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Fuzzy Controller Parameters´ Proposal in Matlab Enviroment

Štefan Koprda, Martin Magdin

Department of Informatics
Faculty of Natural Sciences
Constantine the Philosopher University in Nitra
Tr. A. Hlinku 1, 949 74 Nitra

Abstract: In this paper we deal with the creation and design of fuzzy controller using Matlab. As the founder of fuzzy theory is considered Azerbaijani Prof. Lotfi Zadeh. In his article in 1965 is first time specified term "fuzzy" [8]. Defining of Zadeh fuzzy sets is based on the efforts of experts to build multivalued logic. Multivalued logic (Lukasiewicz logic) allows to work with imprecise (vague) terms and eliminates gaps of "classical" two-valued logic that we utilized in the art since ancient times. The use of vague terms can not be avoided especially when describing the behavior of complex systems. Their exact analytical description would be technically infeasible or prohibitively complicated, and therefore for realization very expensive. Cause of fuzzy theory can also be formulated by means of the so-called Law incompatibility (incompatibility) by Druckmüller [2].

Keywords: fuzzy controller; regulation; Mandani; Matlab; Fuzzy Inference System

I. INTRODUCTION

With the development of computer technology we now increasingly faced with penetration of modern management methods into practice. An example is the adaptive control, robust control, artificial intelligence and expert systems.
Analyse of scientific literature reveals that, early works on automatic generation control was introduced by Cohn [1] in 1957. Elgerd [3] in 1970 introduced the concept of modern optimal control in an interconnected power system.
An important part of artificial intelligence and control in practice is and will continue to represent fuzzy logic and its applications. We use it wherever it is impossible to carry out a mathematical description of the controlled system, or is a very complex system, that is for control purposes inapplicable [5].

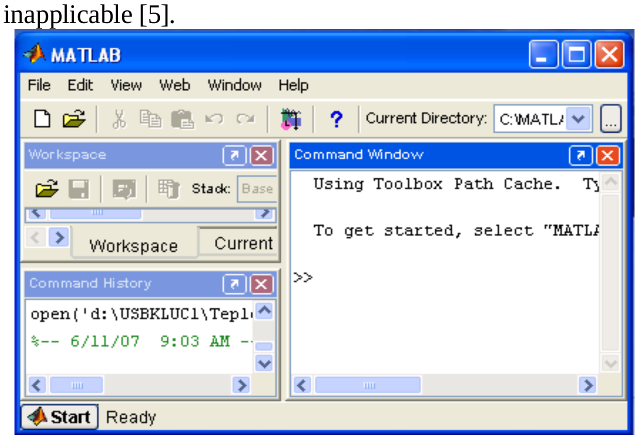

Fig. 1 Environment of program Matlab

In this paper we describe with the environment Matlab, which (is used in the design of fuzzy controllers) is used for teaching the subject Basics of Automation at the Department of Electrical Engineering and Automation, Faculty of Agricultural Engineering Slovak University of Agriculture.

II. PROPOSED STRUCTURE AND PROPERTIES OF THE FUZZY CONTROLLER

In following Figure is structure of model fuzzy-PID controller [7].

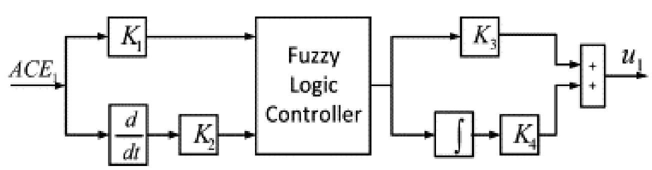

Fig. 2 Structure of model fuzzy PID controller

Performance of the fuzzy-PID controller depends on the input scaling factors K1 and K2 and output scaling factors K3 and K4.
For the fuzzy logic controller of the inputs, rate of change and the output are transformed into five linguistic variables namely NB (Negative Big), NS (Negative Small), Z (Zero), PS (Positive Small) and PB (Positive Big). Triangular membership function shown in Fig. 3 [7] is used for both the inputs and the output.

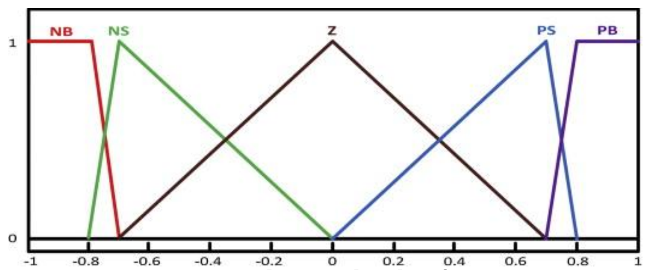

Fig. 3 Triangular membership function

Since each variable of the fuzzy controller (two inputs and one output) has 5 membership functions, 25 rules are required to generate a fuzzy output. The rule base of the fuzzy logic controller is given in Table 1. Fuzzy rules play major role in the performance of fuzzy logic controllers and therefore, in this paper the rules are investigated extensively by studying the dynamic behaviour of the system. The firing strength of the fuzzy control rules are obtained by using Mamdani interface engine.

Fuzzy rules for the inputs and output [7].

ACE	ΔACE				
	NB	NS	Z	PS	PB
NB	NB	NB	NB	NS	Z
NB	NB	NB	NB	Z	PS
Z	NB	NS	Z	PS	PB
PS	NS	Z	PS	PB	PB
PB	Z	PS	PB	PB	PB

Custom design work of fuzzy controller (FR) we can be created using an interactive graphical environment Graphical User Interface (GUI), or by using the command line Command Line (CL). By the designing is need to define the input and output variables, their ranges, membership functions and their parameters, entering interference and decision rules, setting methods fuzzyfication and defuzzyfication [4]. For these requirements, we can express the block structure of the FR as shown in Figure 4. This structure is methodological design tool, in accordance with the Fuzzy Logic Toolbox it will be labeled as *Fuzzy Inference System (FIS)*. Graphical User Interface (GUI) provides tools for creating, editing and displaying FIS. Fuzzy interference system (FIS) includes all processes associated with the choice of inputs, including the controller parameterization to determine the output of the controller using fuzzy logic.

FIS consists of three editors: *FIS Editor* (editor of the interference system of fuzzy controller), see Figure 4. *Membership Function Editor*, see Figure 5, *Rule Editor* and two display *Rule* and *Surface Viewer*.

FIS Editor we activate in to create a new fuzzy interference system with command Fuzzy. Activation of the existing fuzzy inference system is activated command fuzzy meno.fis. In our case it will FC_PR1.fis.

III. FIS Editor

The main menu includes a drop-down menu *File, Edit, View*, allowing storage and call files and editing of fuzzy system using the GUI tools. On the *Edit* menu we can their be added or cancel and determine so the number of inputs and outputs.

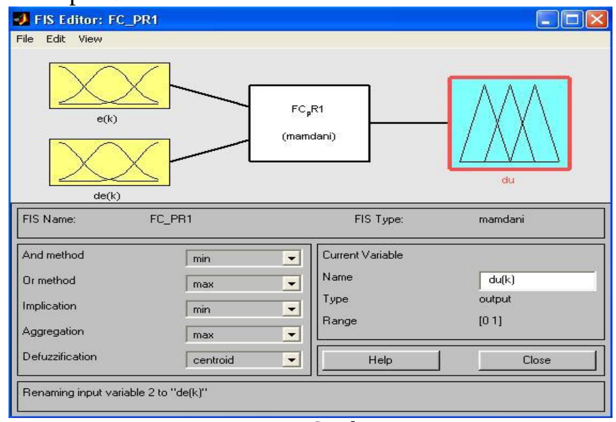

Fig. 4 FIS Editor

In this editor you can choose the type of fuzzy controller. Thus Mamdani or Sugeno. In our case, we chose Mamdani type.

IV. Membership Function Editor (MF Editor)

Starts either in the FIS editor, double-click the icon of exit or entry, or through pop-ups *Membership Function Editor*.

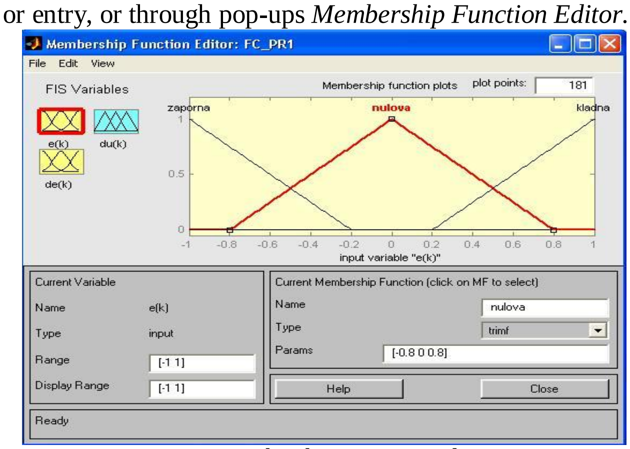

Fig. 5 Membership Function Editor

If you select an input signal (e (k), de (k)), clicking its icon in the left corner, the selected icon is red around the perimeter and windowed "Memership function plots" to see all the membership function with parameters set as the names of the variables - Term.

In the window "*Current Variable*" is referred the name, type, scope and extent of the screen labeled Password: Name, Type, Range, Display Range. In this window, we can write the necessary ranges. It is advisable to first for chosen variable set the range.

V. Rule Editor

With the Rule Editor we can start in FIS editor via the pull-down window *View-Edit Rules*. It contains fields for edit and display. This field can directly edit the rules manually, or use the buttons. Custom rules can be compiled using the drop-down menu of input and output linguistic variables (e (k), of (a) and (k)). Rule Editor offers a drop-down menu for the input and output variables, where each entry consists of the name of a linguistic variable - term. Therms can combine with the operators "AND" or "OR".

VI. Rule Viewer, Surface Viewer

Rule Viewer (graphic presentation of the process of interference) is activated by selecting the View drop-down menu *Rule Viewer*. It contains all the rules and the shapes of membership functions of inputs and outputs and their interference. Surface Viewer (graphic presentation of the process of interference) is activated by selecting using the drop-down menu *View* with choosing *Surface Viewer*. Displays the space of values of output variables depending on the input variables. For the fuzzy control is generally contemplated control error and its derivative.

VII. Conclusion

Problems with modelling of continuous processes are apparent in solving dealing with multi-level control systems, where in addition to extensive process management levels, there is also another level of management responsible for the continuous optimization process [6]. Is naturally, that the quality of any product technology needs to be improved by replacing the complex and the technology itself, as well as the continuous optimization of operation in which it is necessary to use not only the exact theoretical resources and practical experience respectively heuristic methods of dispatching management level. Right here are opening new possibilities of using of fuzzy controller and environment Matlab as a replacement for a person at control and optimization processes.

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