Sit-to-Stand and Stand-to-Sit Control Mechanisms of Two-Wheeled Wheelchair

N. M. Abdul Ghani
Faculty of Electrical and Electronics Engineering,
Universiti Malaysia Pahang,
Pekan Campus,
Pekan 26600, Malaysia
e-mail: normaniha.ghani@gmail.com

M. O. Tokhi
Department of Automatic Control
and System Engineering,
University of Sheffield,
Sheffield S1 3JD, UK
e-mail: o.tokhi@sheffield.ac.uk

This paper presents a mechanism for standing and sitting transformation of a wheelchair using a two-wheeled inverted pendulum concept with reduced torque requirement, in simulation studies. The motivation of this work is to design a compact standing mechanism to help an elderly/disabled person with functional limitation in lower extremities to maneuver in small and confined spaces and enable them to perform standard daily life routines independently. The wheelchair system at the upright standing position is tested with different travel distances, and the challenge is to control both sit-to-stand and stand-to-sit operations in a stable manner using flexible-joint humanoid. An additional spring/damping element is incorporated at each wheel to provide a comfortable ride for the user especially during stand-to-sit transformation task. A PD-fuzzy control with modular structure is implemented, and the performance of the system is observed through VISUAL NASTRAN 4D (VN4D) visualization software and simulation in MATLAB. The stand-to-sit performance tests have shown more than 38% reduction in tilt and back seat angles fluctuation in linear travel motion using a suspension system, while the initial tilt torque needed is 50% less than the amount required in previous designs. [DOI: 10.1115/1.4032800]

Keywords: reconfigurable wheelchair, sit-to-stand, stand-to-sit, PD-modular fuzzy logic control