Humanoid Robot Control Architecture

INSTITUTO SUPERIOR TÉCNICO
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IDMEC

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Abstract:

In this paper we present the current development status at the Humanoids Robotics Lab of the Department of Mechanical Engineering at Instituto Superior Técnico in collaboration with Robosavvy Ltd. The developments we present include the software development for interfacing the Matlab real time workshop toolbox with the humanoid robot controllers, hardware development towards wireless communication between the local robot controller and the remote PC, the identification of the internal and external dynamic parameter of the humanoid servos and structure respectively, the dynamics modeling and simulation using simMechanics and virtual reality toolbox. Our aim is the development of a humanoid robot able to make complex motions like walking, running and jumping through real-time feedback control techniques.

Related Bibliography

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•C. CARDEIRA, A. W. COLOMBO, R. SCHOOP, 'Wireless solutions for automation requirements', *in ATP International – Automation Technology in Practice, IFAC-affiliated journal, Vol. 2, September 2006, pp 51-58.*
•LENNART LJUNG, 'System Identification: theory for the user', *Prentice-Hall, 1987*
•BHANDERI, D., 'Linux Soft Real-Time Target V2.2', http://www.control.auc.dk/~danji/downloads/, *March 2007*.
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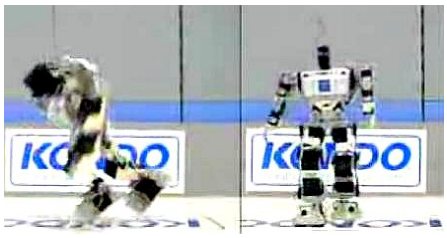
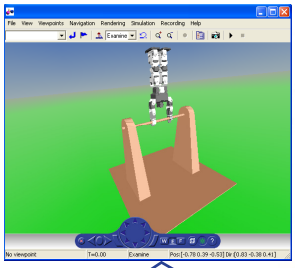
Current Humanoid Control Paradigm - Open Loop Control

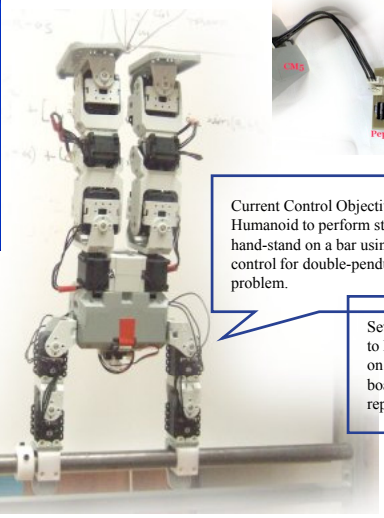


Current commercially available humanoid robots are designed to perform motions using open-loop control providing the users a simple paradigm to create pre-orchestrate multi-DOF walking gaits. These robots are usually not able to move on uneven terrain and it is difficult or impossible to get them to perform movements that require instantaneous reaction to momentary instability. A popular way to compensate for these predicaments is to over-capacitate servo torques and to incorporate large foot soles, low center-of-mass and better shock absorption, resulting in humanoid robots with little resemblance to the human physique. Our long term objectives are to allow affordable humanoid robots to run, skateboard, jump and in general to react in a human-like physical way in dynamically unstable situations and uneven terrain.

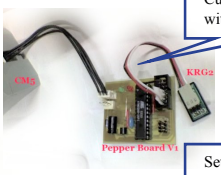
Our 100Hz Closed-Loop Control Bioloid Research Environment



Real-time Simulink 3D Visualization



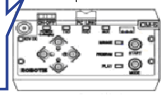
Current Control Objective: Humanoid to perform stable hand-stand on a bar using optimal control for double-pendulum problem.



Custom Sensor Board with Gyro attached

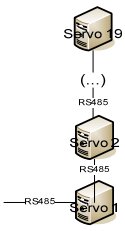
Computer w/Simulink, RTW, Real Time Windows Target

RS232



CM5

Setup1: Robot connected by serial line to PC. Real-Time-Windows Target controls Humanoid.



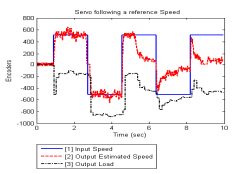
Host Computer w/Bluetooth

Bluetooth

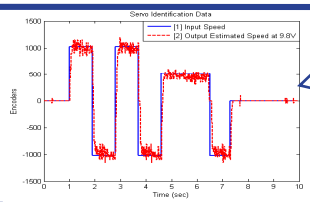
Robostix/Gumstix Pack

Setup2: Robot connected BlueTooth to PC. Real-Time-Linux Target runs on Gumstix Embedded Controler board controls Humanoid and reports to remote PC.

Bioloid System Identification

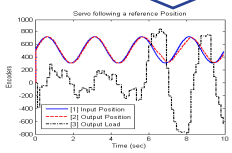


Servo's behavior when in speed control…

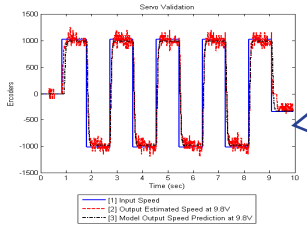


Identification of the AX12 Servo's Speed control mechanism

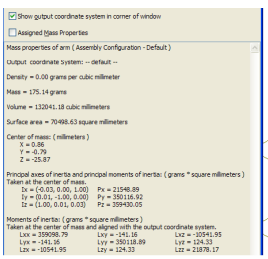
$$TF = \frac{0.06217z}{z^2 - 1.469z + 0.5544},$$

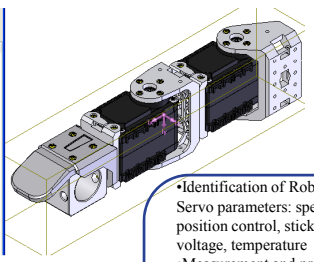


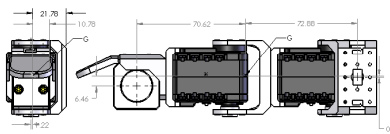
… and in position control



Validation of the identified speed control mechanism Transfer Function







- Identification of Robotis AX12 Servo parameters: speed and position control, sticktion, voltage, temperature
- Measurement and precise modeling of all parts of the Bioloid Kit
- Identification of Mass and Inertial Moment of all Bioloid parts and assemblies
- Latency and speed measurement of serial and BlueTooth communications between PC and robot

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