https://doi.org/10.7250/CONECT.2024.074

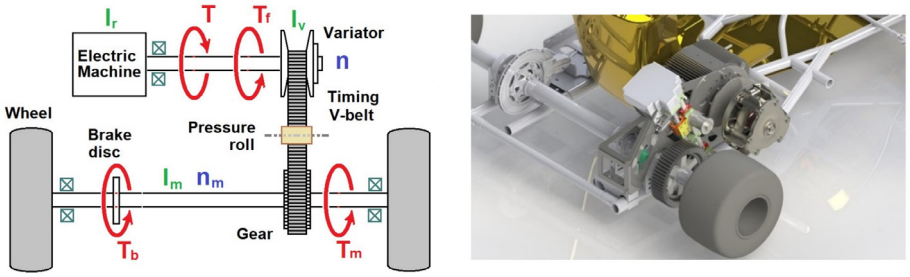
STEPLESS TRANSMISSION OPTIMIZATION FOR GREEN MICROMOBILITY

Andris MARTINOVS[1], Antons PACEJS[2], Andris MARTINOVS Jr.[3], Ērika TEIRUMNIEKA[4*], Josef TIMMERBERG[5], Dāvis ĀBOLIŅŠ[6], Guntis KOĻČS[7], Edgars ZAICEVS[8]

[1–4, 6–8] *Rezekne Academy of Technologies, Atbrīvošanas Aleja 115, Rezekne, LV-4601, Latvia*
[5] *Jade University of Applied Sciences, Friedrich-Paffrath-Straße 101, 26389 Wilhelmshaven, Germany*
[*] ***Corresponding author.*** *Email address: Erika.Teirumnieka@rta.lv*

Abstract – Small, electrified vehicles are becoming possible for urban environmental mobility due to their environmental performance, including zero-emission driving. Vehicles of this type use electric motors as sources of mechanical energy. Today, two types of transmission are most used in electrical micromobility vehicles (skateboards, scooters, tricycles, quadricycles, mopeds, motorcycles, go-karts, etc.): chain transmission and belt transmission. This transmission types provides a constant gear ratio that can only compromise between the maximum speed and the starting torque values, thus reducing the usage efficiency of the engine. This reduces vehicle manufacturers' choice of less powerful drive and control elements, as well as balancing performance and efficiency at low and high speeds and on terrain. A novel design of a continuously variable transmission (CVT) for an electric go-kart is presented in this paper. The CVT consists of an inertial driving pulley mounted on an electric motor shaft, a timing V-belt, a gear wheel on the drive axle and 2 pressure rolls, which are moved by a servo motor for tensioning the V-belt. Gear ratio of a transmission can change seamlessly in the range of 1.5–2.2. The CVT has been tested under real conditions. The top speed of the electric go-kart with the given CVT and motor power 24.7 kW is 133 km/h; time to accelerate to the top speed is 25 s. Total efficiency of the transmission (motor shaft, CVT, drive axle and wheels) is 65–72 % now, but there exist a lot of possibilities to improve it in the future. The conditions under which the novel CVT has an advantage over belt and chain transmissions with constant gear ratios have been studied. The developed mathematical model, the method for determining its constants, the algorithm for numerical calculations and the optimization criterion makes it possible to determine the optimal gear ratio for a vehicle with various CVT (not only belt) at any point in time in different racing modes. The model has been proved experimentally during acceleration and deceleration tests of the go-kart; it describes precisely the motion of the go-kart within the speed measurement error. The developed solution is applicable in urban micromobility. An optimized and stable transmission system focused on energy efficiency, resource saving, using less powerful drive and zero-emission.

Keywords – Continuously variable transmission (CVT); electric vehicle; go-kart; green transport; micromobility



The drive of the go-kart. (A) Schematic of the CVT dynamic model; (B) 3D model of the CVT on the go-kart.

ACKNOWLEDGEMENT

This study is supported by the ERDF project "Continuously variable transmission for electric micromobility vehicles" KC-PI-2020/62 of Investment and Development Agency of Latvia (LIAA).