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Nonlinear optimization of the crane movement in the transient mode

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Statement of the Problem: Optimal control problems of tower, bridge and overhead cranes provide the basis for developing the effective control systems. Practical importance of optimal control problems is connected with increasing of cranes' productivity, energy efficiency and reliability. A wide range of methods have been used in the studies of the optimal control problems: principle maximum, dynamical programming, controllability function method, reduces the original problem to the nonlinear programming problem. One of the features of the optimal control problem is criterion. For instance, requirement of increase the energy efficiency leads to the necessity of utilizing the nonlinear criterion. Such problem has not been previously studied. The purpose of this study is to obtain optimal law of tower crane carriage motion according to nonlinear energy criterion.

Methodology & Theoretical Orientation: In the investigation the two-mass dynamical model has been used (one mass represents the carriage, another – the cargo). The optimization criterion was root-mean-square power of the carriage drive during the start-up mode. The initial conditions of the system correspond to the rest state. The final conditions describe steady velocity of the masses with no oscillations of the cargo. The optimal control function was a scalar multiplication of the state vector and the vector of coefficients to find. In order to find them the modification of PSO technique was used.

Findings: The plots, which have been built in the figure 1, clearly show that found optimal control transmits the system from origin (initial state) to the point of desirable final conditions and does not cross the boundary of the domain. Conclusion & Significance: Obtained results allows for decreasing the energy losses in the tower crane drive. In addition, the developed approach has clearly showed its efficiency for the complicated nonlinear problem solving.

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