- принудительное переключение режимов работы пользователем;
- обратная связь с пользователем (информация о состоянии аккумуляторов, режиме работы контроллера).

Заключение. Новый контроллер повысит отказоустойчивость системы, так как позволит объединить несколько ветрогенераторов в станцию с возможностью взаимодействия (перераспределения энергии) при избыточной разрядке на одной из подстанций. Использование резервного аккумулятора даст возможность системе функционировать в нормальном режиме при кратковременных перебоях.

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СРАВНЕНИЕ НЕЧЕТКОГО И ПИД РЕГУЛЯТОРА В ЗАДАЧАХ КОНТРОЛЯ УРОВНЯ НЕФТИ

Целью данной научной работы заключается в исследовании процесса управления уровнем нефти в баке с применением классической теории управления. В работе был предложен пропорционально-диференциальный закон управления и получены результаты моделирования в среде Matlab. Также был разработан нечеткий регулятор и полученны для него соответствующие результаты. Результаты показали, что с применением нечетких методов управления результат более сглаженный, и в результатах практически отсутствует задержка за счет быстрого переходного процесса. Также основным недостатком классической теории управления является выбор параметров регулятора. Процесс моделирования и проектирования нечеткого регулятора выполнен полностью в Fuzzy Logic Toolbox Toolbox и Simulink в MATLAB.

Управление; логический нечеткий контроллер; интегрированная нечеткая система; база правил; нефть.

I.S. Kobersi, S. Abdulmalik. V.V. Ignatev

COMPARE BETWEEN FLC AND PID REGULATORS IN THE OIL LEVEL CONTROL TASK

The purpose of this project is to design a simulation system of fuzzy logic controller for oil tank level control by using simulation package which is fuzzy logic Toolbox and Simulink in MATLAB software. Then we take the oil tank level control by using PD controller, for a long time, the choice and definition of the parameters of PD are very difficult. There must be a bad effect if that you do not choose nicely parameters. To strictly limit the overshoot, using fuzzy control can achieve great control effect. In this paper, we take the liquid level oil tank, and use MATLAB to design a fuzzy control. Then we analyze the control effect and compare it with the effect of PD controller.

Control; fuzzy logic controller; rule viewer; fuzzy integrated system; oil.

1. Introduction. During the past years, fuzzy control has emerged as one of the most active and fruitful areas for research in the applications of fuzzy set theory, especially in the realm of industrial processes, which do not lend themselves to control by conventional methods because of a lack of quantitative data regarding the input-output relations. Fuzzy control is based on fuzzy logic-a logical system that is much closer in spirit to human thinking and natural language than traditional logical systems. Fuzzy logic is a form of logic whose underlying modes of reasoning are approximate instead of exact. Unlike crisp logic, it emulates the ability to reason and use approximate data to find solutions. FLCs are knowledge based controllers consisting of linguistic “IF-THEN” rules that can be constructed using the knowledge of experts in the given field of interest .The fuzzy logic controller (FLC) based on fuzzy logic provides a means of converting a linguistic control strategy based on expert knowledge into an automatic control strategy. In this paper, we take the liquid level water tank, and use MATLAB to design a Fuzzy Control. Then we analyze the control effect and compare it with the effect of PD controller.

Control of oil flow system is a routine requirement in many industrial processes. The control action of chemical and petroleum industries include maintaining the controlled variables. Fuzzy logic control (FLC) can be applied for control of oil flow and level in such processes. This technique is particularly attractive when the process is nonlinear. The objective of the controller in the level control is to maintain a level set point at a given value and be able to accept new set point values dynamically. This paper presents a FLC method for the level control of tank system.

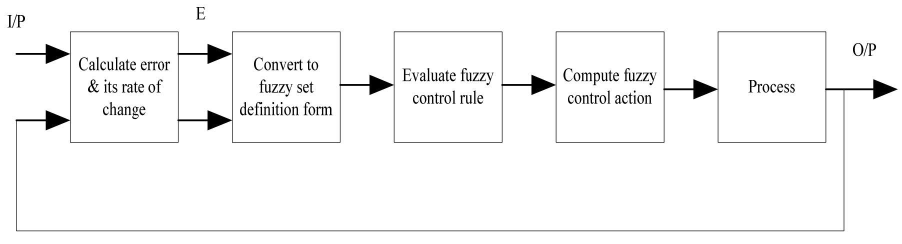


Fig. 1. Block diagram of a control system using fuzzy logic control

Liquid(oil) tank system and model equations: It is important to understand the mathematics of how the single tanks system behaves. This is system modeling and it is a very important part of control systems analysis.

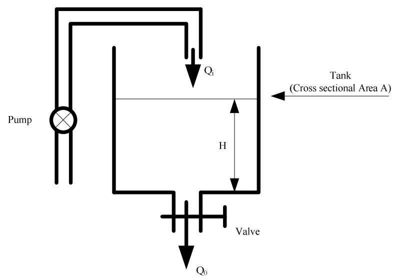


Fig. 2. A single oil level system

The system model is determined by relating the flow Q_i into the tank to the flow Q_0 leaving through the valve at the tank bottom. Using a balance of flows equation on the tank, it is possible to write:

$$Q_i - Q_o = AdH \,/\, dt. \quad (1)$$

Where, A is the cross-sectional area of the tank, and H is the height of the oil in the tank. If the valve is assumed to behave like an idea sharp edged orifice, then the flow through the valve will be related to the oil level in the tank, H, by the expression

$$Q_o = C_d a \sqrt{2g.h}. \quad (2)$$

In this equation "a" is the cross sectional area of the orifice. "C_d" is called the discharge coefficient of the valve. This coefficient takes into account all oil characteristics, losses and irregularities in the system such that the two sides of the equation balance. And "g" is the gravitational constant g=980 cm/sec^2.

In (2) assumes C_d is a constant so that Q_0 has a nonlinear relationship to the level H for all possible operating conditions. Ideally the nonlinear relation is the square root (2), but in a practical valve there is a more complex non-linear equation. Combining (1) and (2) gives

$$A\frac{dH}{dt} + C_d a\sqrt{2gH} = Q_i. \quad (3)$$

2. Designing of fuzzy logic controller.

1 – the FIS editor: We have defined two Inputs for the Fuzzy Controller. One is Level of the oil in the tank denoted as "level" and the other one is rate of change of oil in the tank denoted as "rate" and defined one output of the controller is denoted by "valve". Both these inputs are applied to the rule editor. According to the rules written in the rule editor the controller takes the action and governs the opening of the valve. It may be shown as:

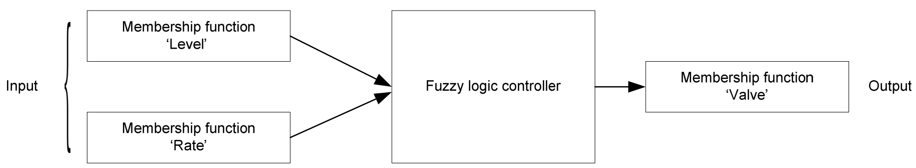


Fig. 3. Mamdani type fuzzy controller

2 – the Membership Function Editor: The membership function editor is the tool that lets displays and edits all of the membership functions associated with all of the input and output variables for the entire fuzzy inference system. When opened the membership function editor to work on a fuzzy inference system that does not already exist in

the workspace, there are not yet any membership functions associated with the variables that you have just defined with the FIS editor. Fuzzy set characterizing the Input and output.

Table 1

Character of membership function "Level"

Level		**Range: -1 to 1**
Fuzzy Variable	**MF used**	**Crisp Input Range**
High	Gaussian MF	(0.3,-1)
Ok	Gaussian MF	(0.3,0)
Low	Gaussian MF	(0.3,1)

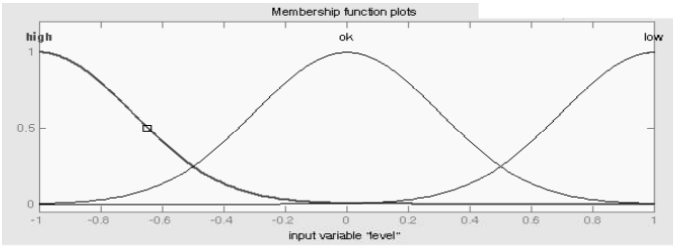


Fig. 4. Membership function Fuzzy Set characterizing the Input level

Table 2

Character of membership function "Rate"

Rate		**Range: -0.1 to 0.1**
Fuzzy Variable	**MF used**	**Crisp Input Range**
Negative	Gaussian MF	(0.03,-0.1)
Zero	Gaussian MF	(0.03,0)
Positive	Gaussian MF	(0.03,0.1)

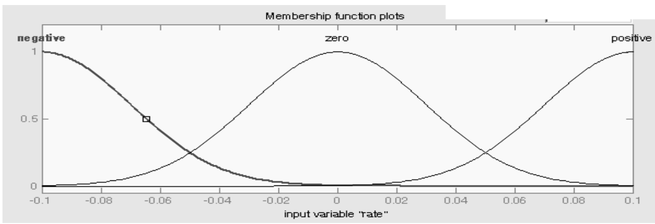


Fig. 5. Membership function Fuzzy Set Characterizing the Input rate

Table 3

Character of membership function "Valve"

Valve		**Range: -0.1 to 0.1**
Fuzzy Variable	**MF used**	**Crisp Input Range**
Close_fast	Triangular MF	(-1.0 -0.9 -0.8)
Close_low	Triangular MF	(-0.6 -0.5 -0.4)
No_change	Triangular MF	(-0.1 0 0.1)
Open_slow	Triangular MF	(0.2 0.3 0.4)
Open_fast	Triangular MF	(0.8 0.9 1.0)

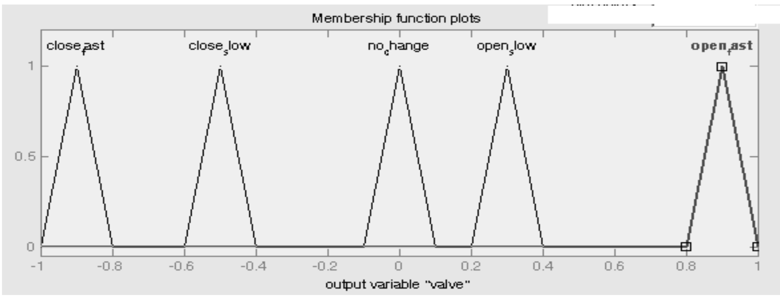


Fig. 6. Triangular membership function output valve

The Rule Editor. When we are constructing rules using the graphical Rule Editor interface is fairly self-evident. Based on the descriptions of the input and output variables defined with the FIS Editor, the Rule Editor allows how needs to construct the rule statements automatically. Choosing none as one of the variable qualities will exclude that variable from a given rule.

If level is ok ***Then*** valve is no_change
If level is low ***Then*** valve is open_fast
If level is high ***Then*** valve is closed_fast
If level is ok ***And*** rate is positive ***Then*** valve is close_slow
If level is ok ***And*** rate is negative ***Then*** valve is open_slow

3. Design and modeling using Simulink. Subsystem's description:

1. Valve. The oil flow level can be controlled by using limited integrator in the simulated valve subsystem may be shown as:

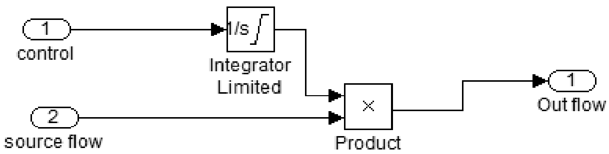


Fig. 7. Block diagram of valve subsystem

2. Liquid tank: The block diagram for the liquid(oil)tank may be shown as:

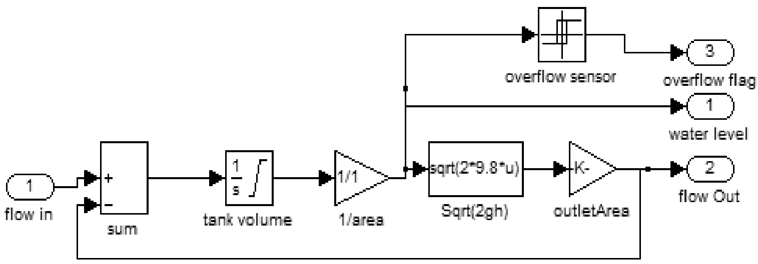
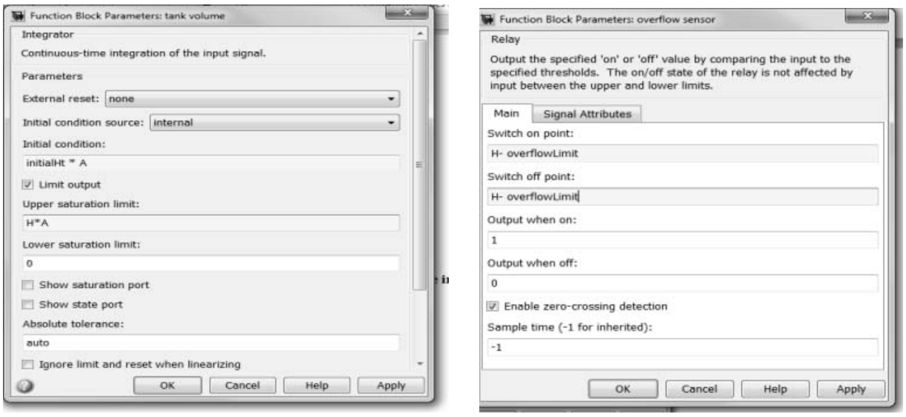


Fig. 8. Block diagram of liquid (oil) tank

Model equation for the liquid(oil) tank system block As stated previously in equation (1),(2) and (3).

Values of the parameters in the model equation are given as a=0.05 m, A=1m^2, H=2 m, and assume the initial oil level high (initialht)=0.05,overflow sensor distance from top(overflowLimit)=0.

Then the function block parameters for tank volume and overflow sensor are in the following:



a b

4. Results and discussion. The model for PD controller:

1 – A model for conventional (PD) controller for liquid (oil) level control

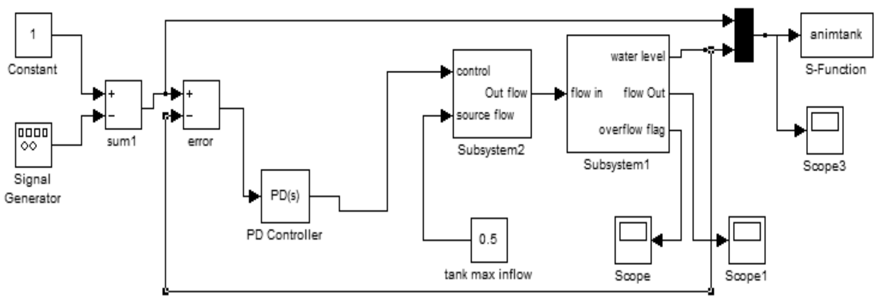


Fig. 9. A model by using PD controller

The Results:

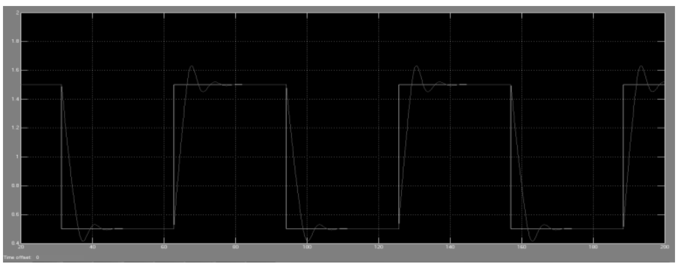


Fig. 10. The result using PD controller

It is seen that PD controllers drives the system unstable due to mismatch error generated by the inaccurate time delay parameter used in the plant model. Transients & overshoots are present when PD controller is used to control the oil level.

2 – A model for fuzzy logic controller:

A model for Fuzzy Logic Controller for oil level control.

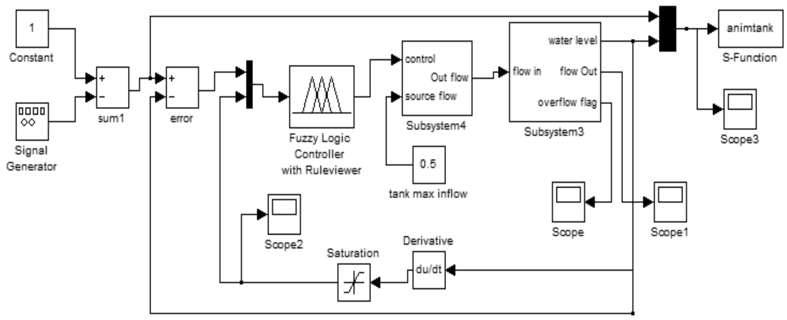


Fig. 11. A model by using fuzzy logic controller

In this model we are must connected the fuzzy logic controller with ruleviewer block with the FIS that is we constructed in the FIS Editor.

The Results:

Response of oil Level Controller using Fuzzy Logic Controller.

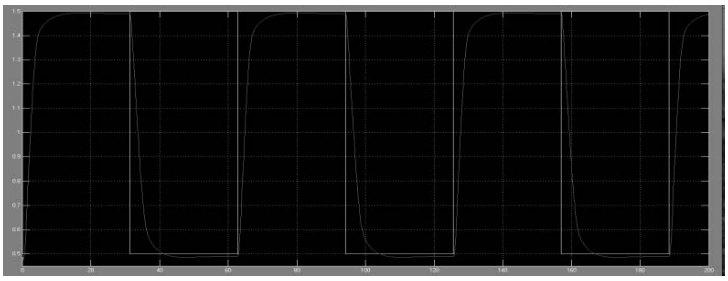


Fig. 12. A result using Fuzzy Logic controller

FLC provide good performance in terms of oscillations and overshoot in the absence of a prediction mechanism. The FLC algorithm adapts quickly to longer time delays and provides a stable Response**.**

DISCUSSION:

In our exercise, we took the oil level tank , and used MATLAB to design a Fuzzy Control. Then we analyzed the control effect and compare it with the effect of PD controller. As a result of comparing, Fuzzy Control is superior to PD control.

FLC provide good performance in terms of oscillations and overshoot in the absence of a prediction mechanism. The FLC algorithm adapts quickly to longer time delays and provides a stable response while the PD controllers drives the system unstable due to mismatch error generated by the inaccurate time delay parameter used in the plant model.

FLC can give more attention to various parameters, such as the time of response, the error of steadying and overshoot. Comparison of the control results from these two systems indicated that the fuzzy logic controller significantly reduced overshoot and steady state error.

FLC significant improvement in maintaining performance over the widely used PD design method in terms of oscillations produced and overshoot.

The rise time in case of PD controller is less but oscillations produced and overshoot and settling time is more . But in case of fuzzy logic controller, oscillations and overshoot and settling time are low, so FLC can be applied where oscillations can't be tolerated in the process.

Comparison results of PD and FLC are shown above.
The overall performance may be summarized as (tab. 4)

Table 4

Parameter	PD	FLC
Overshoot	Present	Not Present
Settling Time	More	Less
Transient	Present	Not Present
Rise Time	Less	More

Conclusion. The Fuzzy Logic Controller provides the accurate control of the oil level in any industrial application . so Unlike some fuzzy controllers with hundreds, or even thousands, of rules running on dedicated computer systems, a unique FLC using a small number of rules and straightforward implementation is proposed to solve a class of level control problems with unknown dynamics or variable time delays commonly found in industry. Additionally, the FLC can be easily programmed into many currently available industrial process controllers.

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