics on irrigation performance, including water consumption, yield and crop quality, allowing farmers to make informed decisions to improve production processes. Intelligent irrigation systems play an important role in modern agriculture, ensuring efficient use of water resources, increasing yields and reducing costs, which contributes to the sustainable development of the agro-industrial complex [1].

Automation of the irrigation system is an important tool for ensuring optimal growth and development of crops. Our smart irrigation system is designed keeping in mind the needs of farmers and the goals of optimizing the irrigation process. The main purpose of our system is to provide automatic water supply in accordance with the requirements of the crops. Product features include automatic activation of the relay motor to supply water according to set parameters, real-time measurement and control, as well as self-monitoring capabilities and completely eliminating the need to manually operate the system. Irrigation is a key aspect of a successful garden and farm, and our system offers a convenient and reliable solution to automate this process. It is equipped

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with a wireless sensor network to measure and control the irrigation system, ensuring uniform and efficient water distribution for the garden or farm. Our irrigation system also uses machine learning algorithms to determine soil moisture levels, predict water needs, and optimize irrigation cycles. This allows efficient use of water resources and prevents water loss. Thus, our smart irrigation system provides a comprehensive solution to automate and optimize the irrigation process, providing increased yields and resource savings for farmers and gardeners. The goal of the project is to develop an intelligent irrigation system that automatically controls water supply depending on the level of soil moisture, which will save water and reduce the burden on the environment [2].

To achieve this goal, the following tasks are expected to be performed [3]:

Creating an IoT (Internet of Things) model to collect soil moisture data.

Construction of the Sugeno model. Application of machine learning algorithms to analyze collected data and determine the degree of soil dryness. The project considers two algorithms: KNN (K-nearest neighbors) and Naive Bayes (Naive Bayes classifier).

Implementation of functionality that will allow the system to make a decision about turning on or off the water supply based on the results of analyzing soil moisture data.

Testing and comparing the performance of different machine learning algorithms for determining soil dryness.

Implementation of the developed system in practice and evaluation of its effectiveness in real conditions of agriculture or horticulture.

The implementation of this work will make it possible to create an innovative irrigation system, which, in addition to saving water, will also reduce the need to manually control watering and increase crop yields [4].

Adding a linear regression algorithm to calculate water requirements and predict the next water cycle will allow you to more accurately determine not only the degree of soil dryness, but also quantify the amount of water required for irrigation. This will improve water efficiency and help save

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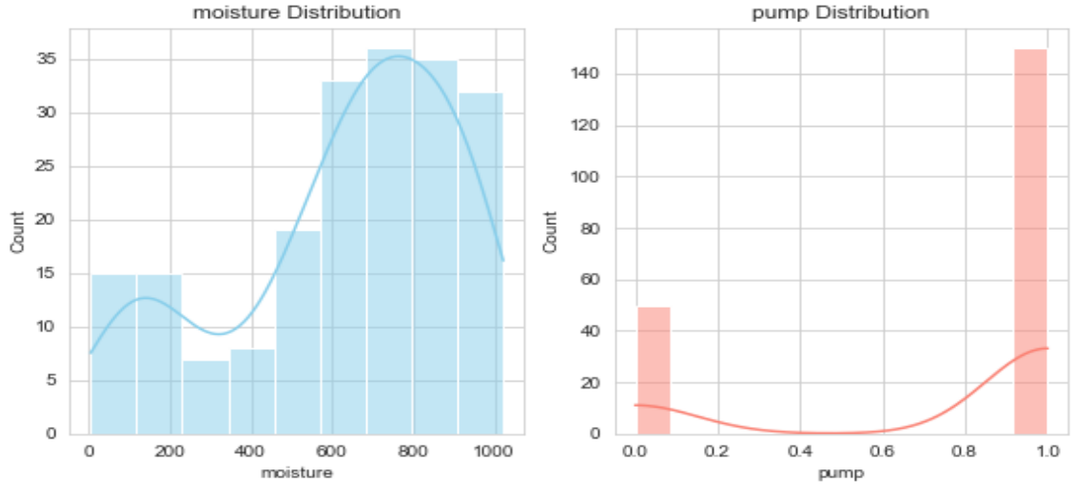
water, preventing unnecessary costs. In addition, the implementation of an algorithm based on the fuzzy Sugeno model for predicting pump on/off will allow more flexible control of the irrigation system depending on the current needs of crops and environmental conditions. A fuzzy model allows us to take into account the fuzziness and uncertainty in the data, which is especially important in agriculture, where conditions can change. These improvements will significantly improve the efficiency and accuracy of your irrigation system, resulting in optimized water use, increased yields, and reduced irrigation costs [5].

2. Materials and methods.

A data set containing information about soil moisture in various areas was used to train and test the smart irrigation system. The data set may also include other parameters such as temperature, light, and soil type.



To develop algorithms for data processing and irrigation system control. Machine learning libraries: For example, scikit-learn, to create a fuzzy logic model based on the Sugeno model. To collect data, soil moisture sensors are used, which can be placed at a certain distance from each other in the irrigation zone.

3. Results. Collected soil moisture data is analyzed to identify patterns and trends.

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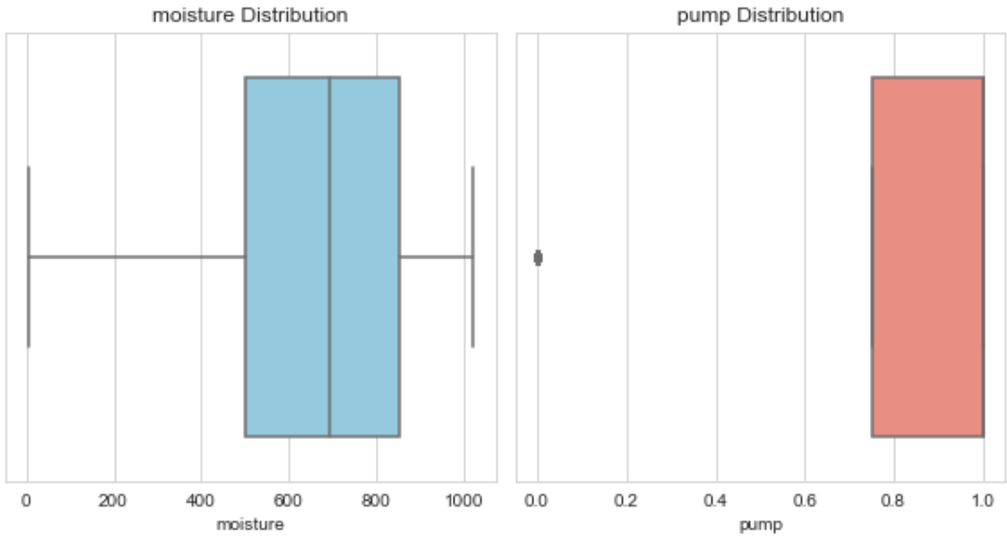
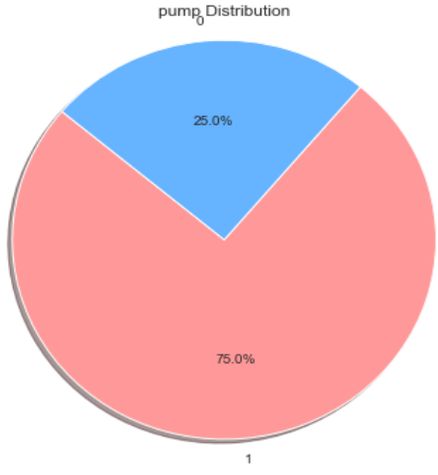


Based on the collected data, a fuzzy logic model is developed based on the Sugeno fuzzy model, which determines the optimal irrigation conditions depending on the soil moisture level and other factors. Using the resulting model, software is developed to control the irrigation system, which controls the pumps depending on soil moisture data.



These materials and techniques are used to create a smart irrigation system that ensures optimal use of water resources

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and increases crop yields.

Intelligent irrigation system can be applied in various fields:

Agriculture: In agriculture, it can be used to automatically water fields of crops such as grains, vegetables, fruits and nuts. This will optimize the use of water resources, increase productivity and reduce manual labor costs.

Landscape Design: In the field of landscape design, a smart irrigation system can be used to automatically water lawns, flower beds, ornamental plants and other landscape features. This will help maintain green spaces in optimal condition and improve the appearance of the surrounding area.

Urban landscaping: In cities, irrigation systems can be installed in parks, squares, streets and other public places to maintain green spaces and improve the environmental situation.

Sports Venues: In sports venues such as football fields, tennis courts, golf courses and others, a smart irrigation system helps keep the lawns in perfect condition for sports activities.

Vegetable gardening and summer cottage farming: In a home garden or summer cottage, the irrigation system ensures regular watering of vegetables, berry bushes, fruit trees and other crops, which helps to increase the yield and quality of the crop.

Thus, the scope of application of an intelligent irrigation system includes agriculture, landscape design, urban gardening, sports facilities, as well as home gardening and summer cottage farming.

4. Conclusion. During this project, an intelligent irrigation system was developed based on the Sugeno fuzzy model. This system is an innovative solution for automating the irrigation process, which allows optimizing the use of water resources and increasing crop yields. Creation of a fuzzy logic model based on the Sugeno model, capable of making water supply decisions depending on soil moisture levels and other factors. Development of irrigation system control software that effectively controls actuators (such as pumps) according to the output of a fuzzy logic model. This smart

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irrigation system has a wide range of applications in agriculture, horticulture and landscaping. It allows agricultural producers to automate the irrigation process, reduce water consumption and increase yield levels. The system thus represents an important step towards sustainable use of water resources and improved agricultural efficiency.

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SCIENTIFIC EDITION

SCIENTIFIC COLLECTION «INTERCONF+»

№ 43(193) | March, 2024

The issue contains:

Proceedings of the 6th International
Scientific and Practical Conference

SCIENTIFIC GOALS AND PURPOSES IN XXI CENTURY

Seattle, USA
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All materials are reviewed.
The editorial office did not always agree with the position of authors.

Journal's frequency: monthly

Sighed for online publication: March 20, 2024.

Printed: April 19, 2024. Circulation: 200 copies. Format 60×84/8.
Batang & Courier New typefaces. Offset paper 100gsm. Digital color printing.

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Certificate on the entry of publishing business subject in the State Register of Publishers, Manufacturers and Distributors of Publishing Products of Ukraine: ДК № 7882 of 10.07.2023.