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GENERAL ALGORITM FOR THE DYNAMIC CALCULUS OF THE PLANAR MECHANISMS WITH CLEARANCES

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ABSTRACT

The present paper shows an general algorithm for dynamic calculus of the planar mechanisms with clearances. In the dynamic calculus of the planar mechanisms with clearances steps we meet many difficulties due to the complexity of the moving equations solving and results interpretation. In the followings paragraphs will be presented a general algorithm to solve this kind of problems based on the Lagrange equations for the non-holonomic constraints. The Lagrange equations, for the non-holonomic constrains, are given in the equation (1):

$$[B]\{\dot{q}\} = \{C\} \tag{1}$$

On obtains:

$$[M]\cdot\{\ddot{q}\} = \{F(q,\dot{q},t)\} + [B]^T\cdot\{\lambda\} \tag{2}$$

By derivation of the relation (1) on obtains equation (3):

$$\{\ddot{q}\} = [M]^{-1}\cdot\{F\} + [M]^{-1}\cdot[B]^T\cdot\{\lambda\} \tag{3}$$

$$[B]\cdot\{\ddot{q}\} = \{\dot{C}\} - [\dot{B}]\cdot\{\dot{q}\} \tag{4}$$

Substituting (3) into (4) results:

$$[B]\cdot[M]^{-1}\cdot\{F\} + [B]\cdot[M]^{-1}\cdot[B]^T\cdot\{\lambda\} = \{\dot{C}\} - [\dot{B}]\cdot\{\dot{q}\} \tag{5}$$

and using following notations

$$[M]^* = \left[[B]\cdot[M]^{-1}\cdot[B]^T\right]^{-1} \tag{6}$$

$$\{A_1\} = [M]^*\{\dot{C}\} - [M]^*[\dot{B}]\cdot\{\dot{q}\} - [M]^*[B][M]^{-1}\{F\} \tag{7}$$

on deduces the Lagrange multiplications matrix:

$$\{\lambda\} = \{A_1\} \quad (8)$$

If on denotes:

$$\{A\} = [M]^{-1}\{F\} + [M]^{-1}[B]^T\{A_1\} \quad (9)$$

on obtains the second order differential equation

$$\{\ddot{q}\} = \{A\} \quad (10)$$

which based on the notations:

$$\{q\} = \{Z_1\}; \{\dot{q}\} = \{Z_2\} \quad (11)$$

it reduces to the first order differential equations system

$$\begin{cases} \{\dot{Z}_1\} = \{Z_2\} \\ \{\dot{Z}_2\} = \{A\} \end{cases} \quad (12)$$

This system can be solved numerically using the fourth order Runge-Kutta method if are given the initial conditions (13):

$$t = 0, \{Z_1\} = \{Z_1^0\}, \{Z_2\} = \{Z_2^0\} \quad (13)$$

On considers the crank-slider mechanism OAB presented in the figure 1.

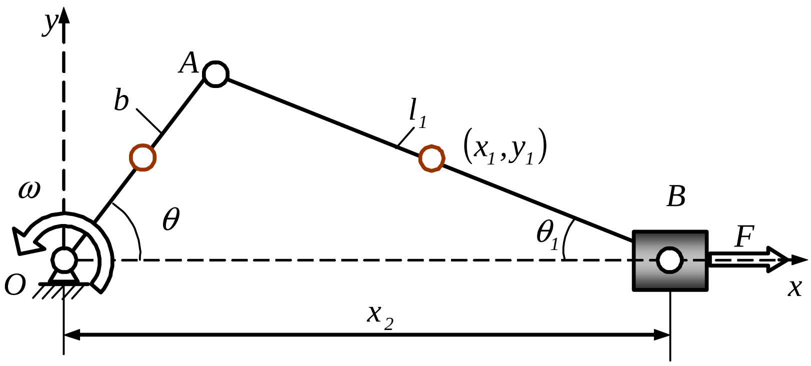

Fig.1. The crank-slider mechanism without clearance.

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