Smart Rice Farming

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Problem Statement

- Traditionally farmers are using irrigation technique which is generally controlled manually. The farmers irrigate the land by turning on the water-pump at regular intervals or when they feel it is required. But the problem is that they use their intuition to predict the amount of water required. Very often their decision also considers the weather situation or forecast.
- Moreover the use of fertilizers and their proportion are also based on farmers' intuition. And as there is no guarantee that their intuition will always be correct, it sometimes causes disaster for farming.
- Additionally sometimes the field gets infested with rats and other insects which causes huge loss to farmers.

What we have achieved?

- Automation of irrigation system based on data collected from different sensors.
- Decision making framework based on Fuzzy rule-based systems.
- Integration of weather forecast in Fuzzy System for sensible decision making.
- Detection and reporting of presence of insects in field using IR sensor
- Soil condition monitoring using PH sensor and moisture sensor.
- Notification to users (the farmer) based on soil PH-level.
- Solar powered system using solar panel and battery

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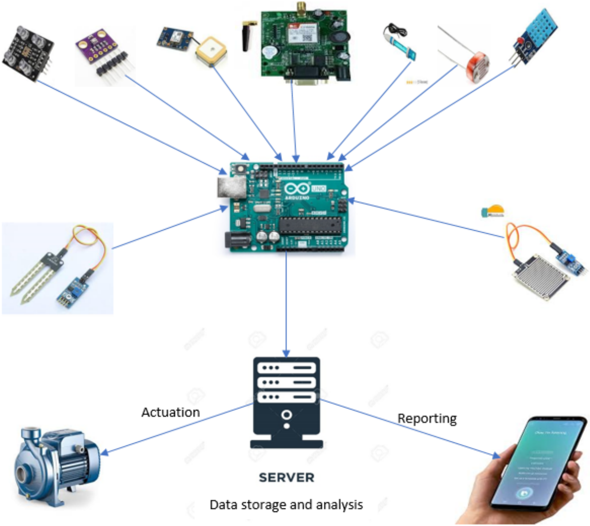
Overview using block diagram



Sensors / Actuators Used

Sensors	Sensing Parameters
DHT11	humidity and temperature
BME280	atmospheric (barometric) pressure
YL69 Soil Moisture Sensor	soil moisture
Rain Sensor FC-37	rain falls
PH Sensor Module V 1.0	PH level of soil
TCS230 Color sensor	leaf color (greenness measurement)
LDR 5mm	light intensity

Table: Sensors used in the project

Sensors / Actuators Used

1. GSM module (SIM800): Sends SMS to the farmer about PH-level of soil, possible presence of insects, and the weather forecasting for the next day.
2. GPS module (SKG13BL): In multi-node environment (if field is large), it provides positional details (the coordinates) from where the corresponding node is collecting the information.
3. WiFi Module (ESP8266): It enables Arduino to send sensor data to the web server.

Web Server & Database Used

1. We have used XAMPP v7.2.27 in our project, which consists of **Apache HTTP Server**, MySQL, **MariaDB**, and interpreters for scripts written in the **PHP** and Perl programming languages.
2. Server-side script: PHP v7.4.1
3. Database Server: MariaDB v10.4.11

Weather Forecasting API Used

Weather API details

- We are using **OpenWeatherMap API** service.
- OpenWeatherMap is an online service that provides weather forecast data.
- It provides weather forecast data based on city name and country name.
- It also provides weather forecast data based on **GPS location (latitude, longitude)**.

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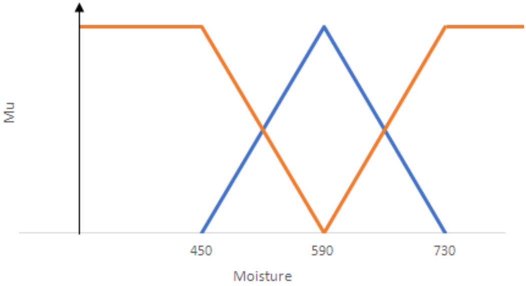
It highly depends on the size of the field, amount of water dispensed by the water pump / hour. We consider the total number of hours, a pump will be running

Parameter Symbol.	Pump operational for (Hrs)
amt^N	0
amt^L	1
amt^M	2
amt^H	3

Table: Amount of water dispensed (in terms of hours for which a pump remains operational)

Parameter: Moisture of soil



Fuzzy Rules for Decision Making

$$\mu_M = \begin{cases} 0, & \text{if } x < 450 \\ \frac{x-450}{590-450}, & \text{if } 450 < x < 590 \\ \frac{730-x}{730-590}, & \text{if } 590 < x < 730 \\ 0, & \text{if } x > 730 \end{cases} \tag{1}$$

$$\mu_L = \begin{cases} 1, & \text{if } x < 450 \\ \frac{590-x}{590-450}, & \text{if } 450 < x < 590 \\ 0, & \text{if } x > 590 \end{cases} \tag{2}$$

$$\mu_H = \begin{cases} 0, & \text{if } x < 590 \\ \frac{x-590}{730-590}, & \text{if } 590 < x < 730 \\ 1, & \text{if } x > 730 \end{cases} \tag{3}$$

Fuzzy Rules for Decision Making

P_1: **Soil Moisture,** O_{1j}: **Fuzzy Reference Descriptor**

$$O_{11} = \{\mu_L(1), \mu_M(0), \mu_H(0)\} \rightarrow amt^{H}_{P_{11}}$$
$$O_{12} = \{\mu_L(0), \mu_M(1), \mu_H(0)\} \rightarrow amt^{M}_{P_{12}}$$
$$O_{13} = \{\mu_L(0), \mu_M(0), \mu_H(1)\} \rightarrow amt^{N}_{P_{13}}$$

Fuzzy Descriptor corresponding to the obtained moisture data

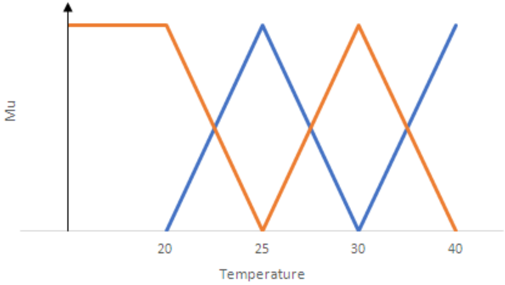
$$R_1 = \{\mu_L(v_1), \mu_M(v_2), \mu_H(v_3)\}\}$$

$$d(O_{11}, R_1) = |\mu_L(1) - \mu_L(v_1)| + |\mu_M(0) - \mu_M(v_2)| + |\mu_H(0) - \mu_L(v_3)|$$
$$d(O_{12}, R_1) = |\mu_L(0) - \mu_L(v_1)| + |\mu_M(1) - \mu_M(v_2)| + |\mu_H(0) - \mu_L(v_3)|$$
$$d(O_{13}, R_1) = |\mu_L(0) - \mu_L(v_1)| + |\mu_M(0) - \mu_M(v_2)| + |\mu_H(1) - \mu_L(v_3)|$$

$$amt_{P_{1j}} = \underset{j \in \{1,2,3\}}{minarg}\{d(O_{1j}, R_1)\}$$

P_1: Soil Moisture $\rightarrow amt_{P_{1j}}$

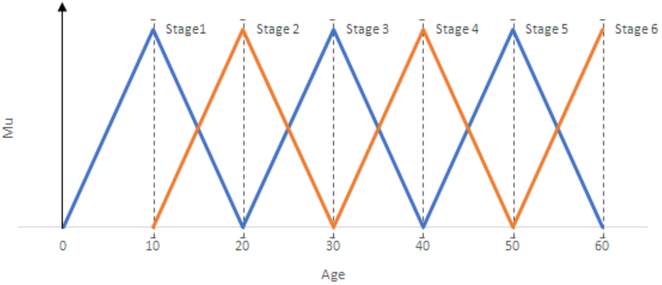
Parameter: Atmospheric Temperature



Similarly,

P_2: Atmospheric Temperature $\rightarrow amt_{P_{2j}}$

Parameter: Age of plant



Similarly,

P_3: Age of plant $\rightarrow amt_{P_{3j}}$

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Fuzzy Rules for Decision Making

The parameters are as follows:

Parameter No.	Details	Variable Name
1	Soil Moister	$amt_{P_{1j}}$
2	Atmospheric Temperature	$amt_{P_{2j}}$
3	Age of the plant (in days)	$amt_{P_{3j}}$
4	Atmospheric humidity	$amt_{P_{4j}}$
5	Leaf Color	$amt_{P_{5j}}$
6	Rain Fall	$amt_{P_{6j}}$
7	Forecast of rain for next day	$amt_{P_{7j}}$

Table: Parameter for fuzzy rule

$$total\_amt = \max_{1 \le i \le 7} \{amt_{P_{ij}}\}$$

Questions Please?

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