THE CONTROL OF THE CRAB POSITION BY DUAL

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ABSTRACT

The topic of this paper is the design of the model of the crane, its description by the help of differential equations and the suggestion of the position controller. The next I'd like to show the suggestion of the algorithm for the drive and the regulation of the load-position (peak value). From this reason there are used classic PID controller, neuro-fuzzy controller and learnt neural network. In this paper is shown the variant with neuro-fuzzy regulator.

1 THEORETICAL PART

1.1 THE DIAGRAM OF THE CONTROL LOOP

Wiring diagram of the control loop (see fig. 3) is consisted of these parts:

- the servo-drive operates the crab travel of the crane system. On the crab is placed CCD camera. With the help of this camera we can scan the information about the load and then move it into PC1. Here is computed the position of the load and then by RS232 to move this information into PC2. There is the algorithm in PC2 for the drive and the regulation of the peak value of the load. Thanks this algorithm we can control the speed-value of the servo-drive (is controlled from control system DUAL). The connection between PC2 and DUAL is made by RS232.

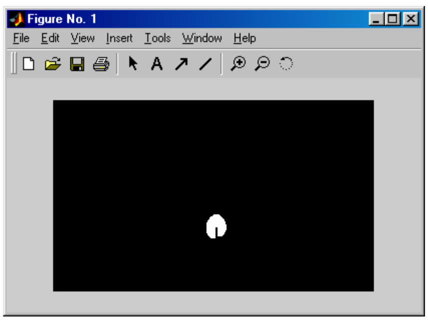

Fig. 1: *The scanning of the load*

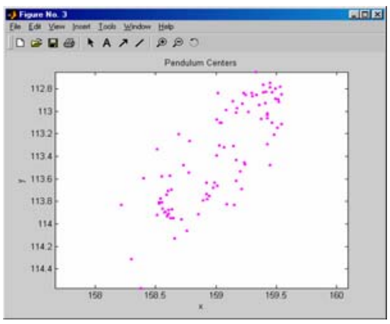

Fig. 2: *The position of the load*

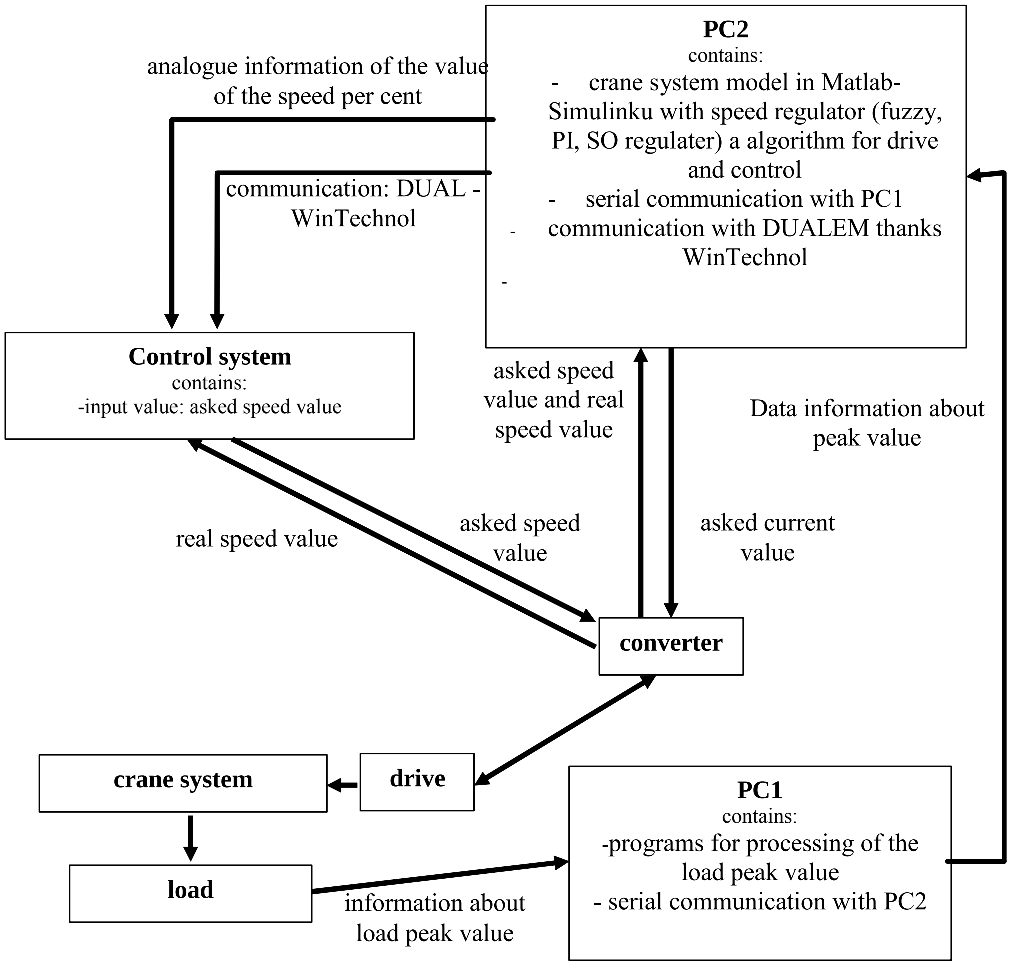

Fig. 3: *The crane*

1.2 THE COMPUTER VISION

The processing of computer vision is taken in program MATLAB. For input of data from CCD camera is used IMAGE ACQUISION TOOLBOX. By the help of the program VYKYV.MAT [1] is got the information about the load and is also computed here the position of the load. (See fig. 1 and 2).

1.3 THE SUGGESTION OF THE ALGORITHM FOR THE DRIVE AND THE REGULATION

For the suggestion of the algorithm for the drive and the regulation of the speed-value of the servo-drive (it drives the crab) we are used equations [2]. For these equations were generated model in MATLAB – SIMULINK. Thank this model and [2] are computed the values shown in Tab. 1 and Tab.2. For the check we used the real-system. Simulations were used for the cable length: 40 cm and 92 cm. Due to these measurements we learned the speed-value of the servo-drive. We have to set up the constant R407 [3] in the value 150.000.

Degree α - counted from equation	Pixels – max and min peak value	F%	Speed	Speed in Matlab	R407	Pixels equal with F%	Pixels – difference (max-min)	Degree equal with pixels
0,186	158,5-161,22	1	9,8	0,0062	150.000	310	2,72	0,18
0,93	154,78-168,38	5	49	0,031	150.000	302	13,6	0,9
2,04	145,66-175,66	11	108	0,069	150.000	290	30	1,985

Tab. 1: *Computed values for the length of the cable 92 cm*

Degree α - counted from equation	Pixels – max and min peak value	F%	Speed	Speed in Matlab	R407	Pixels equal with F%	Pixels – difference (max-min)	Degree equal with pixels
1,22	158,3-161,9	1	9,8	0,0062	150.000	310	3,6	1,314
6,1	150,1-168,13	5	49	0,031	150.000	302	18,03	6,57
13,6	139,7-179,6	11	108	0,069	150.000	290	39,75	14,5

Tab. 2: *Computed values for the length of the cable 92 cm*

Using the values from tab. 1 and tab. 2 we can suggest the drive and the regulation algorithm.

$$92 - 40 = 52 \qquad 92/52 = 0{,}0175 \tag{1),(2}$$

$$3{,}17 - \left(\left(\left(rope.\ real\ value\right) - 40\right) * 0{,}0175\right) = first\ value \tag{3}$$

$$2{,}65 - \left(\left(\left(rope.\ real\ value\right) - 40\right) * 0{,}0125\right) = second\ value \tag{4}$$

$$Fx\% = second\ value\ - \left(x-1\right) * first\ value = \max.peak.\ value\ for.\ rope\ length\ and\ F\% \tag{5}$$

$$Pixels = 312 - F\% * 2 \tag{6}$$

For the known length of the cable with the load and required angle, which we cannot get over, we have to compute the range in the pixels for which the condition is realized. Then we transfer the values (1-6). The result is: maximal ratio of the speed-value of the servo-drive (F%).

By the overrun of the peak value (the action of the disturbance variable), we have to react on this situation. Therefore the regulation is also implemented in the model. The information from CCD camera is used for feedback. The whole suggestion is in: (7-20).

$$1{,}32 * F = \deg ree \qquad \frac{dergee}{1{,}32} = F \;\; asked \tag{7),(8}$$

$$\frac{14{,}5}{11} = 1{,}32 \qquad \frac{1}{1{,}32} = 0{,}75F \tag{9), (10}$$

$$\frac{1{,}985}{11} = 0{,}18 \qquad 0{,}18 * F = \deg ree \tag{11), (12}$$

$$5{,}5 - 0{,}75 = 4{,}75 \qquad \frac{1}{0{,}18} = 5{,}55F \tag{13), (14}$$

$$0{,}18 * F = \deg ree \qquad Fx = 0{,}75 + X * 0{,}091 \tag{15), (16}$$

$$\frac{4{,}75}{52} = 0{,}091 \qquad x = rope.\; real\;\; length - 40 \tag{17), (18}$$

$$asked\;\; pixels\;\; value \;\; = \frac{fourth\;\; value + (Fx - 1) * third\;\; value}{2} \tag{19}$$

$$F1\% = 9{,}25\;\; ot/\min \tag{20}$$

2 THE RESULTS OF THE REGULATION

2.1 CRAB TRAVEL WITH VARIABLE LENGTH OF THE CABLE WITH THE LOAD

In the first experiment we use drive algorithm. The conditions are:

- the peak value of the load is not measured by CCD camera; the crab travel: 0-72 cm; in the experiment we change the length of the cable from 92 to 40 cm; maximal peak value: 5 degrees; for this length and the max peak-value is F%=25 = 231,15 ot/min.

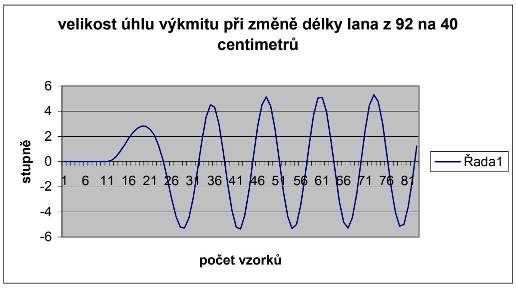

Fig. 4: *The peak-value*

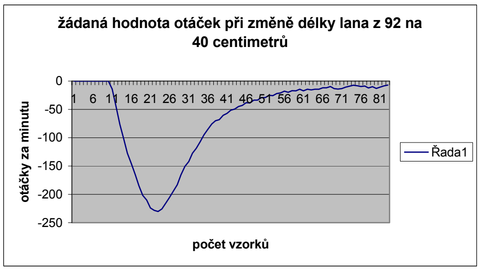

Fig. 5: *The speed-value*

As we can see (see fig. 4) the system reacted on the change of the cable-length very good and the peak value was not overrun. On the fig. 5 we can see the speed-value.

In the second experiment we also use CCD camera for feedback. . The conditions are:

- the crab travel is 0-72 cm; the length of the cable = 55 cm, maximum peak value 3 degrees = 7,7 pixels; for this length and max peak value is F%=3,75 = 34,68 ot/min.; into the system we bring on purpose the speed-value, which is higher than F% = 3,75 (creation of the disturbance variable), F%=14 = 131,8 ot/min. This speed-value is for 10 degrees (2*25,88 pixels); regulator reacts on this situation in the peak value 3 degrees

Fig. 6: *The speed-value*

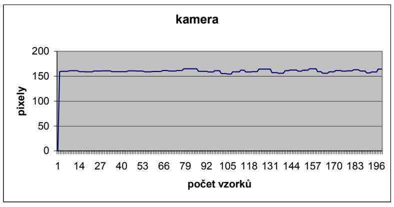

Fig. 7: *The peak-value from the CCD camera*

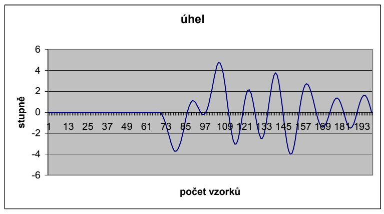

Fig. 8: *The peak-value*

As we can see (see fig. 8) , the system reacted on the disturbance variable without any problem and the peak-value (5 degrees) was not overrun. On the fig. 7 we can see the values of the load position (in pixels) from the CCD camera.

ACKNOWLEDGEMENTS

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[2] Přikryl, L.: The modern manners of the regulation, Plzeň 2003

[3] www.mefi.cz