

퍼지 로직에 의한 최적 시스템 요소 선택

System Selection Assistant based on Fuzzy Logic

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Abstract

This report contains information about "System Selection Assistant"(SSA) - Program, which can help customers of manufacturing company to select optimal electro-mechanical system for their purposes.

This Program shows main principles of programs, which can help to make decision, using knowledge of experts. Program consists of two main parts: "Expert's part" must be tuned by expert and "Customer's part" can be used to make final decision about optimal parts of system.

This report describes all parts of SSA program and shows simple example of selection parts of electro-mechanical system.

Key Words : fuzzy logic, electro-mechanical systems, SSA

1. Introduction

Just imaging that you need System to make mechanical motion (for example, opening doors, rotating spindle, etc).

For this purpose you have to use DC motor, Encoder and Control System based on Microcontroller. You also have limited fund.

The Company who makes systems like you need and has big experience in this area can help you. You should select DC motor, Encoder and Control System. Cost of the DC motor depends on its power. Different types of encoders have different values of resolution parameter and their cost depends on needed accuracy. Control System is electronic circuit, which reads information from Encoder and controls speed and position of DC motor. Control System consists of system board - main circuit and microcontroller. For this Project we suppose, that several types of system boards for different microcontrollers have the same cost, because it is not important to this study. Cost of microcontroller depends on

performance, and in this project we suppose, that we can use any kind of microcontrollers in each System.

Different purposes of customers need different configurations of systems. The first customer wants to use his system for slow motion with high accuracy; the second customer wants to use his system for fast motion with low accuracy, but the third customer needs fast system with high accuracy. Which combination of components of system will be the best for each customer? It's better to use special software, which helps them to select components of system. This software already tuned by experts and every customer can just set their conditions and see recommended system combination.

2. Problem Statement

For achieving goals described in previous part we should create special software. This Program has to consist of two main parts: Expert's Part and Customer's Part.

In Expert's Part expert should set up evaluation method based on Fuzzy Logic, and in Customer's part customer should input his financial and accuracy conditions. Also Customer's Part should realize automatic search of optimal system parameters.

To create evaluation method based on Fuzzy Logic we must create all parts of it from fuzzy-sets and fuzzy-numbers to "If...then..." rules, inference and defuzzification [1].

Using this Program should be very simple for users (for expert and customer), so it must show all steps clearly.

3. SSA program

SSA (System Selection Assistant) is the name of program, which realizes main principles described in previous part. This Program is written with Borland Delphi 7 IDE.

Program consists of expert's part and customer's part.

Expert's part consists of first three tab-sheets of main tab-control of Program. First tab-sheet is used for creation fuzzy-sets. Second tab-sheet is used for creation fuzzy-rules table. Third tab-sheet is used for inference and defuzzification.

First step of using this Program is creation of fuzzy-sets and fuzzy-numbers of these sets.

On the picture 1 you can see screenshot of first tab-sheet.

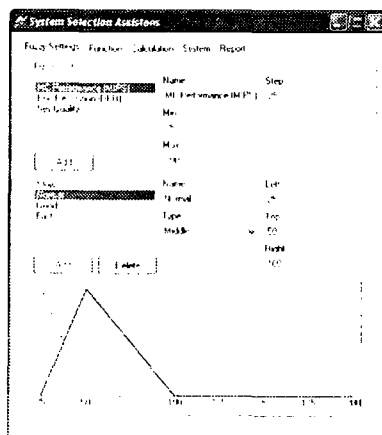


Fig1. Fuzzy Settings

In this tab-sheet you can create fuzzy-sets using "Add"button. For each fuzzy-set you must input name and working range. Also you can input Step parameter, but it is used only for visualization of axis.

Use the second "Add" button to create fuzzy-numbers. For each fuzzy-number you must input name, values of left, top and right vertexes of triangle. Also you must select Type of fuzzy-number. You can select "Middle" to create triangle, "Left" to create triangle without left vertex or "Right" to create triangle without right vertex. For example, if you select "Left" type of fuzzy-number it means that output value of any input value less than value of Top vertex is equal 1.

When you edit parameters of fuzzy-sets or fuzzy-numbers Program automatically draws them in Graph-box.

After creation of fuzzy-sets you can build fuzzy-rules table. Use Function tab-sheet to do it. You can see it on the picture 2.

Input 1	Input 2	Output
MC Performance (MIP)	Enc Resolution (DPR)	Sys Quality

	Low	Normal	High	VeryHigh
Slow	Rough	Rough	Poor	Optimal
Normal	Rough	Poor	Optimal	Well
Good	Poor	Optimal	Well	Perfect
Fast	Optimal	Well	Perfect	Perfect

Fig2. Table of "If... Then..." rules

In this tab-sheet you must select input and output fuzzy-sets from combo-boxes. After that Program creates empty rectangular cells table. Now you should fill this table. For this choose cell and select value in combo-box at the bottom of window.

Now, settings of Expert's part of Program are finished.

Inference and defuzzification

You can test working of fuzzy inference and defuzzification. To do this

use Calculation tab-sheet. You can see Calculation tab-sheet on picture 3.

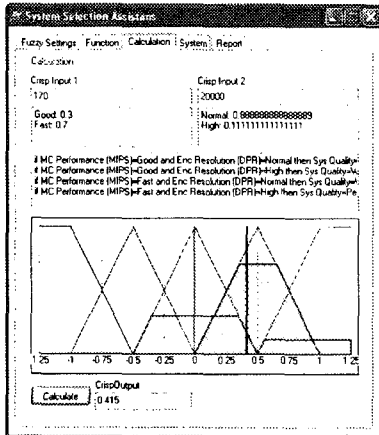


Fig3. Calculation tab-sheet

In this tab-sheet you can input crisp value of input parameters and press "Calculate" button. Program automatically selects input fuzzy-numbers with values. After that it builds "if...then..."rules, using Memdani method [2],[3]. At last Program defuzzifacates figure to crisp output value. Program uses "Bisector of Area"method. For calculating area it uses numeric integration of final figure. So it allows showing output value with 3 digits of precision.

Customer's part consists of last two tab-sheets of main tab-control of Program. First tab-sheet is used for input financial conditions. You can also use this tab-sheet for checking cost of different system combinations manually. Second tab-sheet is used by Program for output report for customer.

For selecting system you should use System tab-sheet. You can see this tab-sheet on picture 4.

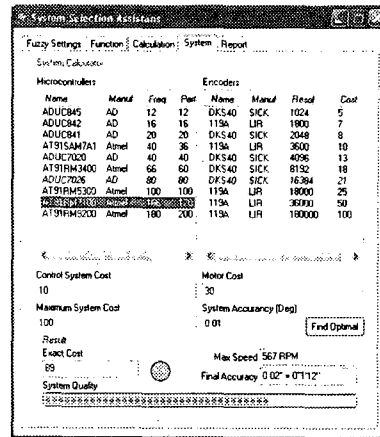


Fig4. Lists of Components and Financial Conditions

In this tab-sheet you should input Control System Cost, Motor Cost, Maximum System Cost (it means your fund) and System Accuracy into input-boxes. You can manually select different microcontrollers and Encoders from lists and Program will show you Total Cost of system, Max Speed and Final Accuracy. Also Program shows you System Quality in progress-bar and Color Light.

When you press "Find Optimal" button Program finds all system combinations for you financial conditions and shows them in Report.

You can see Search Report of Report tab-sheet on picture 5.

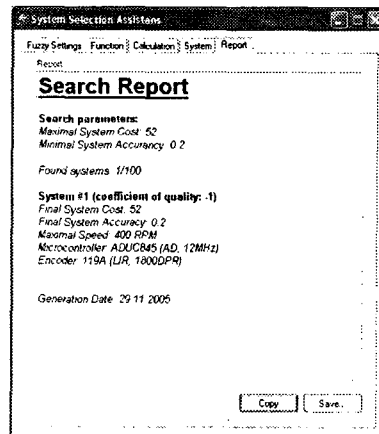


Fig5. Search Report

In Search Report program shows Search Parameters, number of found systems and descriptions of each system. The most optimal system is first, but you can select

another system because final selection depends on your opinion only.

4. Computer simulation

Let's imagine that you need the electro-mechanical System. Parameters of this system are:

- Control System Cost - 10;
- Motor Cost - 30;
- System Accuracy - better than 0.01°;
- Maximum System Cost - 100.

You should input these values in input-boxes like shown on picture 6.

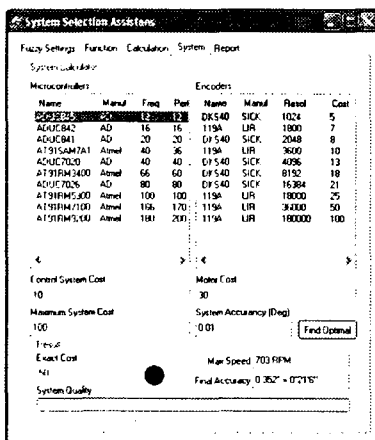


Fig6. Example of financial conditions

When you input parameters you can press "Find Optimal" button and Program will generate Search Report for you. You can see it on picture 7.

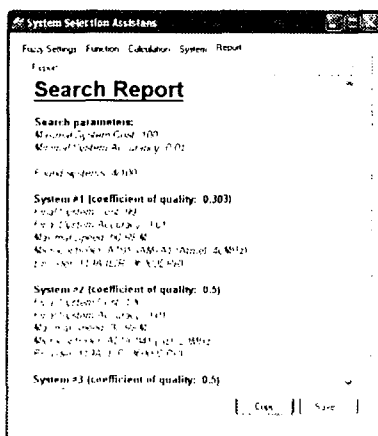


Fig7. Example of Search Report

You can select your final System from this list or you can input new financial parameters.

So, you can select your System in several steps. It is much more useful and it takes less time, than trying to select parameter of system manually. For example, in the Lists of Components of this Program there are 10 items in each list. So, we have 100 combinations of system parameters and we have to waste long time to choosing them manually.

5. Conclusions

When we don't know exact relations between parameters of used components and final quality of electro-mechanical System it is very difficult to make decision, which System is better. Even excellent expert can't say exact mathematical function of their relationship. In this case we should use Fuzzy Logic Theory to create evaluation method. We can use knowledge of expert about different combinations of system parameters and these knowledge help us to evaluate others combinations.

The example presented here shows how to realize this method easily.

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