Swimming goes high tech with EPFL-developed inertial systems

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Scientists from EPFL's Laboratory of Movement Analysis and Measurement have developed inertial systems, worn in a full-body swimming suit, which can analyse the strengths and weaknesses of elite-level swimmers during workout sessions. It's a revolutionary new tool for coaches.

Will EPFL play a role in creating the next Michael Phelps or Laure Manaudou? Researchers from the Laboratory of Movement Analysis and Measurement (LMAM), working in collaboration with the University of Lausanne, have at least taken the first step, by developing a tool that can help improve elite swimmers' workouts. Upon the request of the Lausanne Natation swimming club, they developed waterproof inertial systems to be sewn into the swimming suit, equipped with accelerometers and gyroscopes that can record a variety of measurements as the athlete swims. "This system, called Physilog III, has a number of advantages over the conventional cameras that coaches have been using up to this point," explains Farzin Dadashi, a PhD student who's in charge of the project. "A camera can only focus on one swimmer at a time and it takes several days to analyze the data. Worn by the swimmers, our system provides a practical tool to analyze the performance from several athletes simultaneously, and it only takes a few minutes."

Extensive crawl and breaststroke tests

To carry out his Swiss National Science Foundation-sponsored research, Farzin Dadashi ran the Lausanne Natation swimmers, who are among Switzerland's best, through a complete battery of tests. Two strokes were analyzed: front crawl and breaststroke. "We developed a special swimsuit that had pockets in strategic locations into which the sensors could be inserted (four on the arms, one on the back and two on the legs)." This allowed them to calculate a variety of parameters, such as instantaneous swimming speed and coordination. "To measure the index of coordination, we found the time gap between propulsion of each arm by automatic detection of stroke temporal phases. The UNIL researchers focused on the physiological analysis of the data, using a gas analysis system – the swimmer's gas exchange – thanks to a sort of snorkel. Using the results of their study, we are now able to associate the energy expenditure with our coordination index and speed measurement."

Sophisticated technology

Building these sensors and fusing signals to develop this technology weren't easy tasks, because analyzing swimming involves a specific set of challenges. "Just making the sensors water resistant took a lot of time," Farzin Dahashi points out. EPFL professor Kamiar Aminian, who is Director of LMAM, concurs. "This is a challenging project, because movements in the water are very different from movements on land. You have to take into account buoyancy and the drag force, for example," he explains. "Moreover, aquatic locomotion also involves continuous body sliding, which makes the estimation of speed more challenging." All these obstacles have meant that up to this point, swimming has had to sit on the sidelines in terms of biomechanical modelling of sports. The new technology and algotithms developed by EPFL should get swimming back in the game, however. Thanks to EPFL's inertial system, coaches will be able to give their swimmers valuable feedback that will help them better "organize" their technique, reduce wasted energy expenditure by improving coordination and thus improve their overall performance.

Football and running

LMAM is no newcomer to biomechanical modeling in sports; similar analyses have also been carried out for golf, tennis and boxing. And the laboratory doesn't intend to stop there; current and future projects will look at ski jumping, ski touring, cross country skiing, football and running.

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