Bio mimetic actuation, sensing and control technology for Limit Cycle bipedal walkers
ESBiRRo: Enhanced Sensory Bipedal Rehabilitation Robot

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Project Objectives

- The aim of the 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 (consortium decision to increase the value of the project).
- General approach through integration of:
  - LC control strategies (reduce energy consumption)
  - Biomimetic reaction strategies (counteract perturbations and enhance stability)
  - Addition of rich sensory information (inertial sensors)
  - Novel bioinspired actuated system
  - Validation of concepts with biped robot and lower limb exo-skeleton

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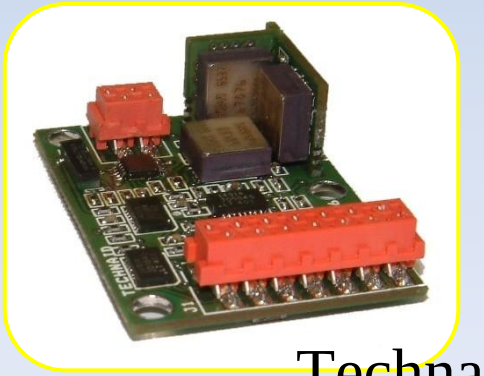
Project background

TUDelft family of bipeds

CSIC, Ossur work on exoskeletons



Technaid family of IMUs

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Technical objectives

- 1. Enhancement of global stability of Limit Cycle bipeds
  - a. Incorporation of advanced actuation
  - b. Inclusion of multiple sensory systems
  - c. Integration of an adaptive (biomimetic) control structure
- 2. Implementation of recovery strategies from gait perturbations
  - a. Review the sensorial and motor control mechanisms of human gait
  - b. Elaboration of sensori-motor control models
  - c. Examine the recovery strategies applied in human gait
- 3. Design and construction of a limit –cycle biped featuring:
  - a. Low energy consumption
  - b. Large stability margins
  - c. Biomimetic motion and recovery reactions

Technical objectives

- 4. Implementation of a limit –cycle control structure on a powered exoskeleton
  - a. Low energy consumption
  - b. Large stability margins
  - c. Biomimetic motion and recovery reactions
  - d. Human performance enhancer
- 5. Prototypes tested and validated

Project dissemination results

- A first poster has been presented at “Icelandic Information Day” organised by the National Research Council of Iceland;
- an invited participation and project presentation at the EURON (European Robotics Network) Annual meeting, held in Crete, Greece;
- a contract has been signed with John Wiley & Sons for the publication of a book entitled “Wearable Robots: Biomechatronic Exoskeletons” partially prepared with the results of ESBiRRo and the previous project GAIT; The manuscript has been submitted, typeset proofs sent for review and corrections proposed. Target publishing date is March 2008, ISBN: 978-0-470-51294-4 (HB).
- D. G. E. Hobbelen, M. Wisse, "Limit Cycle Walking", in book "Humanoid Robots; human-like machines", edited by M. Hackel, 2007, published by Advanced Robotic Systems International, Vienna. Ch.14, pp. 277-294, ISBN: 978-3-902613-07-3.
- Forner-Cordero, A., Moreno, J.C., Cullell, A., Navarro, E., Piedra, I., J.L. Pons, Evaluation of a lower limb exoskeleton for gait enhancemen, 18th International Conference of the International Society for Posture and Gait Research, Vermont, July 14 - 18, 2007.
- A. Cullell, J. Moreno, J.L. Pons, Dynamic simulation of the behaviour of an orthosis for knee and ankle functional compensation during gait, 18th International Conference of the International Society for Posture and Gait Research, Vermont, July 14 - 18, 2007.
- J.C. Moreno, Y. Demiris, J.L. Pons, An hybrid method based on fuzzy inference and non-linear oscillators for control of gait, accepted Biosignals 2008, 25-28 Jan. 2008, Madeira.
- the project website (http://www.iai.csic.es/esbirro) is working since the project starting date.

Project education & training results

- Ongoing PhD work at CSIC on “Biomimetic design of LC bipeds and lower limb exoskeletons” by Juan A. Gallego, Supervisors: J.L. Pons & A. Forner-Cordero.
- Ongoing PhD work at CSIC on “Biomimetic control of LC bipeds and lower limb exoskeletons” by Edyta A. Turowska, Supervisors: J.L. Pons & A. Forner-Cordero.
- Ongoing PhD work at TUDelft by Tomas de Boer.
- M. Sc. Students at TUDelft Daniel Karssen and Jasper Truffino.