VISUAL TRACKING ON AN AUTONOMOUS SELF-CONTAINED HUMANOID ROBOT

Mauro Rodrigues
University of Aveiro
Portugal

Vítor Santos
University of Aveiro
Portugal

Filipe Silva
University of Aveiro
Portugal

Speaker: Mauro Rodrigues, Department of Electronics, Telecommunications and Informatics, University of Aveiro, Portugal (mauro.r@ua.pt)

Topic: humanoid, visual servoing and tracking
Keywords: visual tracking, humanoid robotics, autonomous self-contained system

Introduction

Most roboticists, at least among the young community, has certainly dreamed about building a humanoid robot able to move, perceive and possibly act like humans do. The dream has already come true for some people and is promising every day to become true for a broader set of serious enthusiasts, mainly scientists and engineers. Concerning the engineering perspective, the ultimate challenge is certainly related to full real autonomy, both in power and decisions. Current trends in electronics and embedded systems ensure that is it indeed possible with specially developed hardware, but a real extra to the mentioned challenge is to use off-the-shelf (preferably easy to find at low cost) components.

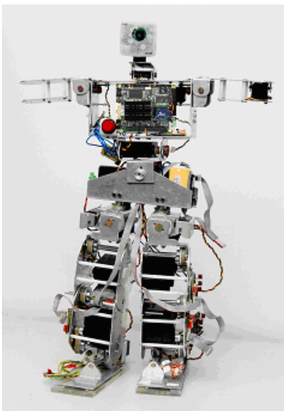
Summary

This paper describes the hardware and software setups that allow a humanoid robot developed from scratch to perform visual tracking based exclusively on onboard components. The robot which was started on earlier projects [1-3] was finally given its full autonomy in what concerns perception and vision capabilities. An embedded PC104-based controller running Linux is now able to interface a IEEE1394 color camera and, using the OpenCV library, can now perform visual tracking of some objects moving on its neighborhood. This embedded controller, besides being responsible for image acquisition and processing, serves as an interface between external monitoring and the distributed control architecture based on a master-multi-slave CAN bus of local controllers for joint actuation and sensor monitoring.

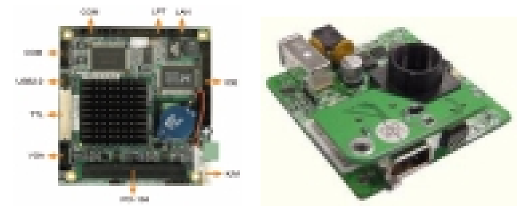
Results

The distributed control architecture relies on a master controller that manages a CAN bus where several slave controllers interface locally all joint control and gathering of all sensor information. This master unit has no superior autonomy on its won since it only keeps the state and maintains dialog with all the slave controllers. Motion directives must be decide by a higher level unit: the central unit. Up to now, that role has been ensured by an external ordinary computer that communicated with the master by means of a serial link. From now onwards, the central unit is embedded in the system making it able to reach complete autonomy, including complex perception such as vision and related algorithms.

The vision system is essentially composed of a low cost FireWire camera yielding images up to VGA resolution in RBG or several compressed (YUV) formats at multiple frame rates (maximum is 30 fps). The camera lies atop a 2-DOF pan-and-tilt system that comprises the "neck" of the robot and is linked to the central unit. The central unit has the following roles: capture images and process them, interfaces to remote monitoring and possibly control and finally communicates with the master controller of the distributed architecture of slave controllers seeded allover the robot's body. This paper describes the hardware and software components of the central and unit, the role of image acquisition and processing, the motion directives to perform visual tracking and several results that show the performance of the system.



Humanoid robot with 22-DOFs



Main central board PC104+ (left) and the vision unit (right)

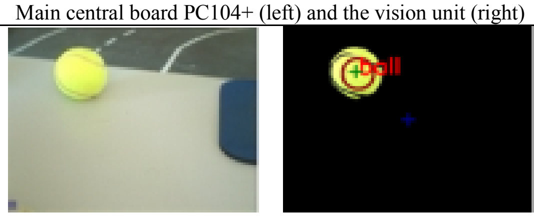


Image acquisition and processing

References

[1] V. Santos and F. Silva, "Design and Low-Level Control of a Humanoid Robot Using a Distributed Architecture Approach", *Journal of Vibration and Control*, Special Issue on Modelling and Control of Artificial Locomotion Systems, vol. 12, nº. 12, pp. 1431-1456 [Online ISSN: 1741-2986; Print ISSN: 1077-5463], December, 2006.

[2] F. Silva and V. Santos, "Multipurpose Small-Cost Humanoid Platform and Modular Control Software Development", book chapter in the publication *Humanoid Robots: Human-like Machines*, [ISBN: 978-3-902613-07-3], edited by Matthias Hackel, 2007.

[3] M. Silva, P. Ferreira, F. Silva and V. Santos, "Local-level Control of a Humanoid Robot Prototype with Force-driven Balance", in *Proceedings of the IEEE/RSJ International Conference on Humanoid Robots*, Nov. 29 – Dec. 3, Pittsburgh, USA, 2007.