MODEL OF THE ALGORYTHMS FOR OPERATING ACTIONS AND MODELS OF THE PROCESSES IN THE FUZZY SYSTEMS OF VIBRODIAGNOSTICS MAIN PUMP UNITS

Main line pump vibration diagnostics

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In modern diagnostic the most informative parameter is vibration (1).
The introduction of the automatic vibration diagnostic system will make the operation of the oil pump stations (OPS) more efficient. However the existing systems of vibrodiagnostics of main pump units in most cases are systems for collecting and recording information.

But the final decision rests with the person.

This circumstance is primarily a consequence of lack of effectiveness of diagnostic models which reflect the real processes occurring in the main pump units (MPU)
In connection with this the task to develop models of processes occurring in main pump units (MPU) of oil pump stations (OPS) and suitable for vibration diagnostic of their elements and nodes is very urgent nowadays.
We choose coordinate “e” (parameter of vibration) and Y (control action) for the fuzzy variables of the system SVD.

According to the values of varieties the state space is divided into elements corresponding to several points.
To define the varieties we use seven basic fuzzy subsets, the same way as was done in work (2,3):
PL, PM, PS

- Positive large, positive medium, and low values.
- Z- zero;
- NL, NM, NH, negative low negative medium, negative high values.

Note that the control actions as well as the state variables can be determined subjectively. However, considering the connection between the input and output variables, we can construct the control rules in terms of Cartesian product of fuzzy sets A_i в X_i, где i = 1,2,...,n,

and create a composition or by using a concept of utility function (4,5). The output of each rule is a fuzzy sub- set which determines the degree of possible values of fuzzy control variables.

The procedure of selecting the control action depends on the degree of fitting. Observing the work of the operator it was established that when describing the system in the space state, input vectors at the time of measurement can be a subjective fuzzy multi sets. At the same time, building a system SVD with the set of heuristic concepts, expressed linguistically, can occur with the use of different (symmetrical as a rule) accessories functions of fuzzy models.

Here are some examples of functions of accessories and we'll arrange their values in accordance with the basic fuzzy subsets.

For a better perception variable states ε, $\dot{\varepsilon}$ and γ of the SVD system, for the first fuzzy model, are shown in different tables.

1-st model:

ε	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6
PB	0	0	0	0	0	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
PS	0	0	0	0	0	0.3	0.6	0.9	1.0	0.9	0.6	0.3	0
					(	0.3	0.5	0.7	1.0	0.7	0.5	0.3	)
PM	0	0	0	0	0	0.3	0.8	1.0	0.8	0.3	0	0	0
					(	0.3	0.6	1.0	0.6	0.3	)		
NO	0	0	0	0	0	0.3	1.0	0.3	0	0	0	0	0
OM	0	0	0	0.3	0.8	1.0	0.8	0.3	0	0	0	0	0
OS	0	0.3	0.6	0.9	1.0	0.9	0.6	0.3	0	0	0	0	0
OB	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0	0	0	0	0

$\dot{\varepsilon}$	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
PB	0	0	0	0	0	0	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
PS	0	0	0	0	0	0	0.2	0.5	0.8	1.0	0.8	0.5	0.2	0	0
PM	0	0	0	0	0	0	0.2	0.9	1.0	0.9	0.2	0	0	0	0
NO	0	0	0	0	0	0	0.2	1.0	0.2	0	0	0	0	0	0
OM	0	0	0	0	0.2	0.9	1.0	0.9	0.2	0	0	0	0	0	0
OS	0	0	0.2	0.5	0.8	1.0	0.8	0.5	0.2	0	0	0	0	0	0
OB	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0	0	0	0	0	0

For the second fuzzy model accessories functions of state variables ε, $\dot{\varepsilon}$ and γ of SVD system are combined in one table.

2-nd model:

ε/$\dot{\varepsilon}$ /γ	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
PB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.7	1.0
PS	0	0	0	0	0	0	0	0	0	0	0	0	0.2	0.7	1.0	0.7	0
PM	0	0	0	0	0	0	0	0	0	0.3 0.3 0.1	0.6 0.5 0.3	1.0	0.6 0.5 0.3	0	0	0	0
NO	0	0	0	0	0	0	0	0.5 0.4 0.1	1.0	0.5 0.4 0.1	0	0	0	0	0	0	0
OM	0	0	0	0	0.6 0.5 0.3	1.0	0.6 0.5 0.3	0	0	0	0	0	0	0	0	0	0
OS	0	0.7	1.0	0.7	0.2	0	0	0	0	0	0	0	0	0	0	0	0
OB	1.0	0.7	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

As can be seen from the table for the second model, with large deviations of ε , the accessories functions of parameters $\dot{\varepsilon}$ and γ.

in accordance with the basic fuzzy sub-sets, positive large - PL, positive medium – PM, negative medium – NM and negative large, NL have the same shape, which improves performance.

While with the small deviation the basic range of accessories functions of these parameters is different. And when approaching the point of stable equilibrium it becomes narrower, thus improving the quality of diagnosis (measurement and control) by providing a quasi - linear mode of SVD system and maintain the required accuracy.

Separate (generalized) case for the parameter ε (the second model):

ε	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
PB	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1.0
PS	0	0	0	0	0	0	0	0	0	0	0	0	0.5	1.0	0.5
PM	0	0	0	0	0	0	0	0	0	0.5	1.0	0.5	0	0	0
NO	0	0	0	0	0	0	0.5	1.0	0.5	0	0	0	0	0	0
OM	0	0	0	0.5	1.0	0.5	0	0	0	0	0	0	0	0	0
OS	0.5	1.0	0.5	0	0	0	0	0	0	0	0	0	0	0	0
OB	1.0	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0

3-d model:

$\varepsilon, \dot{\varepsilon}, \gamma$	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
PB	0	0	0	0	0	0	0	0	0	0	0	0.3 0.2 0.2	0.7 0.7 0.7	1.0 1.0 1.0	0.0
PS	0	0	0	0	0	0	0	0	0	0.1 0.2 0.1	0.6 0.5 0.3	1.0 1.0 1.0	0.6 0.5 0.3	0.1 0.1 0.1	0
PM	0	0	0	0	0	0	0	0.2 0.0 0.2	0.7 0.6 1.0	1.0 1.0 0.4	0.7 0.5 0.2	0.2 0.1 0.1	0	0	0
NO	0	0	0	0	0	0.1 0.0 0.0	0.5 0.4 0.1	1.0 1.0 1.0	0.5 0.4 0.1	0.1 0.0 0.0	0	0	0	0	0
OM	0	0	0	0.2 0.1 0.1	0.7 0.5 0.2	1.0 1.0 0.4	0.7 0.6 1.0	0.2 0.0 0.2	0	0	0	0	0	0	0
OS	0	0.1 0.1 0.1	0.6 0.5 0.3	1.0 1.0 1.0	0.6 0.5 0.3	0.1 0.2 0.1	0	0	0	0	0	0	0	0	0
OB	0	1.0 1.0 1.0	0.7 0.7 0.7	0.3 0.2 0.2	0	0	0	0	0	0	0	0	0	0	0

The starting procedure for the construction of SVD is the task of fuzzy sets as accessories functions of any kind. Besides the above discrete functions of accessories one can enter the continuous functions.

In the second method of task for fuzzy sets it's easy to understand that accessories functions will have the form of Gaussian curve with varying degree of accessories. The desired closed – loop system is described by the rules from the table below.(see model 4)

4-th model:

ε	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
PB												GFP$_1$			
PS										GFP$_2$					
PM									GFP$_3$						
NO							GFP$_4$								
OM					GFP$_3$										
OS				GFP$_2$											
OB	GFP$_1$														

In the latter table there is a definition : GFP – Gaussian accessories function

Similarly we can get the model processes for the parameters $\dot{\varepsilon}$ and γ. However the width of GFP – distribution for them will be different. Another width GFP may be in the final table for the parameter ε depending on the dynamic characteristics of SVD.

The accuracy of the fuzzy system SVD is connected with the choice of the output value of this system. And it's not discussed in this work.

However the quality of transients can be analyzed through simulation.

All these rules are based on little experience. So the fuzzy system SVD either establishes the rules by itself in the process of work with dynamic object , or (in our case) could improve the original linguistic algorithm.

In other words, to the algorithm for computing γ of the control action (in the rules of fuzzy system) logical changes can be made.

They are expected to improve the transition process.

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