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FUZZY MODEL FOR TUBIDITY MEASUREMENT

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Abstract :The cloudy appearance of water caused by the presence of suspended and colloidal matter.In the water-works field a turbidity measurement is used to indicate the clarityof water.Technically turbidity is an optical property of the waterbased on the amount of light reflected by suspended particles.Turbidity cannot be directly equated to suspended solids because white particles reflect more light than cloured dark particles and many small particles will reflect more light than an equivalent of large particle.In the present communication we report a novel fuzzy based model for the characteristics of turbidity.The very idea of fuzzy reasoning by linear function has been explored in modeling the tubidity measuring system.The result shows a great resemblance between the practical results and the results obtaining from the fuzzy based tubidity model.

Introduction

Turbidity is the measurement of scattered light that results from the interaction of incident light with particulate materials in a liquid sample.It is an expression of the optical propertise of a sample that causes light rays to be scattered and absorbed rather than transmitted in a straight line through the sample.Turbidity of water is often caused by the presence of suspended particles like as clay ,silt,finely divided organic particles,plankton,other microscopic organism ,organic acids,dyes.Particulate materials is typically undesirable in water from a health perspective and its removal is always required when the water is intended to consumption.Thus the Turbidity has been as a key water quality monitoring parameter to access the health and quality of environmental water resources.

Fig1.Experimental set up

Turbidity measurement is a qualitative parameter for water but its traceability to a primary standard allows the measurement to be applied as a quantative measurement.when used as a quantative measurement ,turbidity is typically reported generically in turbidity units(TU)or nephelometric turbidity units(NTU).

Turbidity

Turbidity comes from the Greek work 'Turbid'which in simple terms means cloudy ,hazy,or not pure.All drinking water,both raw and treated contains some degree of turbidity due to dispersed suspended solids such as silt,clay,algae,organic/inorganic matter or micro organisms.There are a number of methodologies available to measure the turbidity .simply tubidity is the optical propertise of the interaction between light and suspended particlesin a water.when a beam of light is passed through ultrapure water its path remains relatively undisturbed.However,particulate suspended solids will interefere with the light beam and absorb the light energy and or scatter or reflect the light.

Tubidity measurement

Accurate and precise laboratory or online analytical measurement can be influenced by the following five key parameters:

- Measuring Instrument
- Measuring accessories
- The sample
- The operators
- Standard & reference Material.

The technical validation, comprasability,quality control/assurance,proficiency testing and traceability of any analysis require significant attention to details of all these parameters.

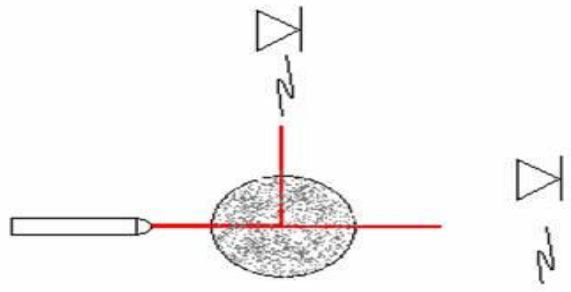

Fig2. schematic concept of turbidity meter.

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When particles are suspended in water and a light is shined through the sample, not all of the light will pass straight through the sample. Instead, the light will reflect off of the suspended particles and some of the light will exit at a right angle to the direction of entry into the sample. Our meter uses a laser pointer as a light source, and two photodiodes as detectors for the intensity of the transmitted and refracted light.The basic setup is shown below in figure2. By measuring the voltages off of both of the photo diodes, we can derive a function which calculates turbidity from the ratio of the voltage across the 90 degree sensor to the voltage across the 180 degree sensor.

Flow Diagram

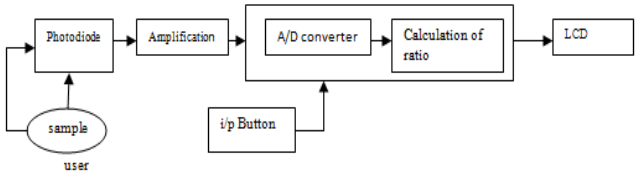

Fig3. Foam Core Container for Turbidity Meter

Problem Statement

The objective of the present work is to model the non linear characteristics of a turbidity meter.The turbidity meter having non linear characteristics in nature and hence some mechanism is required for plotting the accurate non linear characteristics of the meter.

Turbidity Model –A Fuzzy Approach

The turbidity meter has some non linear characteristics .Hence for modeling the turbidity meter in Sugeno method of fuzzy reasonning is used. This approach involves the construction of Fuzzy set for antecedent prt and linear function for consequence part to model non linear dependency between the voltage ratio and the nephelometric turbidity unit(NTU).For modeling of Turbidity meter fuzzy rule by triangular membership function for antecedent part and linear function for consequences part has been employed.The rules are defined here on universe of discourse with respect to the voltage ratio & NTU ranges. The laboratory oservation for turbidity meter used for modeling are shown in below in table1.

Table 1: Voltages, Ratios and Calculated Turbidities

Sample	Measured NTU	90 Degree Photodiode	180 Degree Photodiode	Voltage Ratio	Calculated NTU
1	99	0.067	0.315	0.21269	97.3922
2	216	0.133	0.309	0.43042	200.785
3	315	0.164	0.306	0.53594	365.360
4	405	0.178	0.320	0.55625	405.594
5	523	0.192	0.314	0.61146	529.009
6	627	0.197	0.304	0.64802	621.989
7	722	0.202	0.304	0.66447	666.742
8	899	0.210	0.284	0.73943	893.709
9	1005	0.212	0.272	0.77941	1030.16

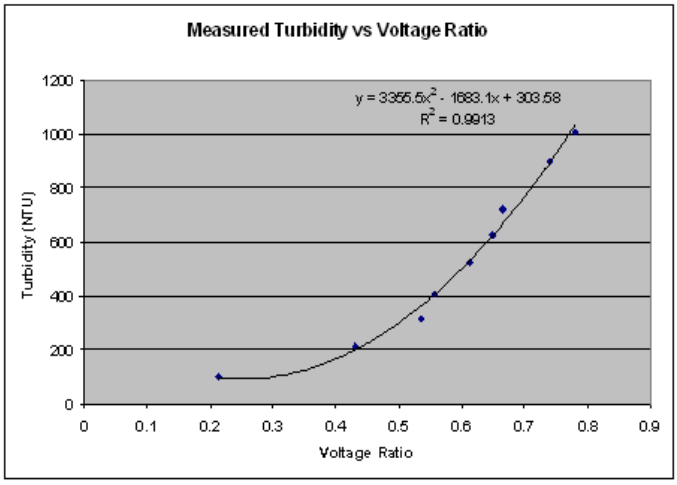

Fig 4.characteristics plot drawn based on observation

Fuzzy logic

This Fuzzy logic Fuzzy logic control is derived from fuzzy set theory. In fuzzy set theory, the transition between membership and non-membership can be graded. Therefore, boundaries of fuzzy sets can be vague and ambiguous, making it useful for approximate systems. Fuzzy Logic Controller (FLC) is an attractive choice when precise mathematical formulations are not possible This paper demonstrate how fuzzy model of Turbidity can be realized based on fuzzy reasoning.Before a fuzzy model is designed let us know that what fuzzy reasoning is all about? It is process in which given a value of input antecedent variables,yields the values of consequent output variable based on imprecise and nonlinear dependency formulated in the rule base. The fuzzy reasoning is broadly classified into two methods: first the Direct method and second the Indirect method.The direct method includes Mamdani's method,Takagi and Sugeno's fuzzy modeling and simplified method.The direct methods are popular due to their simplicity.The indirect method are used for the truth value space and required the complex reasoning mechanism.In the fuzzy modelling of Turbidity we

employed a Takagi sugeno reasoning where the consequences part of the system is linear.

There are three principal elements to a fuzzy logic controller which are shown in figure1.

- A.Fuzzification module (Fuzzifier)
- B Rule base and Inference engine
- C Defuzzification module (Defuzzifier)

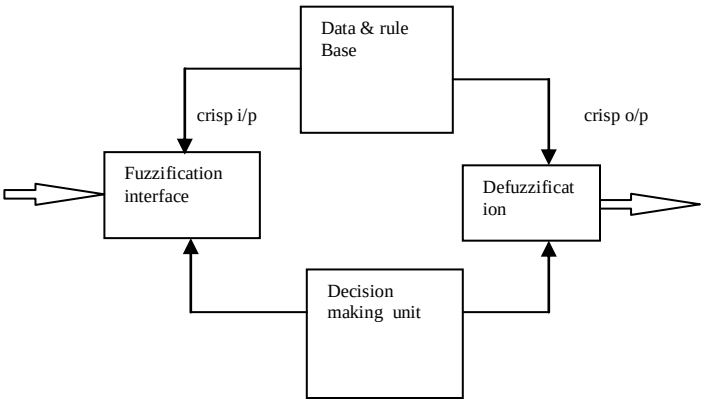

Fig5.various part of the fuzzy control system

Fuzzy Infernace System

The simple rules for modeling the turbidity meter as followos

IF the Voltage ratio very lowTHEN the NTU is very low
IF the Voltage ratio low THEN the NTU is low
IF the Voltage ratio medium THEN the NTU is medium
IF the Voltage ratio high THEN the NTU is high
IF the Voltage ratio very high THEN the NTU is very high

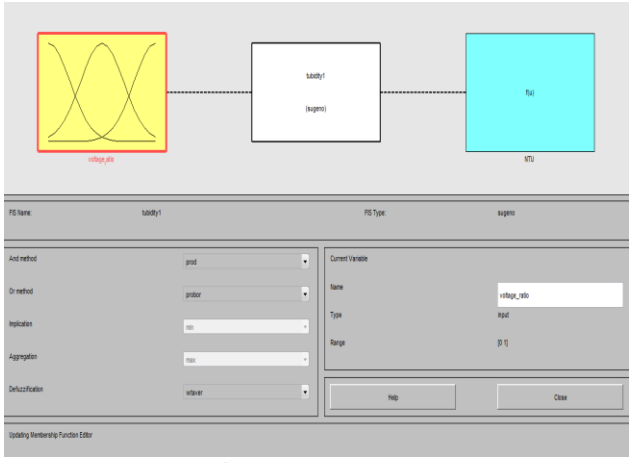

Fig6. Fis editor for tubidity measure model

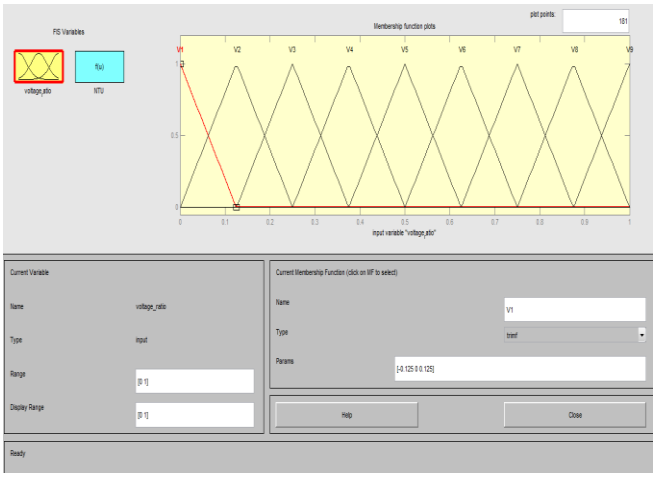

Fig 7. membership function of the voltage ratio Fis turbidity model.

Fig8. membership function of the voltage ratio Fis tur bidity model.

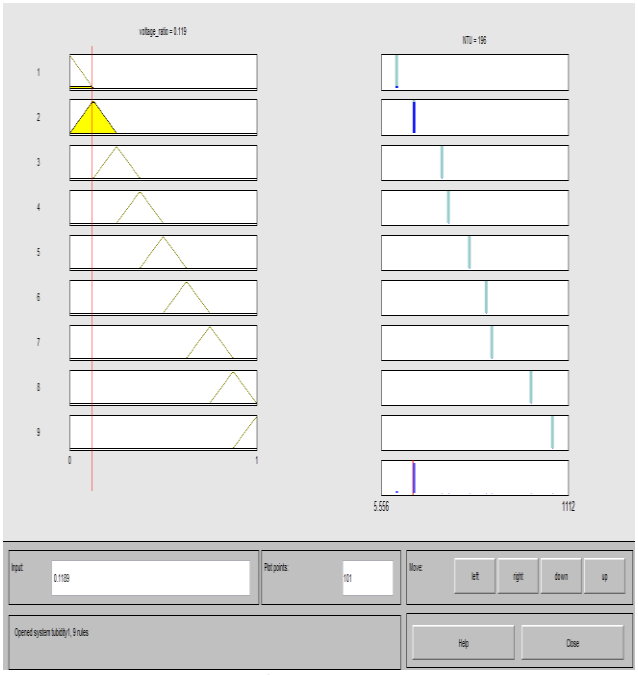

Fig9.the ruleviewer for turbidity model

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Result & Discussion

The data reconstructed pertaining to turbidity characteristics using Sugeno Fuzzy Inference is shown in table 2,while figure 7 depicts the constructed turbidity meter by using data generated in Fuzzy Inference process.comparison with table 1 and figure1 shows the resemblance between practical turbidity characteristics and characteristics generated by the fuzzy model of turbidity .Idea of fuzzy modeling of turbidity is through simple but demonstrate powerful application of fuzzy logic in device modeling based on imprecise data.The same idea can be extended to highly nonlinear and complex electronic devices.

Table2:observation using fuzzy based turbidity model

VOLTAGE RATIO	TURBIDITY(NTU)
0.0518	140
0.0701	156
0.107	186
0.119	196
0.131	209
0.155	241
0.180	273
0.198	297
0.210	313
0.229	337
0.259	368
0.284	376
0.308	384
0.338	394
0.357	400
0.375	406
0.393	424
0.412	442
0.430	460
0.454	484
0.479	508
0.509	536
0.534	556
0.558	575
0.582	595
0.607	614
0.625	629
0.649	635
0.668	640
0.686	644
0.704	649
0.735	657
0.753	666
0.771	701
0.790	735
0.808	769
0.832	814
0.845	837
0.857	860
0.875	894
0.893	912
0.905	925
0.924	943
0.942	962
0.966	986
0.979	999
997	1020

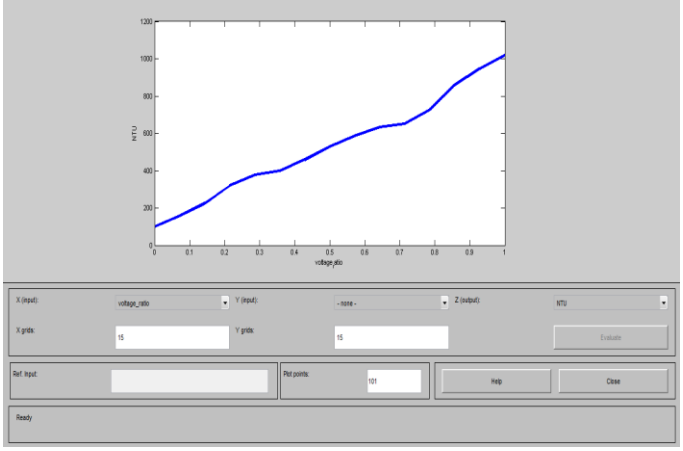

Fig10.Turbidity characteristics by using Fuzzy -Sugeno model

References

[1] Waterwatch Australia, Module 4 - physical and chem ical parameters "Methods Turbidity".

[2] Myre, E, Shaw, R. The Turbidity Tube: Simple and Accurate Measurement of Turbidity in the Field.

[3] W.P Mason,'Measurement of Turbidity in Water' (JACS) Journal Of Amerecian Chemical Socity 1899 *21* (6), pp 516–517 .

[4] Sallehuddin Bin Ibrahim'Turbidity Measurement Using An Optical Tomography Sytem',(IJSE), Vol 5,No 2,2013.

[5] Basic turbidimeter design and concepts(EPA) Turbid ity Guidance Manual 1999.

[6] Ahmad Fairuz Bin Omar and Mohmd Zubir Bin Jafri 'Turbidimeter Design and Analysis' A Review on Opti cal Fiber Sensors for the Measurement of Water Tur bidity, SENSORs 2009, *9*(10), 8311-8335;

[7] Fairuz Omar, A.; Zubir MatJafri, M. Development of Optical instrument as turbidimeter a comparative study. Sensor Review 2012, 32, 134.

[8] Mohd Khairi, M.T.; Ibrahim, S. Md Yunus, M.A. Fa ramarzi, M. A review on the design and development of turbidimeter. Sensor Review 2015, 35, 98.

[9] M. Sadar Making Sense of Turbidity Measurements – "Advantages in Establishing Traceability Between Measurements and Technology"in 2004 National Monitoring Conference, Chattanooga, TN, USA.
[10] Cincinnati,Ohio 'Determination of Turbidity by Nephelometry"Environmental Monitoring Systems Laboratory, August 1993
[11] International Organization for Standardization. Geneva, Switzerland. "ISO 7027: Water quality Determination of turbidity." 1999.
[12] Bas Wijnen, G. C. Anzalone and Joshua M. Pearce, "Open-source mobile water quality testing platform" Journal of Water, Sanitation and Hygiene for De velpment,4(3),pp.532–537,(2014)
[13] John J.Barron 'Turbidity Standards and Reference material' November 1996,
[14] Vanous, R.D, "Understanding Nephelometric In strumentation". American Laboratory July 1978.
[15] Papacosta, K., Almeda, A. "The turbidity measure ment factors for accuracy".Advanced Polymer Sys tems Inc., Redwood,2000.

Biographies

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