

Multi Parameterized Automatic Fuzzy Hx Water Distribution Sytem

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Abstract: Fuzzy systems, including fuzzy set theory and fuzzy logic, provide an affluent and meaningful enhancement of conventional logic. The mathematical protocol generated by this theory is consistent, and fuzzy set theory may be seen as a generalization of classic set theory. This paper investigates the concepts of fuzzy concepts and fuzzy HX rings can be used in water distributive system to distribute water in better way by considering two parameters such as distribution of water to number of homes (industries and restaurants etc.), and Capacity of the main reservoir or cistern. The model, Fuzzy HX subrings based system provides considerable computational complexity reduction with the help of Automatic Filling Tunnels. To the best of our knowledge, all the miniatures used here are introduced first time by our research group and the miniatures work based on the fuzzy HX groups and fuzzy HX rings with the help of the sensors.

Index Terms: Water distributive system, Fuzzy HX group, Fuzzy HX ring, RHT, Multi objective optimization, Water Emergency Ratio, Optimal water distribution.

I. INTRODUCTION

Fuzzy Logic is a simple yet very powerful problem solving technique with extensive applicability used in the current field of business, system control, electronics and traffic engineering. Luochengchong [3] introduced the concept of fuzzy HX group. Muthuraj. R et al., [4] have redefined the fuzzy HX group and the team developed the concept of fuzzy HX subrings. FHXSTR system, introduced by R. Muthuraj et al., [5] earlier is used to reduce the interference in signal transmitting and strengthening the signal transmittance. Similarly in this paper we have tried to propose Automatic fuzzy HX water distribution system to distribute the water in the cosmopolitan cities according to the need of the public as well as the availability at the source. Manual and existing distribution system may give excess of water unnecessarily or may create the water scarcity to other users. So the ultimate aim of this research work is to reduce the water wastage through the necessary distribution also to provide the solution for water scarcity in the metros. As a result, it seems necessary to develop a new methodology of failure risk assessment, which would be as simple as possible and at the same time the obtained results would be satisfactorily reliable. Such an approach will enable the widespread use of failure risk

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assessment in water supply systems management.

Preliminaries

Definition[4,5] Let μ be a fuzzy subset defined on G . Let $\mathcal{H} \subset 2G - \{\emptyset\}$ be a HX group on G . A fuzzy set $\lambda\mu$ defined on \mathcal{H} is said to be a fuzzy subgroup induced by μ on \mathcal{H} or a fuzzy HX subgroup on \mathcal{H} , if, for any $A, B \in \mathcal{H}$,

$$\lambda\mu(AB) \geq \min \{ \lambda\mu(A), \lambda\mu(B) \}$$

$$\lambda\mu(A^{-1}) = \lambda\mu(A)$$

where, $\lambda\mu(A) = \max \{ \mu(x) / \text{for all } x \in A \subseteq G \}$.

Definition[7,8] Let R be a ring. Let $H = \{ \langle x, \mu(x) \rangle / x \in R \}$ be an fuzzy set defined on a ring R , where $\mu : R \rightarrow [0,1]$. Let $\mathcal{R} \subset 2R - \{\emptyset\}$ be a HX ring. A fuzzy subset $\lambda\mu = \{ \langle A, \lambda\mu(A) \rangle / A \in \mathcal{R} \}$ of \mathcal{R} is called a fuzzy HX subring on \mathcal{R} or a fuzzy sub ring induced by H and if the following conditions are satisfied. For all $A, B \in \mathcal{R}$,

$$\lambda\mu(A - B) \geq \min \{ \lambda\mu(A), \lambda\mu(B) \},$$

$$\lambda\mu(AB) \geq \min \{ \lambda\mu(A), \lambda\mu(B) \},$$

where $\lambda\mu(A) = \max \{ \mu(x) / \text{for all } x \in A \subseteq R \}$.

System in force: In India right to fresh water for personal and domestic uses are not mentioned explicitly in Indian constitution but clean and affordable water is essential to life and one of the fundamental rights protected under human international rights law. Fresh water is finite source and it is also very basic requirement for human body. Here we have given few existing water distribution systems. Many of them are handled by manual methods and some of them are not providing the water to necessary area at right time. This will create a scarcity or surplus wastage which are root cause for many other problems.

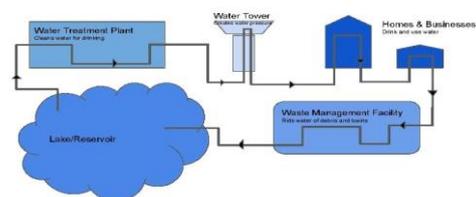


Figure : 2.1.1. (Wikipedia)

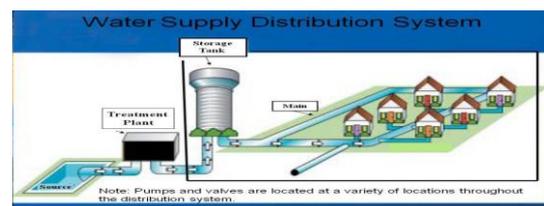


Figure: 2.1.2 (Wikipedia)

Fuzzy Hongxing water distributive system:



This system consists of 3 layers for exact distribution.
 Source (or) Reservoir Main tanks
 Users and sub tanks

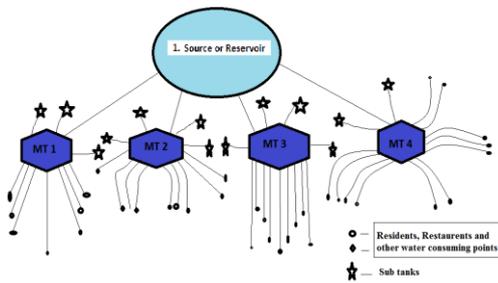


Figure : 2.1.3

Consider the main water source or reservoir being the initial distributing point. The water should be distributed to the Main distributing tanks which are located inside the village or town. Among a group of main tanks we can use fuzzy HX ring concepts to identify the order for the distribution to the main tank of the group. We can identify the tanks using the parameters, Capacitance of the tank and Number of connections available with the particular tank. Using this we can identify Water Emergency Ratio (WER). The Reaching Height Element (tank) possess high value of WER, which will get water from reservoir at first and it will be proceeded through the ascendings order of WER values of the tanks.

For example,

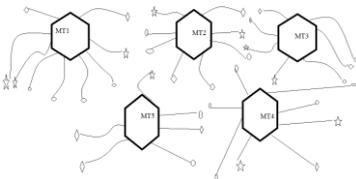


Figure: 2.1.4

Let us assume the following number of connections available in a particular tank.

Tank	Capacity Ltrs	Number of connections		
		Home	Restaur ant	Sub tank
1	100000	20	5	3
2	200000	25	3	5
3	300000	25	2	6
4	250000	20	4	4
5	150000	10	3	2

$$WER_1 = \frac{(n \times 1000) + (m \times 5000)}{c - \frac{(n \times 1000) + (m \times 5000)}{2}}$$

$$WER_2 = \frac{(k \times 10000)}{c - \frac{k \times 10000}{2}}$$

$$WER = 1 - AVG(WER_1, WER_2)$$

Where

- WER = Water Emergency Ratio
- n = number of home connections
- m = number of restaurant connections
- k = number of sub tank connections
- c = available water level in the main tank

So we get the following table,

Main tanks WER values

	Initial capacity (Ltrs)	Home	Rest Au rant	Sub tank	WER 1	WER 2	WER	Level c(1 Hr)
MT1	100000	20	5	3	0.667	0.353	0.49	25000
MT2	200000	25	3	5	0.239	0.286	0.7375	110000
MT3	300000	25	2	6	0.13	0.222	0.824	205000
MT4	250000	20	4	4	0.182	0.174	0.822	170000
MT5	150000	10	3	2	0.189	0.143	0.834	105000

WER represents the fuzzy value of remaining water level of the main tank. In the above case, Its value less than 0.5, hence Tank 1 will get emptied first. It will be indicated by the sensor in the main tank also received by the sensor in the reservoir. The sensor will indicate the shutter 1 to open to provide the water to increase the level of water in tank 1. After tank 1 filled up, the sensor indicate the level of water (equivalent fuzzy value 0.95) to the sensor in the reservoir. The respective sensor in the reservoir will command the shutter 1 to stop the distribution. Then the reservoir will start to distribute the water to the next main tank according to the necessary and its fuzzy values.

The tank which one will become empty first is called "Reaching Height Element", and it may change time to time.

In this connection from above chart, the order of distribution is

- Main tank 1
- Main tank 2
- Main tank 4
- Main tank 3
- Main tank 5

Controlling Board in the Source:

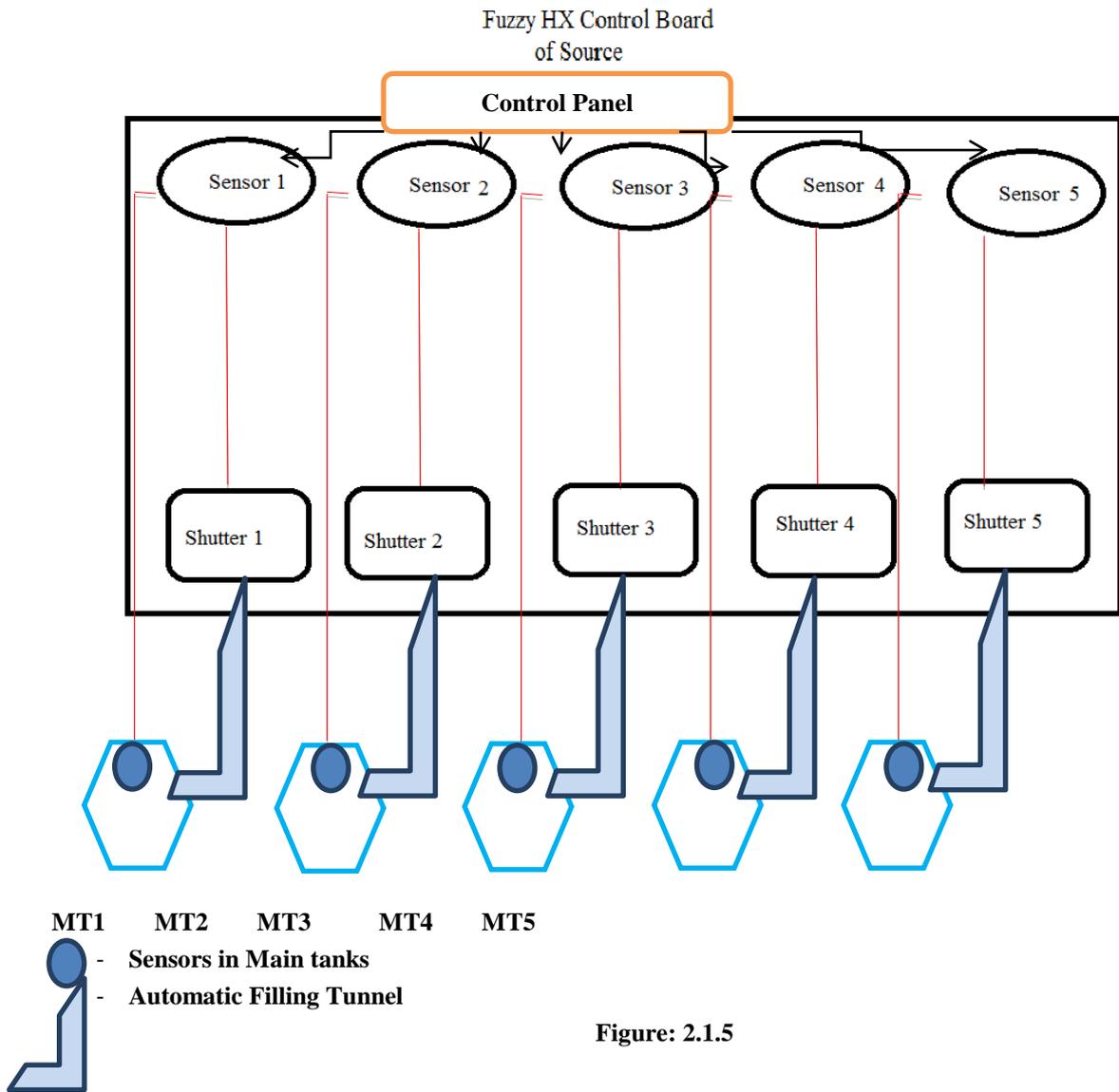


Figure: 2.1.5

Arduino Sensors: Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

METHOD 1: Control panel prepared with the following circuit components.

Circuit Components:

- Arduino UNO
- 16x2 LCD
- PIR Sensor - 5
- Connecting wires
- Bread board
- 1 k resistor - 5
- Power supply
- Motor driver
- Shutter - 5

Circuit:

Single board circuit given in the following diagram and program as follows.

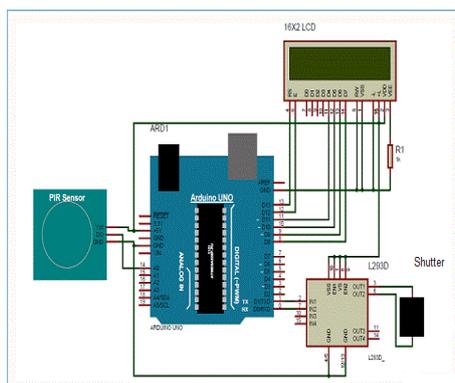


Figure: 2.1.6 (Ref.10.)

Programming Explanation 1:

```
int const trigPin = 6;
int const echoPin = 5;
#define SHUT 3
void setup()
{
  Serial.begin(9600);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  pinMode(SHUT, OUTPUT);
}
void loop()
```

```
{
  int duration, distance;
  digitalWrite(trigPin, HIGH);
  delay(1);
  digitalWrite(trigPin, LOW);          // Measure the pulse
  input in echo pin
  duration = pulseIn(echoPin, HIGH);  // Distance is half
  the duration divided by 29.1 (from datasheet)
  distance = (duration/2) / 29.1;    // if distance less than 0.5
  meter and more than 0 (0 or less means over range)
  Serial.print("distance :");
  if (distance <= 0.95 && distance >= 0)
  {
    digitalWrite(SHUT, HIGH);
    delay(3000);
  }
  else
  {
    digitalWrite(SHUT, LOW);
  }
  delay(100);
}
```

METHOD 2:

Things used in this project

Hardware components

- Adafruit RGB Backlight LCD - 16x2 - 1
- Ultrasonic Sensor - HC-SR04 (Generic) - 1
- Buzzer - 1
- Amazon Web Services DC Motor - 1
- Arduino UNO & Genuino UNO - 1
- Amazon Web Services motor shield - 1
- Jumper wires (generic) - 1
- Software apps and online services

Arduino IDE

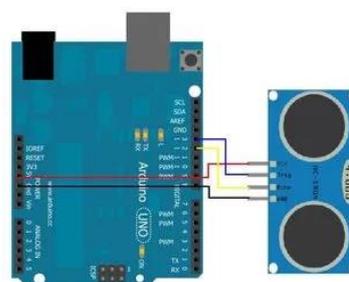


Figure: 2.1.7(Ref.11.)

Programming Explanation 2:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(12,11,5,8,9,1);
const int trigPin=7;
const int echoPin=4;
const int mt_En_Pin1=2;
const int mt_IN1_Pin2=3;
const int mt_IN2_Pin3=6;
int buzz=10;
```

```

longduration;
intlevel;

voidsetup()
{
lcd.clear();
lcd.begin(16,2);
lcd.print("OPEN");

pinMode(trigPin,OUTPUT);
pinMode(echoPin,INPUT);
pinMode(mt_En_Pin1,OUTPUT);
pinMode(mt_IN1_Pin2,OUTPUT);
pinMode(mt_IN2_Pin3,OUTPUT);
Serial.begin(9600);
pinMode(buzz,OUTPUT);
}

voidloop()
{
digitalWrite(trigPin,HIGH);
delayMinutes(2);
digitalWrite(trigPin,LOW);
delayMinutes(60);
digitalWrite(trigPin,HIGH);
duration=pressureIn(echoPin,LOW);

level= duration*0.025;
if(level<=0.5)
{
digitalWrite(13,LOW);
delay(1000);
digitalWrite(mt_En_Pin1,LOW);
analogWrite(mt_IN1_Pin2,50);
analogWrite(mt_IN2_Pin3,0);
delay(2000);
analogWrite(mt_IN1_Pin2,0);
analogWrite(mt_IN2_Pin3,0);
delay(1000);

tone(buzz,1000);
delay(1000);
tone(buzz,1000);
delay(1000);
noTone(buzz);
delay(3000);

lcd.clear();
lcd.setCursor(0,5);
lcd.print("Open");
delay(1000);

analogWrite(mt_IN1_Pin2,0);
analogWrite(mt_IN2_Pin3,50);
delay(3000);
}

else
{
digitalWrite(13,LOW);

```

```

digitalWrite(mt_En_Pin1,LOW);
analogWrite(mt_IN1_Pin2,50);
analogWrite(mt_IN2_Pin3,0);
}
}

```

Sensor 1, Sensor 2 etc., used in the control board are Rotary Encoder Module Brick Sensor Development Board. When you rotate the rotary encoder it counts in the positive direction and the reverse direction. Rotation counts are not limited. With the buttons on the rotary encoder, you can reset to its initial state and start counting from 0.

At the same time the sensor used in the main tanks are programmed to indicate the level of water to the arduino sensors to control the water distribution. If it indicates the level that is below the fuzzy value 0.5 then it will be informed to the respective arduino sensor, then arduino command to open the respective shutter to distribute water to the tank. After some time if the level indicates 0.95, then it will be informed to the arduino sensors and immediately the water distribution to the same tank through the respective channel will be stopped. While the other tank will indicate LOW value less than 0.5 then it will be kept in queue for next distribution. This is completely automatic. Hence, the water distribution at the necessary time may be possible also the wastage can be avoided. We can programme the time for distribution of water as well as the order of the distribution.

Users and Sub tanks:

Home and Restaurants use sub tanks are main water users here. Each user gets water from the main tanks according to time and capacity of the distribution from the main tanks. The water sensors are used at tanks of homes, restaurants and sub tanks for the purpose of indicating water levels to the arduino boards for water to be filled at suitable and necessary time. The levels can be indicated through sensors as WER values in the tanks to the main board. The sensors are programmed to calculate the WER values but they will indicate to the main board if the value goes below 0.5 to get water and the value above 0.95 to stop water.

II. CONCLUSION

Fuzzy logic has been used in numerous applications such as facial pattern recognition, air conditioners, washing machines, vacuum cleaners, antiskid braking systems, transmission systems, control of subway systems, unmanned helicopters, knowledge-based systems for multi-objective optimization of power systems etc. Fuzzy HX groups and Fuzzy HX rings are developing logic and their applications may be highly expected to be used in Communication theory, Water distributive system, Statistical methods etc. Here it is expected that the proposed model is very much useful in automatic water distribution system with the help of arduino and the other sensors. Which will provide water with minimum wastage that is negotiable and it will provide the essential water to sub sources through high sensors with the help of the automatic sensors.

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