# VIDEO ANALYSIS OF THE ROTATIONAL MOTION OF A CYLINDER USING TRACKER

JOZEF KÚDELČÍK, PETER HOCKICKO AND MÁRIA KÚDELČIKOVÁ
*University of Žilina, Žilina, Slovakia*
*E-mail: jozef.kudelcik@uniza.sk*

Contribution is focused on the rotational motion of a cylinder, which represents one of the simplest types of rotational motion. Using video analysis in Tracker [1], the key characteristics of this motion, such as the rotation angle, angular velocity, and angular acceleration, are analyzed and explained [2]. Tracker is a free video analysis and modeling tool built on the Open Source Physics Java framework and is widely used in physics education. It enables students to analyze real experiments through video recordings and to extract quantitative data from them. Based on these data, students can determine the time dependence of physical quantities describing the observed motion. The software can be effectively used both by students in physics seminars and by instructors during lectures to illustrate key concepts and demonstrate the relationships between physical quantities.

Rotational motion is typically introduced in the first year of university physics courses, at a stage when students have already mastered the kinematics of motion in one and two dimensions. Through the video analysis of the uniform rotational motion of a cylinder, the relationships between the physical quantities describing this motion in both polar and Cartesian coordinate systems are clearly demonstrated. However, rotational motion is usually presented only as rotation about a fixed, immobile axis. With the aid of video analysis, it is possible to extend this understanding to the uniform rolling motion of a cylinder on a plane, which combines the translational motion of the center of mass with its rotational motion about that point. The analysis of the center of mass motion employs a uniformly moving coordinate system associated with this point. The final part of the analysis is focused on a cylinder rolling down an inclined plane, where it is necessary to apply previously acquired knowledge of accelerated motion. The rotational motion of a cylinder is further analyzed for different angles of inclination of the plane. For students with prior knowledge of rigid body dynamics, the relationships between kinematic quantities and rotational kinetic energy are also demonstrated, including the connection between angular velocity and the moment of inertia, as well as the role of energy conservation during rolling motion without slipping. In this context, video analysis provides an effective link between theoretical studies of motion and their real-world applications.

[1] https://opensourcephysics.github.io/tracker-website/
[2] J. Kúdelčík, P. Hockicko and M. Kúdelčíková (2022). The application of program Tracker at the analyse of rotation motion, ELEKTRO 2022, Krakow, Poland, pp. 1-4.

Acknowledgments
This work was supported by the Slovak grant agency KEGA through projects no. 006ŽU-4/2024, 003TU Z-4/2024.