THE CONTROL OF THE CRAB POSITION BY DPL TOOLKIT

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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. It acts about the suggestion of the state position controller.

1 THEORETICAL PART

1.1 THE EQUATIONS OF THE CRANE

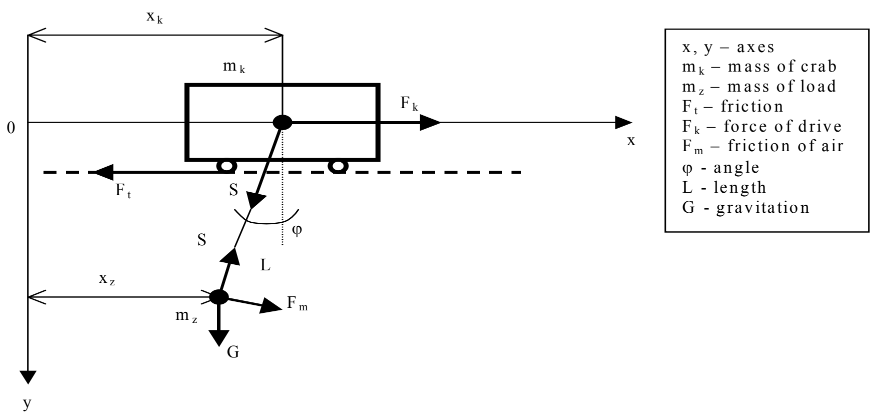

Fig. 1: *The crane*

Assuming that the cable and crane are not flexible, that the center of gravity of the payload is located at L, that there is no damping or other dissipative forces (there are include by the derived of the equations, which describe behaviour of the system, but there are neglect in solution) and that there is motion in only one plane, then the equation governing the physical behavior of the pendulum system can be easily derived. Analytical identification of the model of the crab travel comes out from the force analysis according to Fig.1, from which we can deduce the equation of the crab travel.

$$m_k \ddot{x}_k = F_k - F_t - S\sin\varphi \qquad (1)$$

Now consider applying Newton's second law to the payload.

$$m_z \ddot{x}_z = S\sin\varphi - F_m \sin\varphi \qquad m_z \ddot{y}_k = -S\cos\varphi + m_z g - F_m \sin\varphi \qquad (2,3)$$

The equations for angle of the misalignment of the payload are determined thanks relationship between coordinates.

$$x_z = x_k - l\sin\varphi \qquad y_z = l\cos\varphi \qquad (4,5)$$

Take the derivative twice of the equations for the payload (4,5) with respect to time.

$$\ddot{x}_z = \ddot{x}_k - l\ddot{\varphi}\sin\varphi + l\dot{\varphi}^2 \sin\varphi \qquad \ddot{y}_z = -l\ddot{\varphi}\sin\varphi - l\dot{\varphi}^2 \cos\varphi \qquad (5,6)$$

After installment to the equation of the payload (2,3).

$$\begin{aligned} m_z \ddot{x}_k - m_z l\ddot{\varphi}\sin\varphi + m_z l\dot{\varphi}^2 \sin\varphi &= S\sin\varphi - F_m \sin\varphi \\ - m_z l\ddot{\varphi}\sin\varphi - m_z l\dot{\varphi}^2 \cos\varphi &= -S\cos\varphi + m_z g - F_m \sin\varphi \end{aligned} \qquad (6,7)$$

We will obtain non-linear differential equations for the positional coordinates x and Φ

$$\ddot{\varphi} = \frac{F_k\cos\varphi - F_t\cos\varphi - F_m\cos^2\varphi - m_z l\dot{\varphi}^2\sin\varphi\cos\varphi - (m_z + m_k)g\sin\varphi + (m_z + m_k)\frac{F_m}{m_z}}{l(m_z + m_k) - m_z l\cos^2\varphi}$$

$$\ddot{x} = \frac{F_k - F_t - m_z l\dot{\varphi}^2\sin\varphi - m_z g\sin\varphi\cos\varphi}{m_z + m_k - m_z l\cos^2\varphi} \qquad (8,9)$$

Make the assumption that φ and dφ/dt are small, thus

- small φ implies that cosφ ≈ 1 and sinφ ≈ φ
- dφ/dt small implies that $(d\varphi/dt)^2 \approx 0$

Using assumptions above, equations (14, 15) now become respectively:

$$\ddot{\varphi} = \frac{F_k - F_t - F_m - (m_z + m_k)g\varphi + (m_z + m_k)\frac{F_m}{m_z}}{m_k l} \qquad \ddot{x} = \frac{F_k - F_t - m_z g\varphi}{m_k} \qquad (10,11)$$

2 PRACTICAL SOLUTION

2.1 THE DESCRIBE OF REAL CRANE SYSTEM

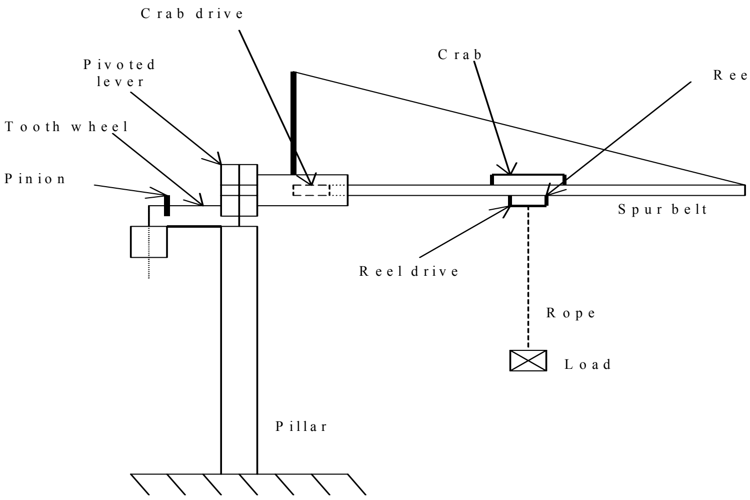

Fig. 2: *The model of the crane system*

The servodrive of the crane movement is formed by AC-servomotor, type M-256-E by firm VUES Brno s.r.o. For this type of motor is chosen frequency invertor UNI 1205 by firm Control Techniques s.r.o. with application modul UD70. The application programs for control UD70 are created in DPL Toolkit (see fig.3.).

The most important part is obtained of peak value. This problem is solved by CCD camera, situated on crab crane.

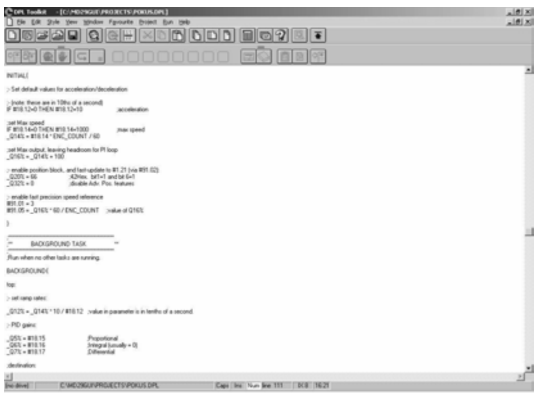

Fig. 3: *DPL Toolkitu*

2.2 COMPUTER VISION

The processing of computer vision is taken in program Matlab. For input of data from CCD camera is used Image Acquision Toolboxu:

vidobj = videoinput('winvideo', 1);

preview(vidobj)

snapshot = getsnapshot(vidobj);

- take a picture of space and change it to matrix of data

For processing the pictures is used Image Processing Toolboxu.

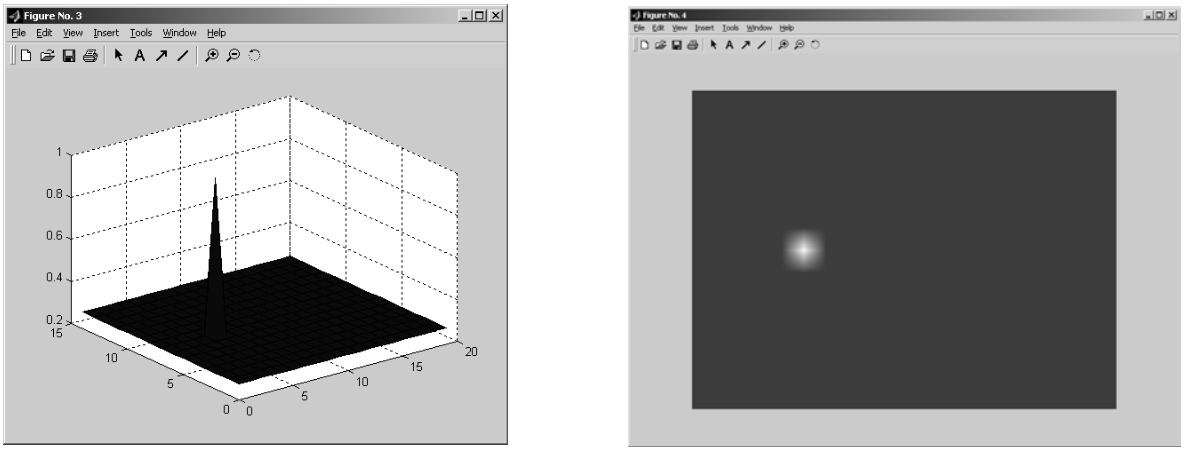

Fig. 4: *Histogram, Modified picture*

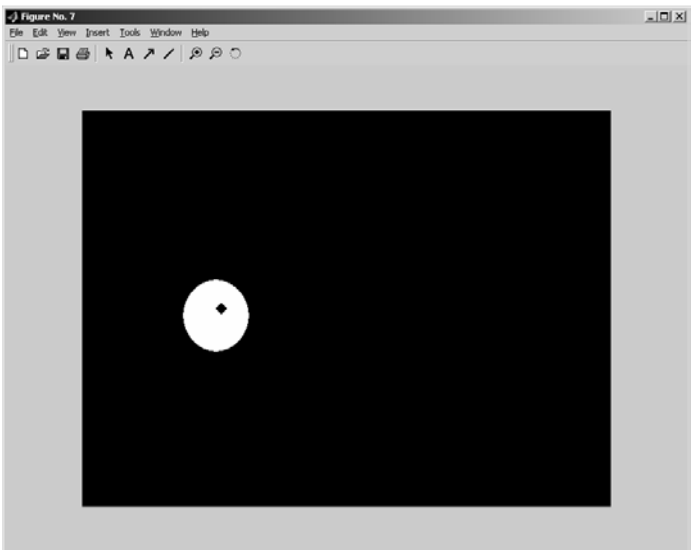

Fig. 5: *Thresholded picture*

Finally we can extract the picture into parameters in axis:

Centroid: [162.3743 249.1811]

The communication between UNI 1205 and the computer is done by RS-232. The dates of angle are structured into the off-set position of the position regulator in UNI 1205 and thanks this we can affect the value of the angle.

ACKNOWLEDGEMENTS

The paper has been prepared as a part of the solution of project No. IS-422216.

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