Bio mimetic actuation, sensing and control technology for Limit Cycle bipedal walkers (ESBiRRo)

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ESBiRRo

Project abstract

The goal of this project is to develop Limit Cycle control and biomimetic recovery reactions for the control of walking, in order to apply these paradigms to design and construct an autonomous walking biped and to improve a robotic exoskeleton for gait support.
Currently, there are biped walking robots made by Japanese companies. These humanoids are based on trajectory control (TC) and its stability is founded on the zero moment point. These robots have two major drawbacks: high energy consumption and small stability margins (unable to walk in fully unstructured environments). In contrast, Limit Cycle controlled (LC) robots, which exploit the dynamics of the mechanical systems (pendulum behaviour of the swinging leg) show lower energy consumption whereas walking stability is comparable to the TC robots. However, the global stability of the LC can be improved with the addition of inertial sensors, a camera and series-elastic actuators, controlled by a Central Pattern Generator (mimicking the central nervous system) which would enable them to react to perturbations (uneven terrains, stumbling over obstacles). Considering that the starting point of the LC robots was inspired on human gait, this project proposes one step further in the evolution of LC robotics: implementing the recovery reactions from perturbations that can be found in biological systems, e.g. human stumble reaction. Thus, advancing current robotic concepts. These new generation robots will keep lower energy consumption than their TC counterparts with improved stability.
The modelling and control of a biped robot will provide further understanding of human gait paving the way for novel actuated orthoses regarded as robotic extensions of the human being: exoskeletons. The construction of a powered ambulatory lower limb exoskeleton will be a breakthrough in the rehabilitation field. It will also provide support devices for ambient assisted living for the ageing society.

It is important to note that as a starting point for the design of the powered exoskeleton we count on the GAIT orthosis developed in the context of a previous European project (GAIT - Intelligent knee and ankle orthosis for biomechanical evaluation and functional compensation of joint disorders. IST-2001-37751 5PM). Although this single-limb knee ankle orthosis is semi-active, it can act as a platform to test new sensori-motor and control systems in order to achieve a complete lower limb exoskeleton or hip-knee-ankle-foot orthosis (see figure 2). In this respect, robotic exoskeletons could evolve outside of industrial environments and serve as support devices for ambient assisted living for the ageing society.

Project Partners:

Instituto de Automática Industrial IAI-CSIC
Delft University of Technology
Ossur HF
Technaid, SL

Project time

Project start: November 1, 2006
Duration: 36 months

Budget

Total budget: 1.737.000 EUR
EU contribution: 900.000 EUR

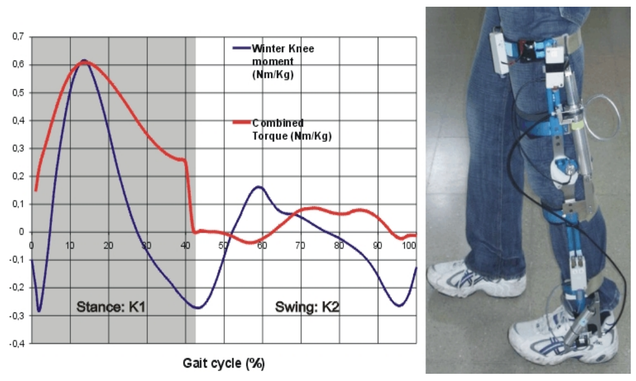

Fig. 2. GAIT orthosis with a torque diagram of the semi-active function during a normal walking cycle.

Fig. 1. "Denise", a pneumatically-actuated Limit Cycle Walker from TUDelft

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