



Roma, November 5, 2014

Subject: **The Butterfly robotic prototype developed by Computational Robotics**

It is a real pleasure for me to write this letter concerning the Butterfly robotic prototype developed by the startup company Computational Robotics.

The Butterfly is an archetypal example of underactuated robotic mechanism; i.e., a mechanism in which the number of degrees of freedom exceeds the number of available control inputs. This kind of systems are becoming increasingly popular in robotics in view of the minimalistic trend in the field (more dexterity with less actuators). With respect to other prototypes of underactuated mechanisms that are commercially available (such as the Acrobot and the Pendubot), the Butterfly is unique in that the second degree of freedom does not describe the orientation of a rotating link, but rather the position of a ball rolling along the outer rim of the main body.

From an educational viewpoint, the Butterfly would be an ideal testbed for studying hands-on a number of fundamental topics such as linear and nonlinear dynamics, system identification, motion planning and feedback control. Thanks to the integration of a vision sensor into the control loop, students can also be introduced to the rapidly growing field of visual feedback.

For researchers, the Butterfly represents an exciting scientific challenge. In fact, due to the intrinsic underactuation, innovative approaches are needed to devise trajectory planning and feedback stabilization techniques. Moreover, due to its unique structure, the system is ideal for research in non-prehensile manipulation (throwing, juggling, etc) and acrobatic motion generation (e.g., stabilization of unstable equilibria). Finally, due to the extremely fast dynamics of the ball, the Butterfly is an excellent benchmark for high-speed visual servoing.

In conclusion, I really hope that the Butterfly can be brought to market in a short time. I would definitely recommend its purchase to robotics and control laboratories in view of its originality and potential for both research and education.

Sincerely

A handwritten signature in black ink, appearing to read 'Giuseppe Oriolo'.

Prof. Giuseppe Oriolo  
DIAG Robotics Lab, Director