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Simulation of PSD controller in Matlab - Simulink

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Abstract: A characteristic feature of all modern means of control in industry is partial to complete decentralization of the control from simple, two-level management, to fully decentralized control using LON (Local Operating Network) technologies. In all, however, is a common feature of existence dispatcher (parent) level that serving for the monitoring of technology or for its optimization in the form of human intervention in the control, With using the higher levels of control we are creating practical adaptive system able while maintaining the level of control to adapt the behavior of the entire control system current state of the technological process. This paper dealt with the analysis of PSD controller and compiling of measurement chains with using which we can regulate the temperature to the desired value.

Keywords*:* Matlab, PSD regulator, Simulation, Control; programming

I. INTRODUCTION

Simulation is a method of acquiring new knowledge about the system, on the basis of the experimentation with its model. For the purposes of simulation must be model described adequately, not every type of model is in fact suitable for the simulation. For more detailed information it is necessary usually repeat the simulation experiments multiple times with different parameters [4]. Process of experimentation in the real world is always loaded with measurement errors and other factors that may cause problems when interpreting the results. Moreover experiments with real systems are often uneconomical, inappropriate or impracticable, especially for expensive and complex network systems. Therefore, we use the computer simulation method, which does not have these disadvantages [2]. For verification of the model is important mainly check the internal logic of the model. We are exploring, whether the model displays all the necessary details and gradually are extracted the logical, semantic and syntactic errors. The aim of the validation of model is validation whether the model adequately shows the proposed system, which can be the case with the design of a new production system rather complicated task [7]. The verification of the model therefore occurs when the creator of the model purposefully tested seemingly correct version of the model due to finding and correction of errors that may arise during the modeling phase. To the validation occurs when a creator of the model and experts assess the extent to which is created model sufficient and satisfactory [8],[5].

II. PSD CONTROLLER

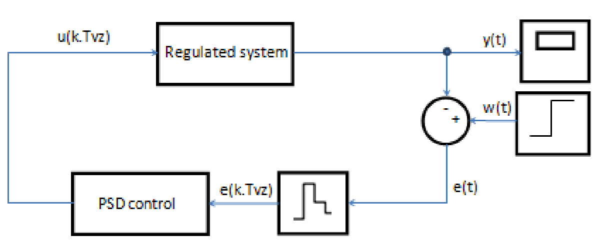
Superstructure of the virtual environment Matlab - Simulink allows solution of nonlinear differential equations with using graphical input system. It allows us to graphically monitor the progressions variables at any point of the involvement. Used, for example to simulate the dynamic behavior of the monitored system. In our case, we consider a system with transfer

$$Gs(p) = \frac{1}{14290s + 1} \tag{1}$$

and a controller with transfer

$$Gr(p) = r_0\left(1 + \frac{1}{T_i} + T_d\right) \tag{2}$$

In environment Matlab - Simulink was created diagram of a control circuit of Figure 1.



Sampling circuits

Fig. 1 Block diagram of the control circuit with PSD controller

The compilation of simulation scheme in Simulink is shown in Figure 2.

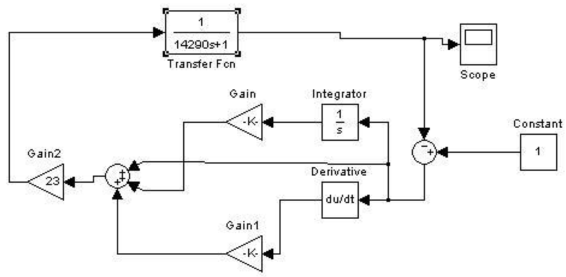


Fig. 2 Simulation scheme PSD controller with the system

The resulting course of the simulation is shown in Figure 3. On the basis on this output from during in the following sections, we will work to tune and optimize the PSD controller.

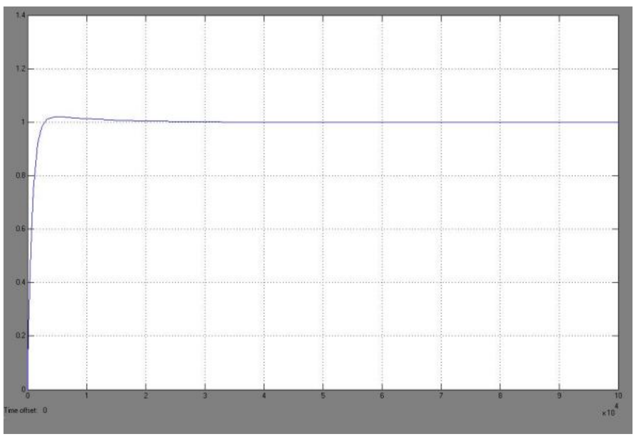


Fig. 3 Progress of the simulation PSD controller with a given system

Parameters of PSD controller were set as follows:
k = 20
Ti = 10 600 s
Td = 100 s .

III. Display of the Frequency Characteristics PSD Controller and System

In these characteristics is plotted separately logarithm of the amplitude frequency characteristic (amplitude of logarithmic frequency characteristics) and especially linear value of phase (phase of logarithmic frequency characteristics) on the vertical axis. In the horizontal axis is plotted frequency in a logarithmic scale.
The compilation of commands in MATLAB for the creation of characteristics:

```
>> gs=tf(1,[14290 1])

Transfer function:
   1
----------
14290 s + 1
 >> grp=1
grp =
   1
>> gri=tf(1,[10000 0])
 Transfer function:
 1
-------
10000 s
 >> grd=tf([100 0],1)
 Transfer function:
100 s

>> gr=(grp+gri+grd)*23
 Transfer function:
2.3e007 s^2 + 230000 s + 23
-------------------------
      10000 s
 >> g=gs+gr
 Transfer function:
3.287e011 s^3 + 3.31e009 s^2 + 568670 s + 23
-----------------------------------------
      1.429e008 s^2 + 10000 s

>> bode(g)
```

To the Figure 4 is displayed amplitude and phase of the frequency characteristic of given the device.

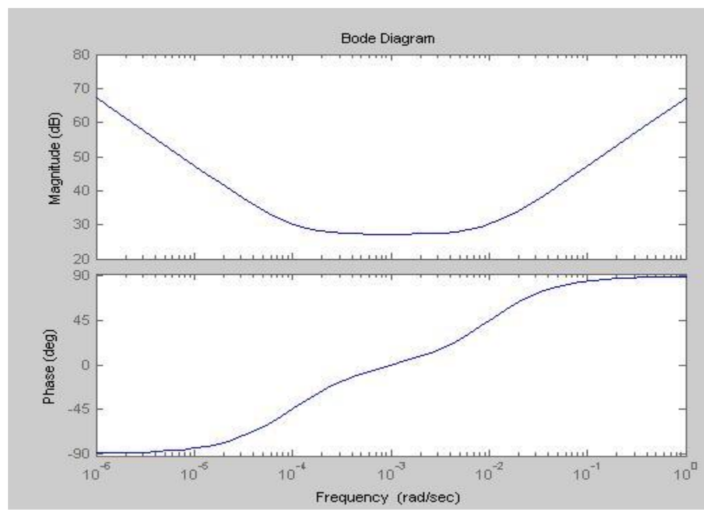


Fig. 4 Amplitude and phase of the frequency characteristic

IV. Regulation of Temperature in Thermodynamic System with Using PSD Controller

The temperature in thermodynamic system was set to 28 °C. To reach a given temperature we used as a heat source bulb, and if it is exceeds the value 28 ºC fan begins to operate. Length of the duration of regulation was 5.75 hours. Sampling time was TVZ = 30s. For to obtain the best criteria of quality control were experimental coefficients PSD controller set as follows:
k = 20
Ti = 10 600 s
Td = 100 s.

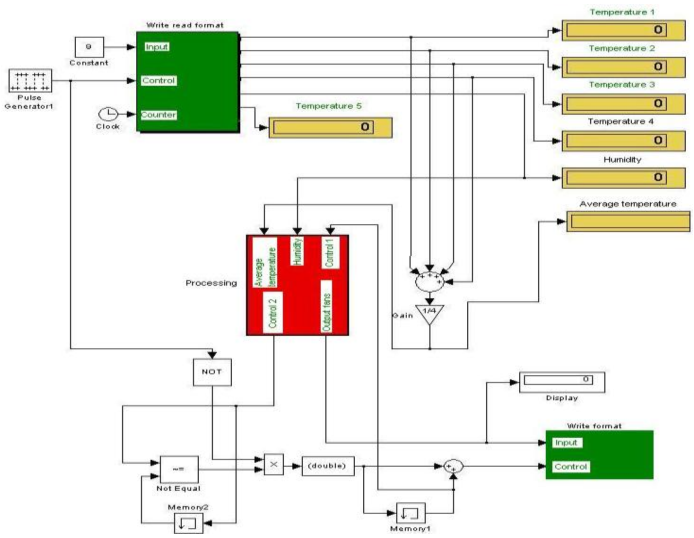


Fig. 5 The control scheme for PSD regulation

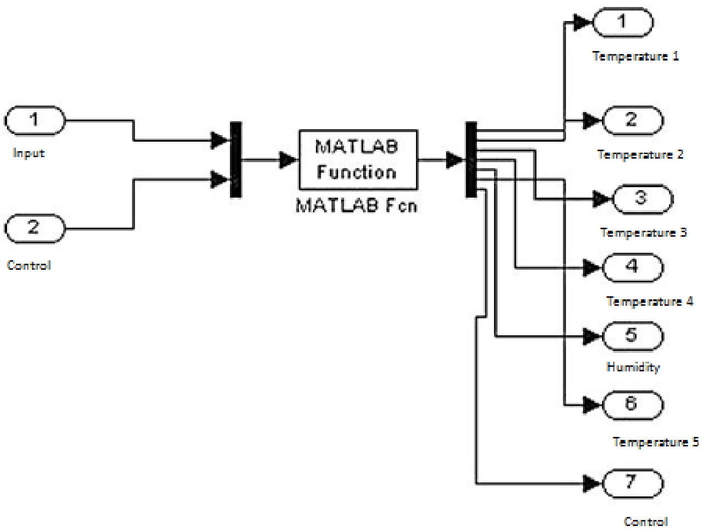
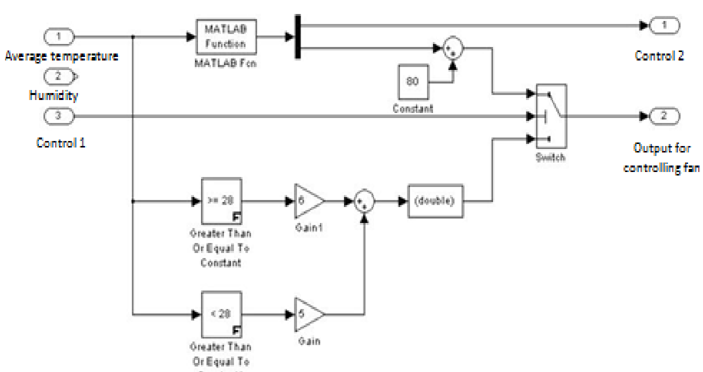


Fig. 6 Block diagram for block "Write-read format"



Control program for block "Write-read format":

```
function vystup=write_read(vstup,i)

size=32;              %number of characters you want to receive%
kon=0;
if i==1             %control - if we add value 1, so ongoing writing and
reading %
   vstup=vstup+48;      %adding - value 48 is for transfer input
information into ASCII code %
   s = serial('COM5');    %COM5 port initialization%
   s.BaudRate=19200;
   fopen(s);            %open port%
   fwrite(s,vstup);      %sending variable "input" to the port%
   [vystup,o] = fscanf(s,'%f,%f,%f,%f,%f,%f,%f\n',size);  %port scanning;
fscanf (port, data, number of characters))%
   time1=clock;

   if o~=size          %determining whether the scanned information has a
given number of characters%
      load udaje.txt;   %If input information has no adequate the number
of characters, from the file is read prior information%
      vystup=udaje;     %sending of information to the "output"%
   else
      f3=fopen('udaje.txt','w'); %if the input information has adequate
number of characters, writes this information it to a file%
      fprintf(f3,'%f %f %f %f %f %f %f',[vystup(1) vystup(2) vystup(3)
vystup(4) vystup(5) vystup(6) kon]);
      fclose(f3);

      f4=fopen('vysledky.dat','a');
      fprintf(f4,'%f %f %f %f %f %f %f %f %f %f %f %f %f\n',[time1(1)
time1(2) time1(3) time1(4) time1(5) time1(6) vystup(1) vystup(2)
vystup(3) vystup(4) vystup(5) vystup(6) vystup(7)]);
      fclose(f4);

      k=dir('vysledky.dat');
      filesize=k.bytes;
      if filesize>=100000
         str=datestr(time1,30);
         movefile('vysledky.dat',str,'f');
         movefile('D:\Vyskum\DN10\*.','D:\Vyskum\DN10\vysledky');
      end
   end
fclose(s);            %closure port%
delete(s);
end
if i<0.1             %If the control = "0", system reads information from a
file wherein information is stored from the last load of variable%
   load udaje.txt;
   vystup(1)=udaje(1);
   vystup(2)=udaje(2);
   vystup(3)=udaje(3);
   vystup(4)=udaje(4);
   vystup(5)=udaje(5);
   vystup(6)=udaje(6);
   vystup(7)=udaje(7);
end
```

Control program for block “Processing”:

```
function riad=PSD(x)
global en1 en2 un1 percenta1
K=20;
Ti=10600;
Td=10;
Tvz=30;
w=28;
norma=5;

en=w-x;      %Calculation of control error%

if en~=en1
a0=K*(1+(Td/Tvz));
a1=-K*(1-(Tvz/Ti)+2*(Td/Tvz));
 a2=K*(Td/Tvz);

   %Equation of PSD regulator for the approximation of integrals%
   deltau=a0*en+a1*en1+a2*en2;

   un=un1+deltau;
    percenta=abs((un/norma)*100);
    per=round(percenta);
    if per>100
      per=100;
   end
   en2=en1;
   en1=en;
   un1=un;
   percenta1=per;

   riad(1)=un;
   riad(2)=per;
end
if en==en1
   riad(1)=un1;
   riad(2)=percenta1;
end
```

In this measurement, we only set values and started measuring. Not performed no optimization of PSD controller. Measurement results are in Figure 8.

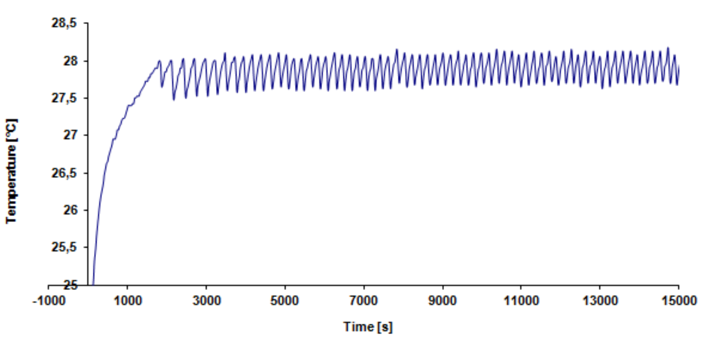


Fig. 8 Process of temperature using PSD controller

Scope at given setting is 0,525 °C. For this measurement shows that PSD controller which was not optimized, behaves like the two-state control. Value ranges for the two-state regulation was 0.65 °C. This means that the difference between the PSD regulation and the two-state regulation is negligible. Value of the difference ranges between regulators is 0,125 °C.

V. DISCUSSION

Energy efficiency enhancement is achieved by utilizing control algorithms that reduce overshoots and undershoots as well as unnecessary fluctuations in the amount of energy input to energy consuming systems during transient operation periods. It is hypothesized that application of control methodologies with characteristics that change with time and according to the system dynamics, identified as dynamic energy efficiency measures (DEEM), achieves the desired enhancement [1]. Computer in the role of PSD controller is able to work only if the controlled variable y (t) is sampled at certain points in time, and only in these moments will calculate the value of manipulated variable. In order discrete PSD controller was able to regulate the output variable as with continuous PID controller, it is necessary derivative and integral (continuous functions of time) using approximation methods to replace with using discrete functions in such a way that faithfully mimic continuous functions [6]. Also, one of the central issues in discrete control is the length of the sampling period TVZ that indicates how much time can be controlled variable without tracking and controlled system without the intervention action. It can be assumed parallels. If controlled system has a larger time constants, the sampling period may be greater [3].

Equation of PSD controller was compiled with using approximating. By using PSD regulation the value of the power bulb and fan is changed depending on the desired temperature in a thermodynamic system. By using PSD regulation, we ensure both conditions. That is, the controller is able to ensure the desired temperature at a preset interval, and was able to more accurately respond the caused disorders.

VI. CONCLUSION

The design of control algorithms is the most important part for ensuring a high quality of regulator processes. Control algorithms with simple modulating controllers proportional, integral and derivative-type (PID) played an important role in the early stages of development automation. In many applications of controlling still we faced with discrete PSD regulators. But with the development of production of integrated circuits with high integration elements arose relatively new structure of governance processes with using microprocessors and microcomputers, called decentralized control. If the computer assumes the function of a discrete regulator and acts directly on the regulated process, thereafter such a method of management we called direct digital control. The design of control algorithms is the most important part for ensuring a high quality of regulator processes.

VII. REFERENCES

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