Mechatronics, an Interdisciplinary Support for Robotics

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***Abstract*—Development of advanced robotic systems involve the capability of exploiting a wide range of different experiences which are conventionally assigned to mechanical, electrical and electronic engineers. Mechatronics is defined as a multidisciplinary science bridging between different competences. For this reason, mechatronics labs offer a fundamental support in developing autonomous robotics systems especially for what concerns unconventional or innovative propulsion systems, sensors and power management systems. In this work author summarizes some of the most significant activities of the mechatronics labs and courses aiming to support the development of innovative autonomous systems at Florence University.**

Keywords—Mechatronics, Propulsion, Smart Actuation Smart Energy Management Systems

I. MECHATRONICS SUPPORT TO ROBOTICS

Development of innovative autonomous systems often requires the adoption of unconventional solutions that regards the way in which vehicle is moved and actuated, and consequently the way in which energy is managed since propulsion and actuation are often the major energy consumptions of a robotic system constraining its motion capabilities and the possibility of completing an assigned mission profiles. For this reason, at university of Florence activities of mechatronics labs are mainly focused on support activities regarding robotics and more generally autonomous systems. These activities started from underwater robotics activities performed on THESAURUS(TecnicHe per l'Esplorazione Sottomarina Archeologica mediante l'Utilizzo di Robot aUtonomi in Sciami) project [1] coordinated by Prof. Benedetto Allotta. As visible in figure 1, for this project, a customized actuation system was designed. This solutions have been further investigated for the development of more complex propulsion layouts, in which also the use of pivoted thrusters to further improve vehicle manoeuvrability features[2]. Further activities on marine robotics supporting development of ultrasound anemometers and testing of autonomous sailing drones [3,4], have been also performed as visible in figure 2.

Theme of unconventional electrified propulsion systems was investigated for activities for underground robotics starting from the electrification of directional drilling machines [5] that was developed for the project STIGE (Sviluppo di Trivelle Innovative per attività Geologiche con alimentazione Elettrica) as visible in figure 3. In this sense it's currently investigated the possibility of designing amphibious systems in order to perform underground and geological research in mixed environments like "very near shore" applications in which the necessity of an underground excavation coexists with an uncertain environment (low dept water, presence of debris, uncertain ground etc.).

For all these applications and more generally for autonomous systems reliability and diagnostic of energy storage systems its fundamental. The idea of these activities is to transfer on autonomous robotic systems, technologies that are currently experienced and investigated on advanced automotive applications. In particular considering citing overcited applications in harsh environments two topics are currently proposed to robotic community:

- Development of real time systems [6-8] able to identify in real time both the real SOC (state of charge) and SOH (state of health) of accumulators of autonomous systems in order to safely manage and foresee partial or total failure of the storage systems that normally preclude completion of the mission, also menacing system survival.
- Contactless or Wireless Power Transfer System[9-10]: wireless power transfer is a potentially interesting solution to simplify docking system of autonomous vehicles also allowing a reliable recharge or power transfer in harsh conditions where precise positioning and protection from external contaminant that are needed with a direct electric connections can be avoided.

CONCLUSIONS

Development of advanced robotic systems especially for what concern autonomous vehicles and drones operating in harsh environments involves the availability of multi-disciplinary competences, as example regarding actuation and power management. Mechatronics can offer a support and a common language to transfer know-how and solutions between different industrial sectors and beyond traditional division of competences and interests.

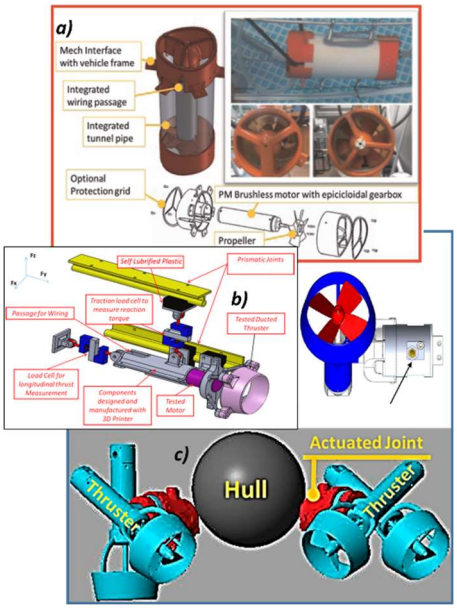

Fig. 1. Design of customized propulsion systems for underwater robotics: a) tunnel thrusters for THESAURUS project, b) testing of different kind of thrusters, c) design of pivoted thrusters

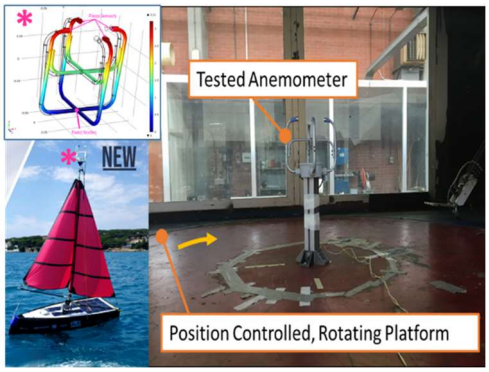

Fig. 2. Development and Testing of Sensors and Systems for Autonomous Sail Drones (Project VELA and related research and didactical activities)

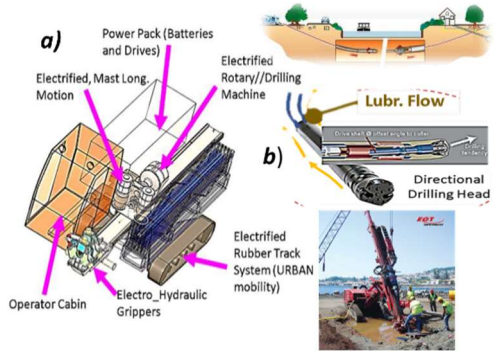

Fig. 3. Applications of underground robotics (STIGE project), design of electrified drilling machines (a) including modelling of directional drilling head (b)

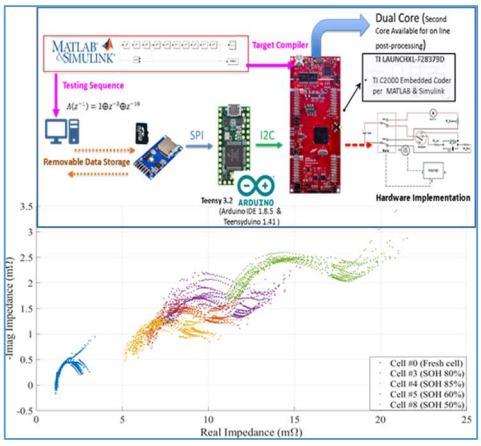

Fig. 4. Development and Testing of Portable diagnostic systems for accumulators of electric vehicles and drones

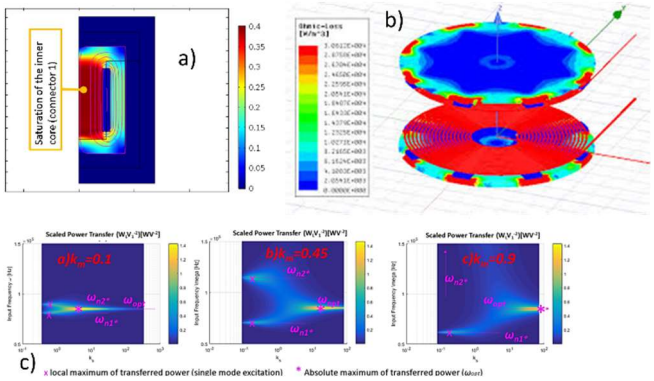

Fig. 5. Development, modelling and testing of different wireless power transfer system (a&b) including the optimization of power transfer respect to different operating condions(c)

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