Shaping the Trajectory of the Billiard Ball with Approximations of the Resultant Contact Forces

Grzegorz Kudra, Michał Szewc, Igor Wojtunik, and Jan Awrejcewicz

Łódź University of Technology, Poland

Abstract: In the work there are presented mathematical models of the contact pressure distribution on a circular contact area and the corresponding rolling resistance, where Hertzian pressure distribution is distorted in a special way in order to move its center outside the geometrical center of the contact area. Then assuming a fully developed sliding and classical Coulomb friction law on each element of the contact, integral models of the total friction force and moment reduced to the contact center are given. In order to improve the convenience of use of the contact models in numerical simulations of rigid body dynamics and decrease their computational cost, there are proposed special approximations of the integral models of friction force and moment. Moreover special modifications of the corresponding expressions for friction forces and rolling resistance are proposed, allowing to avoid their singularities for vanishing relative motion of the contacting bodies. Then the application of the proposed contact models in mathematical modelling of a rigid ball rolling and sliding over a deformable table is presented. Then possibilities of use of the developed simulation models in shaping the billiard ball's trajectory are presented.

Keywords: friction modelling, Coulomb-Contensou model, parameter's optimization, shaping the ball's trajectory