IMPLEMENTATION OF FUZZY LOGIC METHODS & IOT TECHNIQUES FOR ELEGANT FARMING AND PRODUCTION OF CROPS

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ABSTRACT

In India, one of the main industries is agriculture. The development of internet of things technology has made life easier and more intelligent for humans in every aspect. IOT is the term for technology that makes use of ground-level sensors and actuators that are controlled by the user via a network and a graphical user interface. The primary goal of this Research is to employ FUZZY LOGIC & IoT techniques and technologies to make agriculture smarter. In IOT, the term "smart farming" typically refers to a farmer's use of a mobile application to monitor their fields. Temperature and soil moisture levels that may have an impact on plant growth. This paper describes a pump switching system that the user can adjust to their own preferences. Our paper presents a great opportunity for success in utilizing sensors as input and IOT as an output.

Fuzzy logic is an approach to reasoning that deals with approximate rather than fixed and exact reasoning. It's especially useful in situations where information is uncertain or imprecise. In farming, fuzzy logic can be applied in various ways to improve decision-making and optimize operations.

Keywords: IOT, Sensors, Farming, National food security

INTRODUCTION

In agriculture, smart farming is used to gather data—that is, information about the physical phenomena occurring on the field. Temperature and soil moisture are two of the phenomena discussed in this paper. In order to increase crop productivity, the primary objective of farm monitoring in this project is to lessen the need for the farmer to be present in the field. IoT technology is the newest thing in a lot of fields, including agriculture with smart farming systems. Farmers in traditional farming require a lot of labor to manage crops and livestock, which frequently results in the inefficient use of resources. Both crop cultivation and domestic animal care are part of mainstream agriculture. To produce a product, crops and cattle require different kinds of care and management. On the other hand, our project's goal is to assist farmers in controlling crop output. We utilize the significant benefits that fuzzy logic offers to handle sensor data for decision-making. When technology must decide based on a partial or variable value rather than the traditional Boolean logic of true or false / 1 or 0, fuzzy logic enters the picture. Using fuzzy logic improved the project's efficiency, as demonstrated by this study. The farmers' access to and familiarity with IoT resources constituted a drawback of IoT methods in agriculture. It was discovered that farmers would be open to using IoT if the system was more user-friendly. Therefore, the purpose of this study is to suggest a highly simplified IoT system for our purposes. The project offers a smart agriculture-based tool by integrating IoT systems.

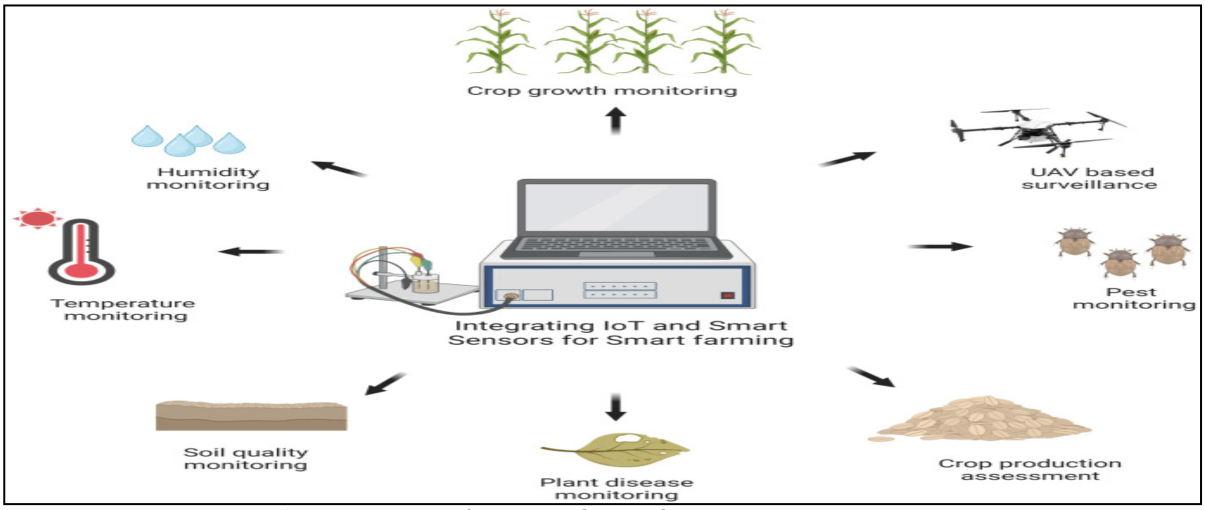

Figure 1 : Integration of IoT and Smart Sensors block diagram

METHODOLOGY

A method of processing variables called fuzzy logic permits the processing of several possible truth values using a single variable. Fuzzy logic uses heuristics and an open, imprecise spectrum of data to solve problems and produce a variety of accurate conclusions. Fuzzy logic is intended to solve issues by taking into account all relevant data and arriving at the optimal solution given the input.

1. The soil is from brown to dark brown.
2. After watering, there isn't a water puddle for a while. When the soil is dry, it is easily destroyed.
3. It is not flexible and sticky when wet.
4. The soil lacks flexibility and stickiness.
5. Depending on the kind of plant being planted, the pH of the soil ranges from 6-7.
6. The amount of nutrients is sufficient for plant growth.

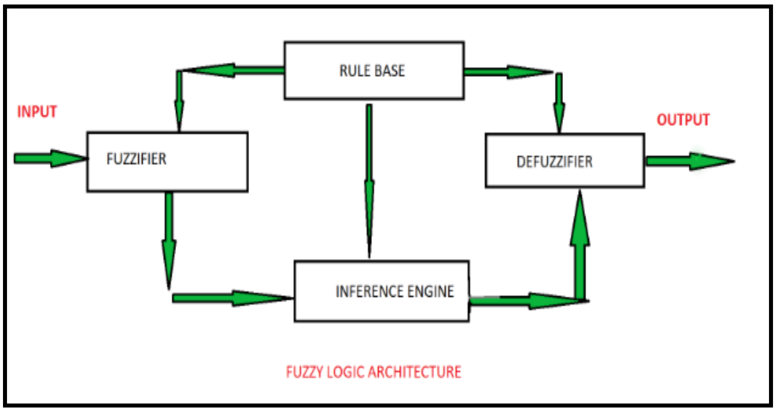

Figure 2 : Fuzzy logic architecture

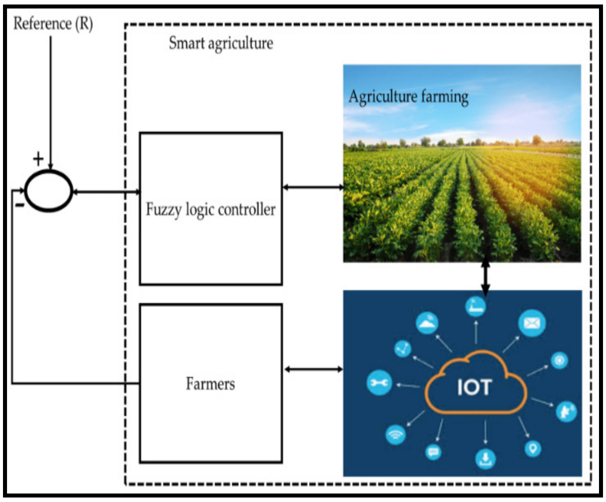

Figure 3 : Fuzzy logic and smart farming

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Future of Smart Farming

Agriculture of the future lies in smart farming. It's a farming method that makes use of technology to boost output, boost productivity, and use less inputs. Utilizing sensors, GPS, and other data-driven methods to maximize crop yields is known as smart farming. Smart farming aims to yield more with less resources. Farmer cost and resource savings are possible when technology is used to boost yields and decrease inputs while maintaining crop quality. By using less water and chemicals, smart farming also lessens its negative effects on the environment.

Information and communication technologies (ICT) are used in smart farming, an agricultural technology that describes how farms are managed and run. It involves gathering data and information about crops, animals, and soil using sensors, drones, robots, and other digital tools, then using that data to maximize agricultural resources and raise yield.

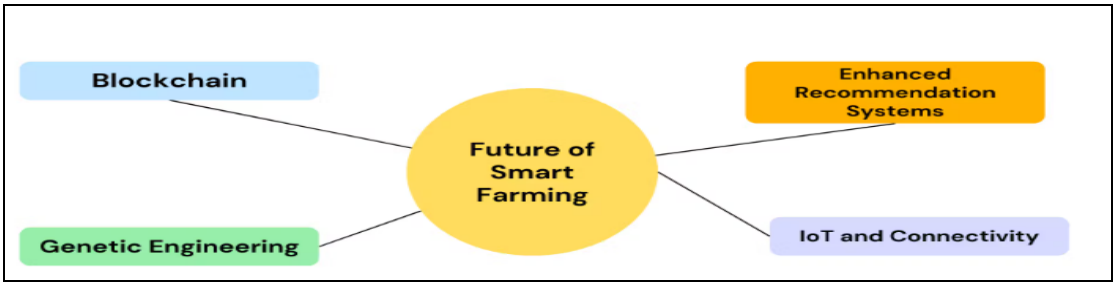

Figure 4 : Future of Smart Farming

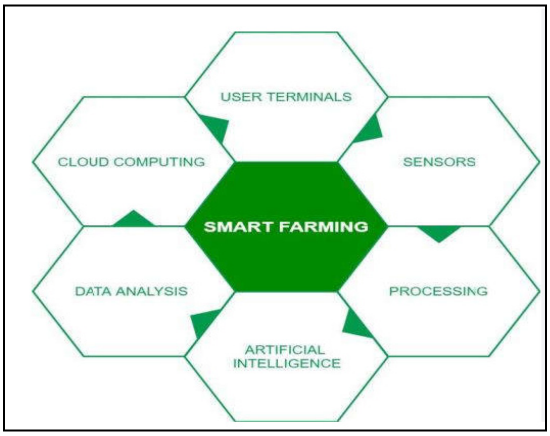

Figure 5 : Smart Farming block diagram

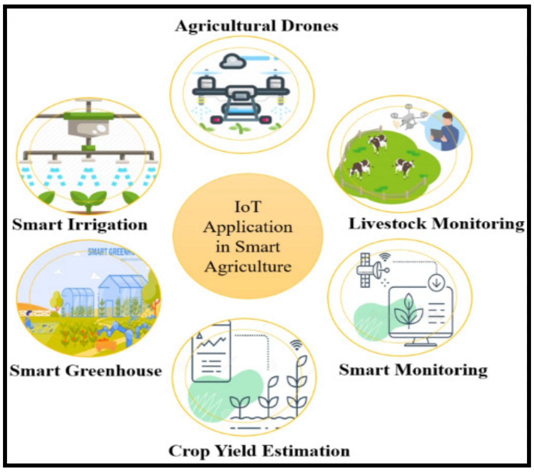

Figure 6 : IoT Application in Smart Farming

Fuzzy Logic Based Smart Farming

Studies show that fuzzy logic is a decision-making method that works similarly to humanoid switch logic. It is a useful approach because it provides a clear method for deriving a conclusion from hazy, unclear, or unclear input data and describes inputs and outcomes in human language.

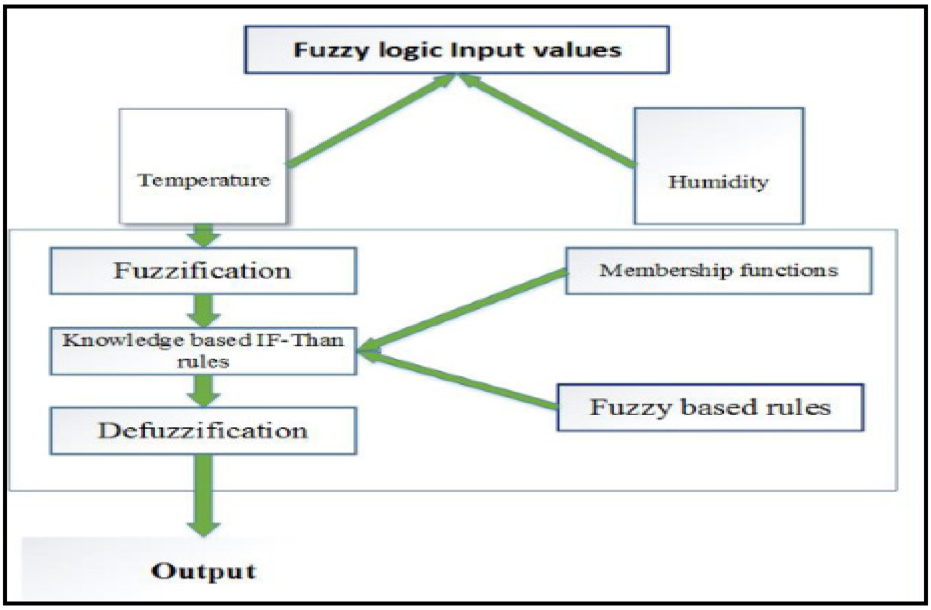

Figure 7 : Fuzzy Logic Input Values

In fuzzy-logic systems, the relationship between the input and output variables is characterized by a fuzzy-rule set. Furthermore, inferences made from a small sample of data might be quite accurate. A fuzzy rule is created when an "if-then" or "and" and "or" expression is used. A fuzzy logic system is depicted in the illustration below. The fuzzifier starts the designated rules with the clear inputs before the de-fuzzifier generates the output.

We use sensor data to compute fuzzication rules. The calculation of the amount of water needed is made easier by the soil moisture sensor. When the relative humidity falls below 17%, we start watering. In FLC, fuzzy logic is used to determine the irrigation duration. The ideal irrigation schedule and frequency are established by the rule-based method. The proposed fuzzy logic controller (FLC) carried out the fuzzication process by using triangle and trapezoidal functions as piecewise linear membership functions. The triangle can be created by using *Equation 1* below.

$$\mu_{triangle}(x;a,b,c) = \begin{cases} 0, & x \leq a \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{c-x}{c-b}, & b \leq x \leq c \\ 0, & c \leq x \end{cases} \quad (1)$$

$$\mu_{trapezoidal}(x;a,b,c) = \begin{cases} 0, & x \leq a \\ \frac{x-a}{b-a}, & a \leq x \leq b \\ 1, & b \leq x \leq c \\ \frac{d-x}{d-c}, & c \leq x \leq d \\ 0, & d \leq x \end{cases} \quad (2)$$

Equation 1 : Fuzzy Logic Equation

Soil moisture threshold

Soil Moisture Reading (%)	(%) Category
0-17	Wilt
18-50	Normal
51-100	Wet
< 100	Not for usable

Table 1 : Soil moisture threshold

Solar shadow coefficient

Soil Solar Radiation Reading (%)	(%) Category
0-4	Dark
5-50	Medium
51-100	Light
< 100	High value

Table 2 : Solar shadow coefficient

Humidity factor.

Soil Humidity Reading (%)	(%) Category
0-49	Low
50-84	Medium
85-100	High
< 100	Not working

Table 3 : Humidity factor

Temperature factor

Soil Temperature Reading (C)	(%) Category
0-16	Cold
17-25	Ideal
26-45	Hot
< 45	Hot Temperature

Table 4 : Temperature factor

Fuzzy rules

1. Switch Position = S
    a. Soil Moisture = Normal
    b. Humidity = Low
    c. Air Temperature = Cold
    d. Solar Radiation = Light (1)
2. Switch Position = M
    a. Soil Moisture = Dry
    b. Humidity = Low
    c. Air Temperature = Cold
    d. Solar Radiation = Light (1)
3. Switch Position =
    a. Humidity = Low
    b. Air Temperature = Cold
    c. Solar Radiation = Dark (2)
4. Switch Position = M
    a. Soil Moisture = Light
    b. Humidity = Low
    c. Air Temperature = Cold

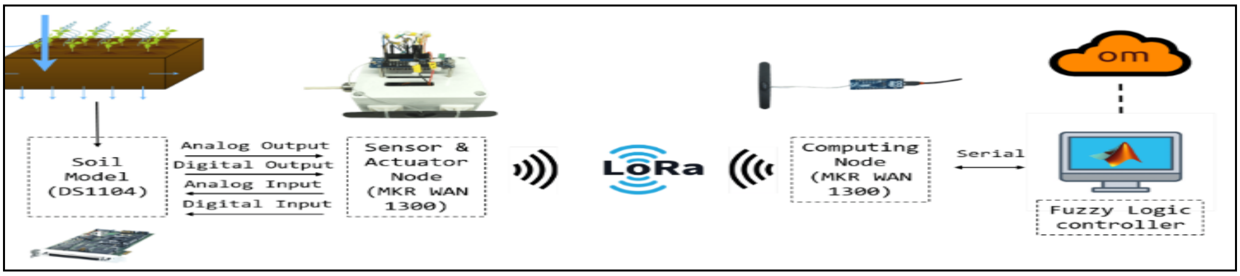

Figure 8

RESULTS

For precise control of the irrigation switch position, a fuzzy inference system based on Mamdani-type fuzzy logic was developed in this work. Four inputs were used to determine the switch position, which ranges from 1 to 5, which are soil moisture, temperature, humidity, and light intensity. When the number is 1, it indicates that the frequency and timing of the water flow are reduced, and when the number is 5, it indicates that the water flow is continuous and unrestricted. MATLAB was used to implement the fuzzy inference system.

Figure 9

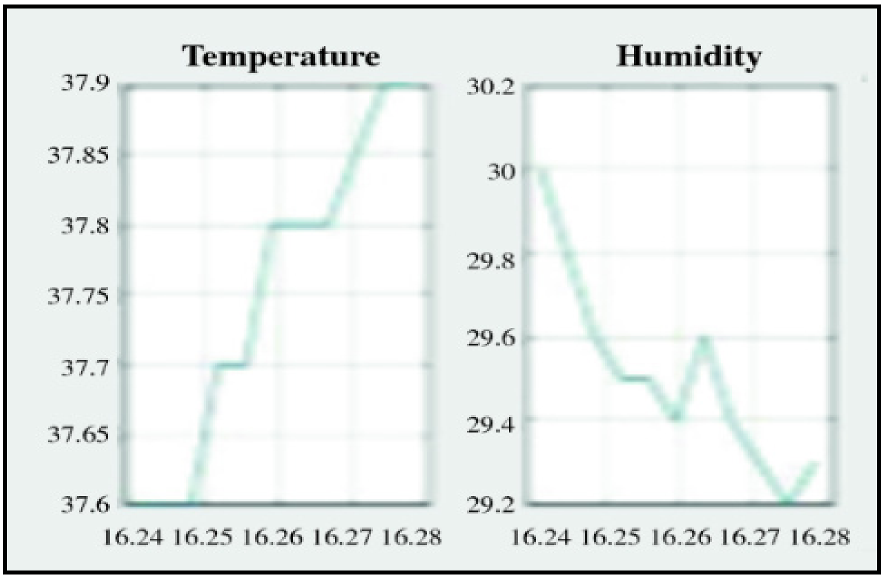

Figure 10

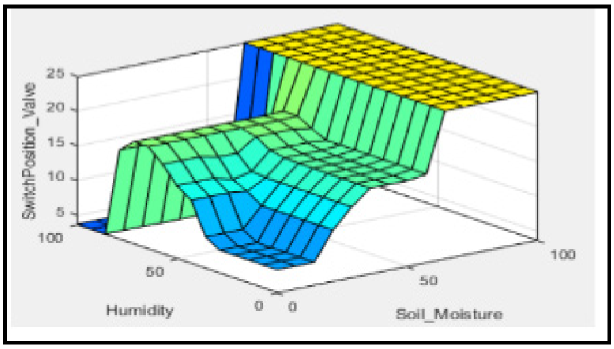

Figure 11

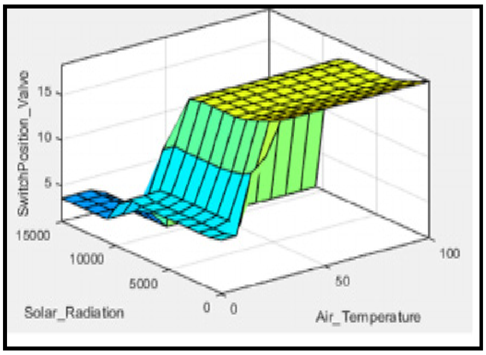

Figure 12

CONCLUSION

We present a process for developing an intelligent irrigation system that addresses the challenges brought on by scarce water supplies in regions with notable water scarcity. The system leverages fuzzy inference techniques and Internet of Things (IoT) technology to support the advancement of irrigation control and the encouragement of water conservation.

The study's test results allow for the following conclusion to be drawn. One possible design for the system is a smart farming system. With a 94.98% success rate, the system can be integrated with the fuzzy logic method on the smart farming system. The temperature and humidity at the designated set points demonstrate that the system is capable of controlling the smart farming system.

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