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Myoelectric devices meet sensory-motor integration

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One of the key features missing in current myoelectric prostheses is sensory feedback—the sense of touch so crucial to our interaction with everything that surrounds us. An EU-funded consortium has overcome this difficulty and is already bringing its devices to market.

The most difficult and crucial phase of any research and development process is undoubtedly the transition from academic research to products answering commercial needs. This can notably be observed in the market of myoelectric interfaces. While the latter have various advantages over body-powered prosthetics—including their use of suction technology and the use of electronic sensors to detect minute muscle, nerve, and EMG activity and translate it into movements—commercially-available devices still lack the capacity to provide their user with sensory feedback.

On the academic level, however, myoelectric interfacing with sensory-motor integration is already feasible. All it would take for this possibility to result in actual products is a two-way transfer of the knowledge in basic neurophysiology research and signal analysis from academia to industrial sectors, and of the requirements of and testing for clinical and commercial viability from industry to academia.

This is where the MYOSENS (Myoelectric Interfacing with Sensory-Motor Integration) project comes into play. Helped by a consortium of internationally regarded European academic teams and industries, Prof Dario Farina of the University of Gottingen has spent the past four years

working on solutions to implement sensory-motor integration into commercially-viable myoelectric devices.

The project, which ended in March 2016, is the first-ever research effort to focus on two aspects: training for the active control of protheses, and rehabilitation of stroke patients thanks to robotics. These two areas require a similar technological ground for sensory-motor integration and for artificial induction of neural plasticity, necessary to (re)learn motor tasks, and the consortium's efforts is already translating into novel, commercially-available products.

How do you explain the absence of sensory-motor integration on current interfaces?

Sensory-motor integration is missing in commercial/clinical interfaces because the systems developed in research laboratories are not yet robust enough to be implemented in clinical devices for daily use. Moreover, it is not yet fully clear if sensory feedback in rehabilitation devices is useful.

For example, while it is obvious that providing some kind of feedback to prosthetic users is useful when all other sensory information are removed, it is much less certain that additional feedback is functionally useful when the natural feedback that amputees maintain (such as vision) is preserved.

What were the main difficulties you faced during the project and how did you solve them?

The project (IAPP type) consisted in translating concepts developed in academia to industry and vice versa. The main difficulty was to design experimental paradigms to compare objectively different solutions for

providing artificial feedback to prosthetic users.

Solutions include different feedback modalities (e.g., electrical stimulation, vibration), different feedback locations (single or multi-site), different feedback variables (e.g., force, speed), and so on. Understanding the best combination of these variables empirically is very challenging and cannot easily be generalised.

Therefore, a theoretical model was developed that could predict the outcome based on fitting parameters in a few experimental conditions.

You specifically chose myo-electric prosthetic control and motor function rehabilitation of stroke patients as applications. Why this choice?

These are two important areas for clinically-viable rehabilitation technologies. Prostheses controlled by myoelectric signals are already on the market (although without sensory feedback) and similarly robotic devices for rehabilitation are available to patients (although without myoelectric control).

The two technologies were missing complementary aspects, the sensory feedback and the motor commands respectively, and therefore were representative of the problems we outlined.

Are you happy with the project results so far?

The project had extremely satisfying results. The most relevant is probably the introduction in the market by Tyromotion, one of the companies participating in MYOSENS, of one of their robotic devices with the inclusion of the myoelectric control we developed within the project. This can have a strong impact in translational research.

Another system developed during the project for the reduction of phantom limb pain in amputees with sensory feedback is under patenting. The project also provided important insights into the role of artificial sensory feedback in prosthetics, which can be used as guidelines to implement effective and practical feedback interfaces.

In addition to these results with direct impact in the market and for the patients, the project produced a large number of specialized publications, organized five successful workshops, and provided training to 11 fellows, three of whom will obtain their PhD degree within the year to come.

Did you test your two devices on patients yet?

Yes, the project was characterized by a strong clinical validation. For this reason, a clinical partner, the Hospital San Camillo of Venice, was included in the consortium. Thanks to this partner, clinical trials could be performed for all the systems developed during the project.

What has been the feedback of potentially interested market players so far?

As already mentioned Tyromotion has recently commercialised a new robotic device equipped with myocontrol. Other than that, Otto Bock HealthCare, industry leader in neurotechnologies, was also part of the consortium and has expressed interest in common patents and in the product development of a new sensory feedback system based on MYOSENS results.

The project ended in March. Are you planning to keep building on its results?

The final goals have all been reached but the consortium is unanimously strongly interested in extending the work within the framework of a second EU-funded project.

More information: Project page: cordis.europa.eu/project/rcn/101648_en.html

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