

Development of an Electrically-Assisted Motor System for Hand Tricycle

Subject: Rehabilitation Engineering

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A hand tricycle is a human powered land vehicle especially for people with spinal cord injuries and paralysis that can be propelled by hand cranking pedals instead of using feet. Hand cycle provides various approaches in rehabilitation for lower limbs paraplegia and helps to prevent complications that may arise due to immobilization. The aim of this project was to develop the motor-assisted hand tricycle with various control patterns.

Introduction

The lower limb paralysis puts the patient at risk for a range of health problems. Disable people need physical rehabilitation in order to strengthen and restore functionality in the muscle groups, skeleton and to improve general health condition and coordination. Hand cycling can provide significant workout and a great sense of freedom for persons with disabilities. Using hand tricycle platform we aimed to build a feedback control system with an electrical motor. This system would be also suitable for rehabilitation of patients with different level of spinal cord injuries and arm's strength. Moreover, this system would allow patients to have decent upper body and cardio training without stressing newly injured body parts.

Methods

A hand sport tricycle (Sopur-Shark) was modified into motor-assisted tricycle. Brushless hub motor 350W from Crystalyte was mounted to front wheel in order to move the entire bike with maximum speed 24 km/h.

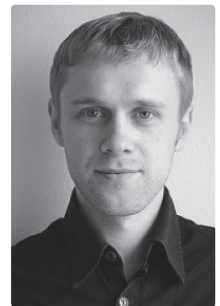


Hand tricycle with an electrical motor

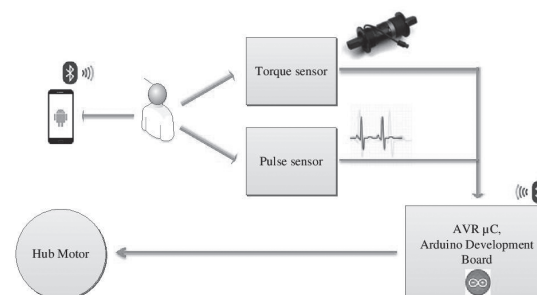
For the control loop and information feedback from a subject we used a torque sensor mounted between pedals. It allowed to obtain adjustable control system related to the force provided by person while cycling. Additionally, we implemented pulse/ heart rate sensor for monitoring the heart rate and condition of the cyclist. The whole system controlled by uC ATmega 2556 based on Arduino ADK development board. Control software was developed in Arduino IDE to control the electrical motor in combination with sensors. For human interface control we use smartphone with Android OS using Bluetooth standard for communication with a controller.

Results

The value of the torque sensor, angular speed and motor power were calibrated. The throttle mode and torque control regime were tested. The pulse/heart beat sensor was added in control loop for electrical motor. First sample of smartphone application was developed with App Inventor 2.



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Control strategy