POLITECHNIKA ŚLĄSKA

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PRZEKSZTAŁCENIE JEDNORODNE W ANALIZIE I MODELOWANIU UKŁADÓW ODZYSKIWANIA ENERGII

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HOMOGENOUS TRANSFORMATION IN THE ANYLYSIS AND MODELING OF THE ENERGY HARVESTING SYSTEMS

Summary

Energy harvesting research is caused by the need to produce energy providing a continuous supply to autonomous systems, reduce the environmental pollution and the systems operating costs. Energy harvesting systems convert energy harvested from external sources into electricity. However the amount of harvested energy is often not sufficient to provide continuous supply to autonomous systems. Therefore such systems have to be optimized, often by the computer simulation, in order to determine the shape, weight, location or resonant frequency.

Main objective of the work involved unification of the mathematical description of the energy harvesting models by their representation as the kinematic chains of a manipulator. The aim of the work was to prove possibility of a homogenous transformation application in the motion description of the energy harvesting system elements.

In the paper a new way of the mathematical modeling of kinetic energy harvest systems was presented. In the modelling the homogeneous transformation known in robotics and the Denavit-Hartenberg notation were used to obtain equations of the motion. Systems, such as a buoy that harvest energy from the wave motion, a wheel with an element that harvest energy from road roughness, and a magnetic spring that harvest energy from vibrations, were presented in the form of kinematic chains. The possible movements were presented by prismatic and rotational joints. Additionally the external force and potential energy forces acting on the systems were analyzed. The form of the Euler-Lagrange equation was used to derive equations of the motion of energy harvesting systems. These equations were further implemented in the Matlab/Simulink program. The results of simulation and physical experimentation were compared.

The results of simulation and experimental tests has confirmed that it is possible describe the energy harvesting system by their representation as kinematic chain with proper combination of joints and using a homogeneous transformation. This modeling method provides unification of the mathematical description of energy harvesting systems and allows to optimized them.