THE QUANTIFIED SELF

Sporting performance is centered on the athlete.

The latest technological developments are used to measure physiological and psychological parameters, analyze performance more effectively and optimize training.

These methods of enhancing athletes' performance can also be applied to the sporting and physical activities of the general public, helping improve their health and well-being on a daily basis.

WHAT IS THE CORRELATION BETWEEN FATIGUE AND BLOOD ANTIOXIDANT LEVELS? HOW CAN MEASURING THEM HELP ENHANCE TRAINING?

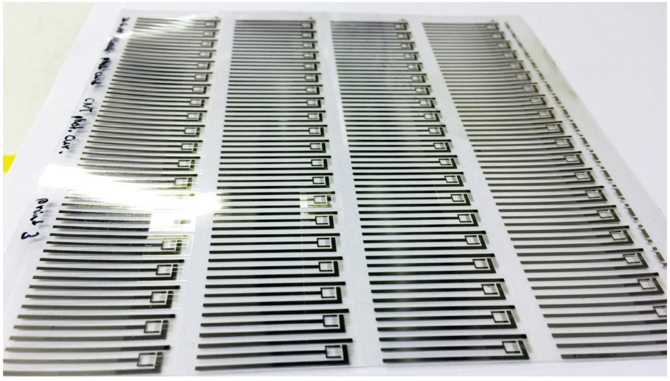
O2SCORE: OPTIMIZING TRAINING

When we engage in a physical effort, the production of free radicals increases and, depending on our recovery rate, antioxidant production also increases to eliminate them. These changes can be used to manage recovery, combat fatigue, optimize training, manage recovery and increase performance.

How fast is an athlete recovering after physical effort? The system developed by O2Score makes it possible to measure blood antioxidant levels in a rapid and practical way, helping athletes manage their training and recovery in order to reduce the risk of injuries and to improve their performance.

During sports training, the consumption of oxygen increases and triggers a series of biological reactions. To determine whether the body has been overworked during training, EPFL's Laboratory of Physical and Analytical Electrochemistry (LEPA) has developed electrodes and an analysis system that can measure the level of the systemic antioxidant defense system in a drop of blood. The electrodes are produced by printing carbon nanotubes, and the speed of measurement means that the system is particularly well suited to the repeated measurements required to manage training and recovery more effectively.

The system is already used by competitive athletes, and studies are under way to develop the most suitable usage protocols and to apply the approach to other related areas, including nutrition and the control of stress and anxiety.



Electrodes.

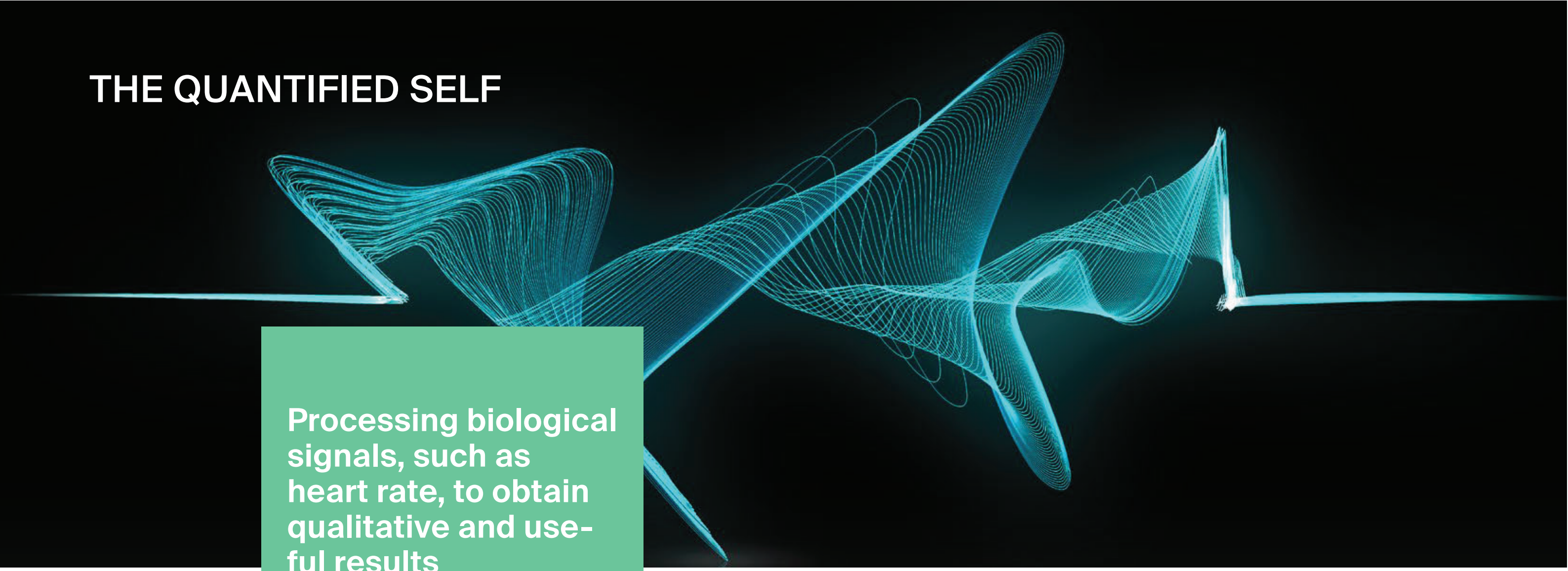
Switzerland's coxless four team, which finished in the top eight in the Rio 2016 Olympics: O2Score users.

First-division team in France: O2Score users.

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Development and production of electrodes - Blood analysis
Laboratory of Physical and Analytical Electrochemistry (LEPA)
Prof. Hubert Girault – lepa.epfl.ch

SCO2RE
Startup spun out of the laboratory



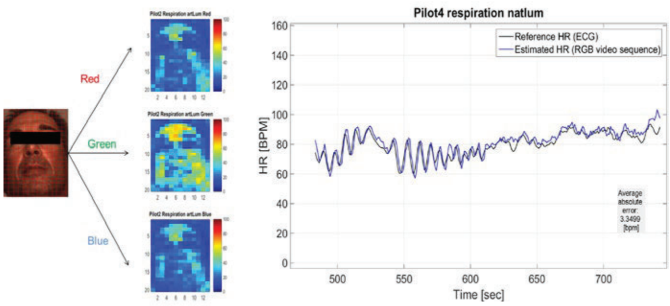
THE QUANTIFIED SELF

Processing biological signals, such as heart rate, to obtain qualitative and use-ful results

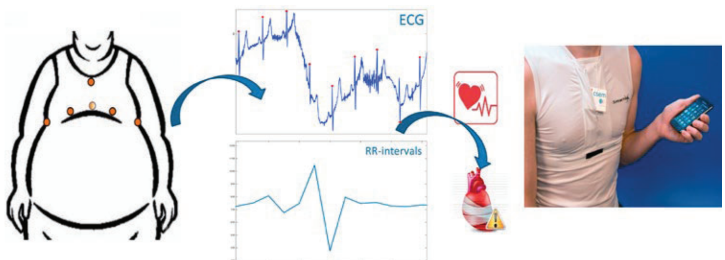
Technical advances in signal processing

In sports, biological signals such as heart rate and sleep quality are increasingly monitored. EPFL's Applied Signal Processing Group (ASPG) specializes in the develop-ment of advanced signal processing techniques, chiefly in the biomedical and sporting fields. For example, Dr Jean-Marc Vesin and his team have taken part in the ObeSense project run by the Embedded Systems Laboratory (ESL). ASPG has developed skills in analyzing activity recorded using electrocardiograms, analyzing heart rate variability and monitoring respiratory activity without a direct sensor.

More recently, ASPG has proposed a project in conjunction with the University of Lausanne's institute of sport sciences (ISSUL) to look at the effect of age on cardiovascular parameters and sleep quality. Signal processing can also be used for other sports-related applications. ASPG is developing expertise in estimating an athlete's heart rate non-intrusively, assessing sleep quality and monitoring performance. The development of new systems involving embedded sensors, such as smart textiles, are opening up new horizons in sports. However, the poor quality of the signals collected by these systems, as well as the lack of complex analytical techniques, mean that advanced signal processing tools are very useful.



Estimating a person's heart rate using video tools.



Robust heart rate extraction.

Acquiring data from an athlete in a controlled environment.

EPFL
Applied Signal Processing Group (ASPG)
Dr Jean-Marc Vesin – aspg.epfl.ch

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UNIL | Université de Lausanne

CHUV

Measuring brain activity to study athletes' emotions and sensations while they're on the move

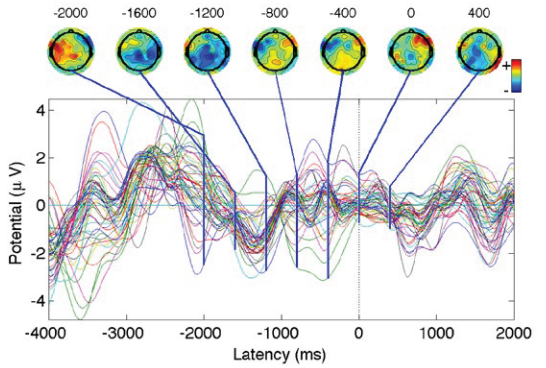
A portable electroencephalography device for measurements on the go

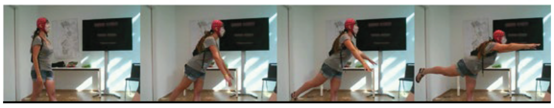
How does an athlete's brain perceives and responds to its environment during sports activity? How aware are athletes of their activity, and how does that awareness affect performance? These issues are central to sports performance. EPFL's Chair in Brain-Machine Interface, led by Professor Millán, is working to better understand them.

Jointly with Professor Hauw's laboratory of sports psychology at UNIL and Professor Staderini at HEIG-VD, the team has have developed a neurophenomenological perspective. Here, analyzing the brain signatures of athletes in action under diverse conditions, together with first-person assessments in the form of interviews, provides insight into how an athlete's brain helps to process the experience of high level performance.

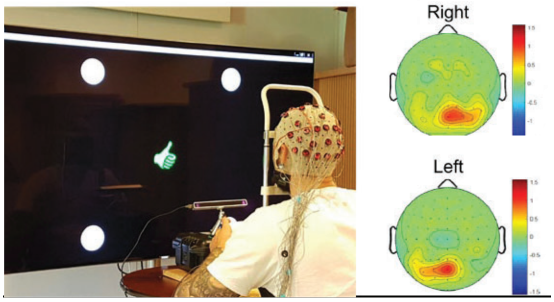
Moreover, in collaboration with A. Lecuyer at INRIA Rennes, and R. Kulpa and B. Bideau at Universitè Rennes 2, researchers study how cognitive monitoring and visuospatial attention affect performance. These studies use virtual reality and neurophysiological analysis to develop neurofeedback strategies to enhance cognitive skills necessary for sports activities

These efforts will bring a better understanding of brain processes that mediate and promote high performance in sports. Paving the way for new tools for monitoring athlete's condition and innovative training methods.





EEG activity and synchronized video of preparatory activity of standing split actions (collaboration EPFL, UNIL, HEIG-VD).



(left) Neuropsychological test of visual attention in goalkeepers. (right) Lateralized patterns of EEG activity correlate with the attended location (collaboration EPFL, INRIA, U. Rennes).

EPFL
Defitech Chair in Brain-Machine Interface (CNBI)
Prof. J. R. Millán et R. Chavarriaga – cnbi.epfl.ch

In partnership with
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www.heig-vd.ch
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UNIL | Université de Lausanne

THE QUANTIFIED SELF

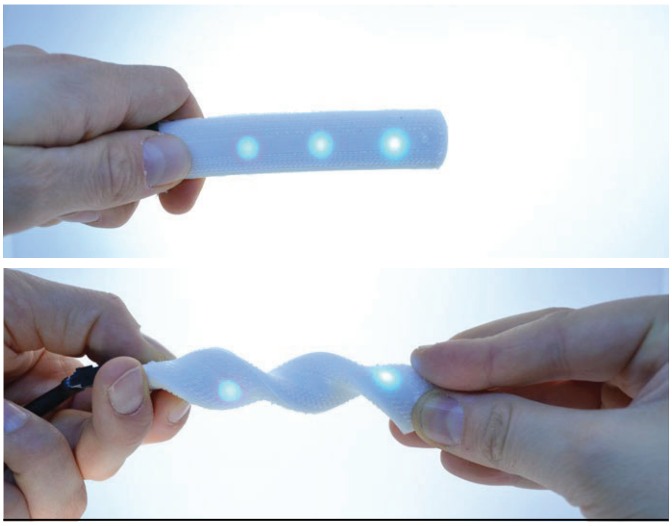
A comfortable, wearable device for measuring physiological parameters while exercising

The next generation of wearable sports sensors

Professional athletes and coaches are using wearable devices on a daily basis, for example as position, heart rate, and activity trackers.

These devices come in the form of hard plastic boxes attached to the athlete's body using a harness or a strap band, which limits their deployment to some parts of the body. It can further result in discomfort for the athlete after long use or in inaccurate data due to the relative motion of the devices with respect to the skin and the skeleton. There is therefore a need to design and manufacture wearables with form factors that imitate the soft skin and tightly conform to the athletes' bodies and movements.

The design and manufacturing solution invented at the Laboratory for Soft Bioelectronic Interfaces (LSBI) enables wearable devices with unprecedented mechanical robustness and compliance. Standard electronic modules are distributed, interconnected and embedded into rubber to build the next generation of smart wristband, headbands, or patches. Skin-like strain gauges designed to track the motion of the fingers have been successfully fabricated and tested in the laboratory. Future work will focus on constructing systems embedding digital sensors and wireless communication functions.



Electronics embedded in a flexible bracelet.

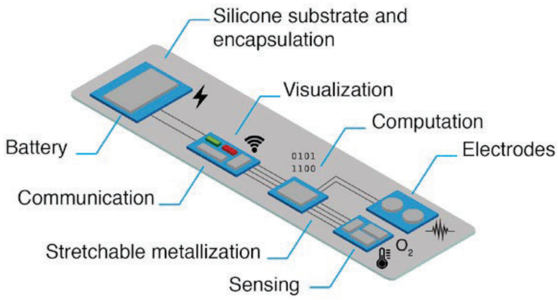


Diagram showing how various components can be connected.

Laboratory of Soft Bioelectronic Interfaces (LSBI)
Prof. Stéphanie Lacour – lsbi.epfl.ch

THE QUANTIFIED SELF

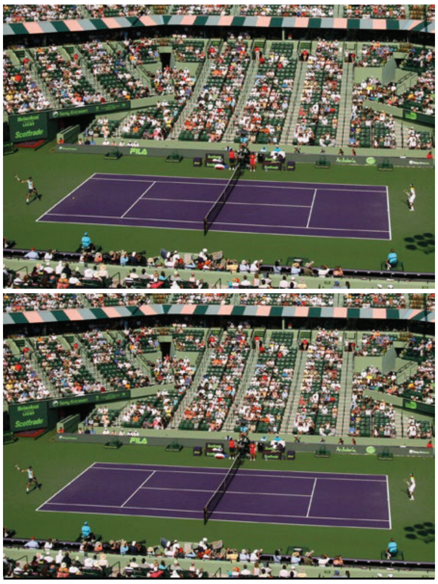
How do visual skills affect sports performance?

Measuring the perception of professional tennis players

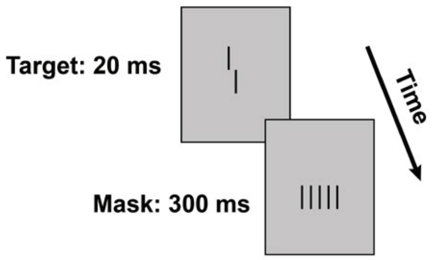
Do professional tennis players have better visual perception than the average person? What is the role of visual perception in athletes?

In tennis, as in many other sports, peak performance depends on excellent visual processing in both spatial and temporal terms. So far, studies have concentrated on athletes' ability to anticipate and make decisions. EPFL's Laboratory of Psychophysics (LPSY), however, has gone further, looking at how the ability to anticipate and make decisions relates to visual perception capacity. In this project, a series of seven visual tests were performed to determine which aspect of visual information processing is better in a tennis player than in a triathlete or a non-athlete.

The results showed that certain temporal processing skills, such as the ability to perceive the speed of an object, are better in tennis players than in triathletes and non-athletes. Data like this can be used to maximize the performance of tennis players in the future, working with their strengths and the visual skills they develop in practicing their sport. These approaches can also be applied to other sports.

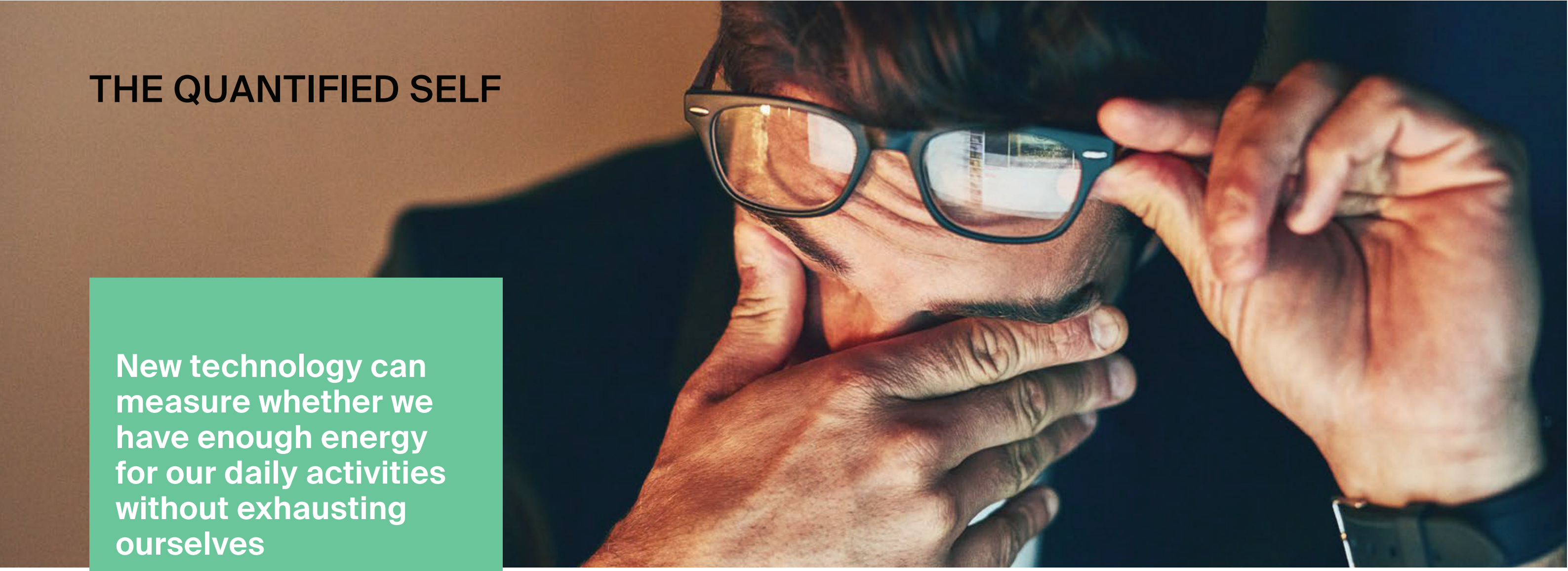


These sample tennis-related images — where the image (top) contains a tennis ball and (bottom) does not — were shown to participants in this experiment. The test was intended to compare the extent to which tennis players correctly detect the ball, compared with triathletes and non-athletes, when the images were shown for a very brief period (13ms). (Original image: Alex Lee).



Example of the stimulus used to study the temporal processing of visual information. Two vertical segments, where the lower one may be to the right or the left of the upper one, are displayed for a very short period, after which they are masked (by a series of aligned vertical segments). The participant must say which side the lower segment was on, left or right.

Laboratory of Psychophysics (LPSY)
Prof. Michael Herzog – lpsy.epfl.ch



THE QUANTIFIED SELF

New technology can measure whether we have enough energy for our daily activities without exhausting ourselves

Combining smart wearables with machine learning on the cloud to develop preventive-care systems

The greater our physiological needs, the more oxygen our body requires and the more our cardio-vascular system must adapt. Whether you are a student on a light training program due to time constraints during the week, or a more active athlete with a much more intense training program, your activity is managed through adaptations of your metabolism and cardiovascular system – which are controlled by your nervous system. The central nervous system receives information from your entire body and modulates your heartbeat and other physiological parameters to meet the dynamic demands of your daily activity. That's why heart-rate variability is a common method for detecting fatigue and one of the key metrics for measuring stress levels.

latest wearable high-tech devices like smartwatches and smartbands can monitor a user's heart rate, heart-rate variability and respiratory rate accurately and in real time throughout the day. Researchers at EPFL's Embedded Systems Laboratory have developed a system for pre-processing and analyzing the data collected by smart wearables as edge devices, and then sending the results to a cloud-based health-care program. This program uses advanced machine learning algorithms developed by BeCare to estimate the user's fatigue (or physical stress level) based on his or her daily physical activity and physiological history. The system uses this assessment to make recommendations, also drawing on the expertise of scientists at UNIL. Individuals, athletes and physical trainers can use the information to improve the recovery process or map out improvements to their daily habits.

Laboratory prototype with separate sensors.

The complete system – which combines smart wearables with machine-learning-based cloud computing technology – can be used to develop personalized training programs for improving athletes' training and helping sedentary people adopt a healthier, more active lifestyle. Moreover, the system can be used as a tool for reducing the risk of long-term physiological pathologies. Initial trials have already been carried out in collaboration with the UNIL-EPFL Sports and Health Center.

EPFL
Embedded systems laboratory (ESL)
Prof. David Atienza Alonso – esl.epfl.ch

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be.care Smart & Predictive Connected Health

EQUIPMENT

Equipment optimizes high-level performance in all sports and can make the difference when it comes to remaining competitive.

Its most crucial function, however, is the athletes' safety and physical well-being.

Amateur athletes also benefit from the latest developments in equipment technology, which enable them to practice their sport with greater ease and comfort.

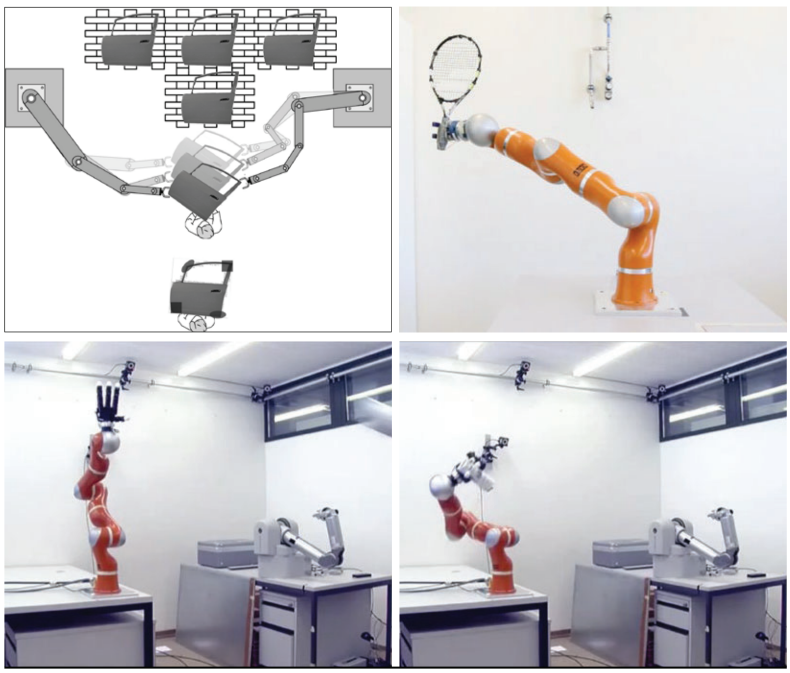
Bringing robots into sports as training partners

Adaptive and rapid control for catching and throwing objects

Playing tennis or baseball with a robot could very soon become a reality. Complex algorithms mean that robots are now able to catch flying objects with fluid, rapid movements.

EPFL's Learning Algorithms and Systems Laboratory (LASA) specializes in developing tools to teach robots how to carry out tasks with the dexterity of a human being. The project consists of teaching a robot how to catch and throw. Results show that robots are able to learn various locomotion and rapid-movement skills. The challenge lies not only in making robots capable of catching with fluid movements, but also of adjusting to unspecified flight trajectories.

In the future, this project will seek to optimize the movements and abilities of robots so that they can be used as training partners for people playing sports such as tennis and baseball. This would enable players and athletes to train alone, while having a better standard of training than by playing against a wall, from which the trajectory of the ball is predictable.



The laboratory's robotic arm programmed to catch flying objects..

EPFL
Learning Algorithms and Systems Laboratory (LASA)
Prof. Aude Billard – lasa.epfl.ch

Using 3D printing to make top-notch safety equipment for athletes

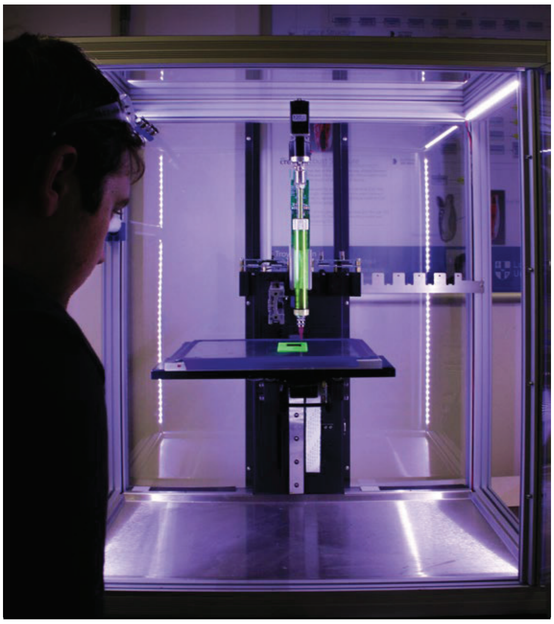
Voxcell: a novel material that can reduce concussions and head trauma during sports

With the design and performance of current helmets, there is still a high risk of concussions and head trauma during an accident. Although they usually provide effective protection against primary injuries caused by an impact – cuts or skull fractures – such helmets show limited effectiveness when it comes to preventing secondary injuries resulting from the energy, or deceleration, experienced by the brain at the moment of impact.

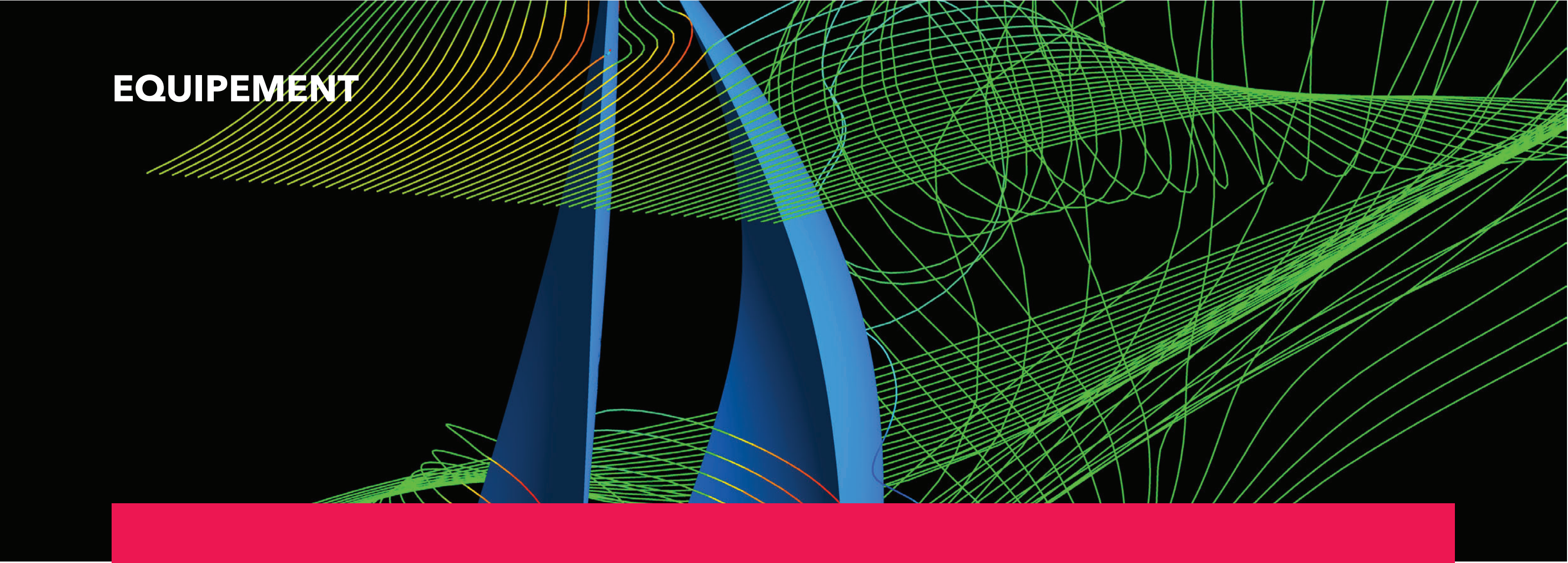
A cross-disciplinary group of EPFL students proposes to improve the quality of current helmets by combining new material with an additive manufacturing method, 3D-printing.

Coming from mechanical engineering, materials science, electrical engineering, and computer science, three students from EPFL collaborated with a materials science researcher from Harvard University to develop a technology using a new material in conjunction with 3D-printing techniques. The project started as a side project and combines different theories that students learned during their courses, the goal being to obtain an industrial process. This solution allows an optimal spatial distribution of the material and is used to manufacture protective inserts, enabling not only to increase the absorbed energy quantity but also to reduce the head acceleration during an impact.

The product manufacturing proceeds by using 3D printing techniques allowing the material to be freely distributed in space. The material is placed in targeted locations to enhance energy absorption in the event of an impact, reducing brain deceleration and hence the degree of brain trauma. This approach improves overall performance and makes a variety of sports safer for everyone.



3D printer in use.



EQUIPEMENT

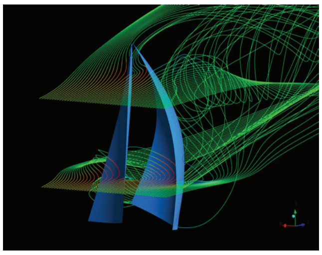
DEVELOPING A DIGITAL MODELING TOOL TO OPTIMIZE PERFORMANCE BY TESTING DIFFERENT GEOMETRIES

COMPUTATIONAL FLUID AND STRUCTURAL DYNAMICS (CFSD)

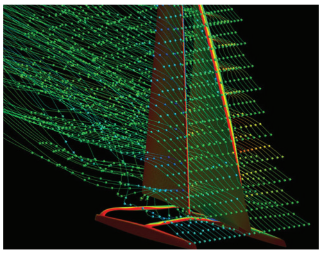
How do wind and waves influence the performance of a boat? How can a cyclist's position be optimized to reduce wind resistance?

Until recently, the most effective way of testing how a piece of equipment performed was by putting it in a realistic situation, such as a wind tunnel or a towing tank. Today, cheaper digital methods are used to model aerodynamics and hydrodynamics. The Computational Fluid and Structural Dynamics (CFSD) laboratory take a mathematical approach to the matter. It is able to simulate a wide range of flows using a mathematical model of the object, factoring in the way it deforms and moves.

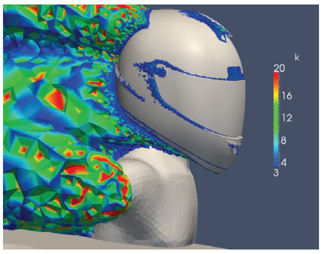
EPFL's Chair of Modeling and Scientific Computing (CMCS), in conjunction with the mathematics department of the Politecnico di Milano, is working to refine this approach. Researchers are studying and developing new approaches allowing them to test, with limited calculation resources, a maximum number of geometries in a short space of time so that engineers can choose the most suitable solution for their problem.



Air flows around the sails of Alinghi AC32.

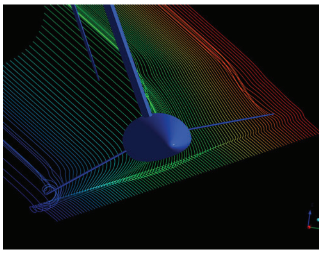


Air flows around the Alinghi AC33 catamaran and pressure on the sails and hull.

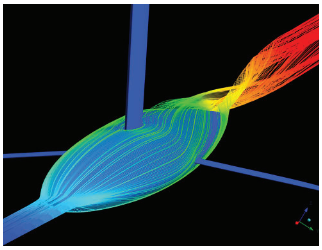


Turbulence kinetic energy behind a MotoGP competition helmet (M0X0FF).

Waves generated by the hull of a coxed eight boat.



Turbulence around the appendages of the Alinghi AC32.



Current lines around the bulb of the Alinghi AC32.

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Digital simulation

Chair of Modeling and Scientific Computing (CMCS)

Prof. Alfio Quarteroni– cmcs.epfl.ch

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POLITECNICO MILANO 1863

Digital simulation

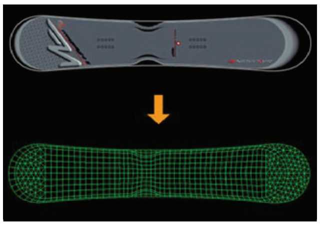
Designing composite structures to enhance performance

Optimal sizing of composite structures for sports equipment

To enhance performance, sports equipment must be increasingly light and rigid. The issue then arises of how to give them the ideal dimensions in order to obtain the expected performance.

Composite materials are increasingly used in sports equipment to achieve lightness and rigidity. The properties of the finished item are determined by the choice of components, the type of reinforcing fibers and their orientation. The design can be optimized through digital simulation that provides information about the mechanical load on the item and the properties of the materials as measured in laboratories. Items are instrumented – through the integration of optical fiber that measures deformation and stress in the structure – to verify their dynamic behavior in use and validate their dimensions. This approach has been applied by EPFL's Laboratory of Applied Mechanics and Reliability Analysis in a number of projects, particularly for the development of snowboards and foils for boats.

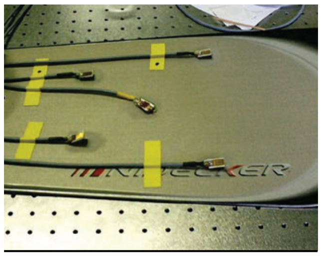
Stress and deformation simulation on the Hydroptère trimaran.



Finite-element modeling of a snowboard.

Simulation of a snowboard.

Test bed for the instrumented snowboard.



Instrumentation of a snowboard.

MOVEMENT AND POSITION

Movements and positioning are crucial issues in sports. Players' positions within their team and their surrounding environment, along with their movements, are key data for analyzing and improving their performance.

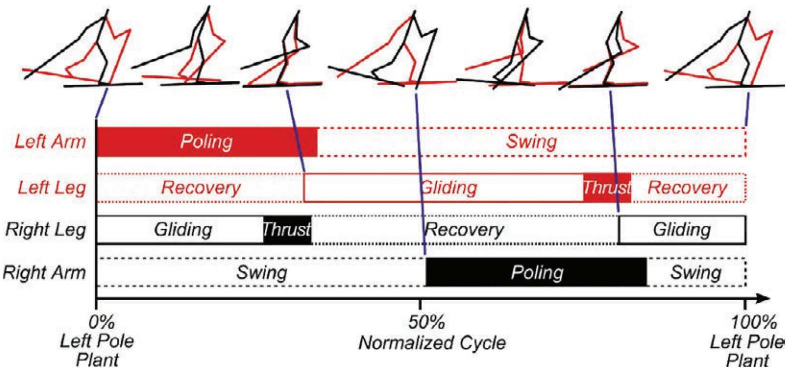
Several pieces of equipment are involved in taking precise measurements: cameras, sensors, drones and algorithms.

The information collected can also be used to give spectators a better understanding of critical points in a game: they can watch a play from several angles or view a specific athlete's performance data.

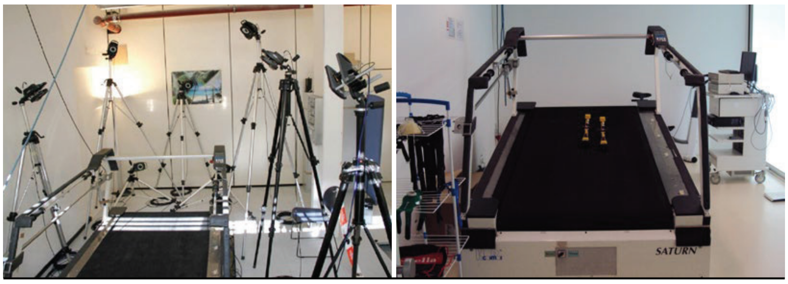
Measuring motion and the kick and glide phases of Nordic skiing for precision analysis

Cross country and ski mountaineering: performance estimation and energy optimization

Wearable systems using inertial measurement units (IMU) have been proposed in a variety of sport disciplines, but their application to skiing and particularly Nordic skiing such as cross country or ski mountaineering is new. New methods based on IMUs fixed on skis, poles and body segments are proposed to estimate spatio-temporal parameters and lower limbs angles for the diagonal stride in classical cross-country skiing. Good accuracy and precision were obtained for detecting each cycle, thrust and pole push phases as well as for estimating cycle speed, cycle length, shank and thigh angles. The system was also sensitive to changes of speeds and inclines and offers a very easy setup to provide an unlimited capture volume for measurements on snow. The algorithm was adapted for ski mountaineering and used to determine an optimal slope and speed allowing minimization of energy expenditure.



Sequence of movements in the diagonal stride technique



Experimental set-ups in the laboratory

EPFL
Laboratory of Movement Analysis and Measurement (LMAM)
Prof. Kamiar Aminian – lmam.epfl.ch

Gaitup make sense of motion
Startup spun out of the laboratory

In partnership with
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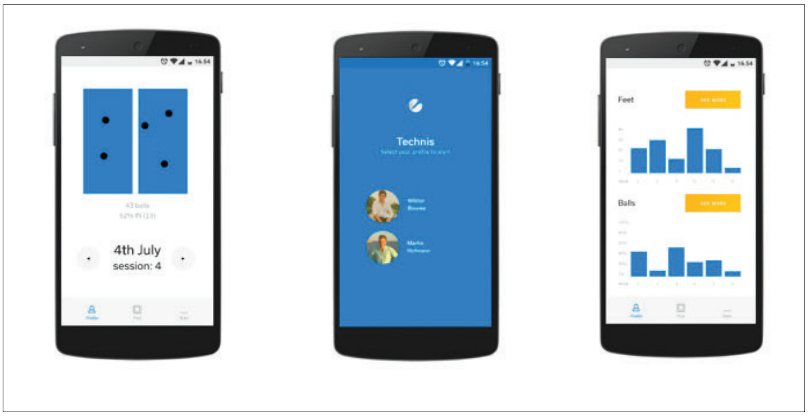
POMOCA

ENHANCING TENNIS PERFORMANCE USING A SPECIAL SURFACE THAT TRACKS BALL IMPACTS AND PLAYER REACTION TIMES

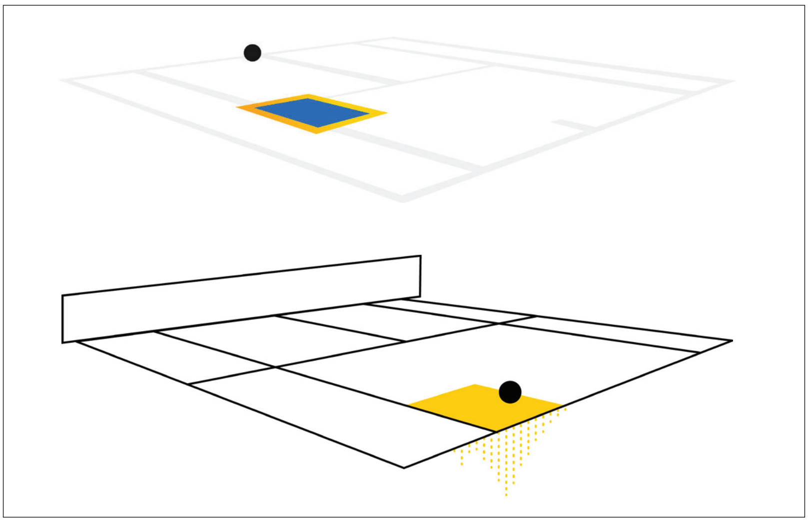
TECHNIS, A SMART TENNIS COURT SURFACE

How can the effectiveness of a tennis shot be measured? How can a player raise performance levels and cut reaction times? The Technis project is a smart court surface that detects physical contact and provides feedback not only about ball impacts, but also about the athlete's speed of reaction.

The surface was designed by Technis, a startup supported by the Laboratory for Photonic Materials and Characterization (LPMAT) with funding from Innogrant. It incorporates a mesh of piezoelectric fibers able to detect physical contact.
Machine-learning algorithms and techniques allow the system to fine-tune its measurements and analysis during use. It can be applied anywhere and is water-resistant, providing an alternative to conventional training. The precise location of impacts, ball speed and player movement stats can be used to analyze performance during training. Data can be visualized using an application, which maps out the various shots played. The system presents an all-round picture of players' performance in a fun way, helping players to improve the technical side of their game.



Technis application for tracking improvements.



Areas equipped with sensors to determine the quality of the player's movements and stroke accuracy.

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Piezoelectric fibers
Laboratory for Photonic Materials and Characterization (LPMAT)
Prof. Gian-Luca Bona – lpmat.epfl.ch

Technis
Startup associated with the laboratory

DATA ANALYSIS

Computers can crunch enormous amounts of data gathered in the heat of the competition, simulate situations based on theoretical models, synthetic data or real world information, generating results and analysis that can be used to unlock performance gains.

From quantified-self applications to movement tracking via the large-scale use of sensors, huge volumes of data are collected about athletes during practice and sports events.

Computers then store, sift through and interpret this data. The results obtained can be used to improve equipment, device or movement and then the athletes' performance. They can also enhance the experience of fans and spectators, giving them greater insight into their favorite sports or games.

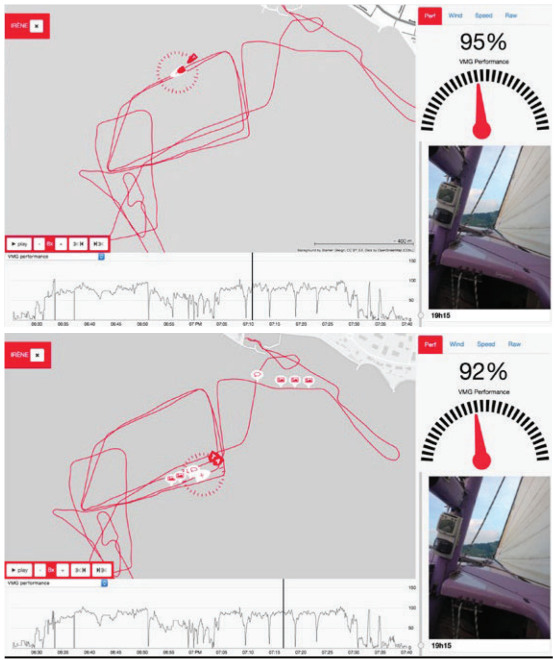
Optimizing a boat's performance in real time and over the long term by logging data from each race

Anemomind: a tool for optimizing sailing performance

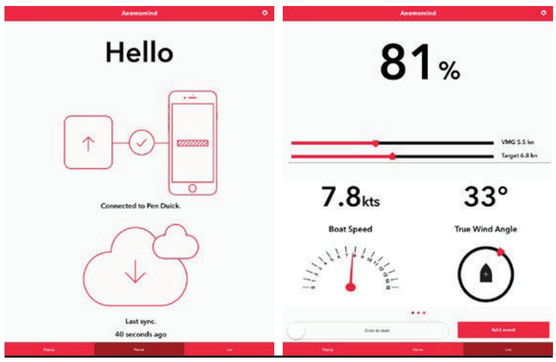
How well is a boat performing in relation to external conditions and its past performance? Is the boat following the best course? Anemomind, a startup that emerged from EPFL's Computer Vision Lab (CVLAB), markets a system that can measure performance in real time using different parameters to reflect external conditions. The relevant data is also logged to unlock performance gains over the long term.

Based on GPS, anemometer, accelerometer, magnetometer and gyroscope readings, the application calculates the boat's position in space and time to determine how well it is performing in the external conditions. Wind and currents are also taken into account in the algorithm, and it should also be able to measure wave sizes in the future. The software can take photos of the sails and establish any correlation between performance levels and settings. The data analysis techniques developed by CVLAB for image processing are applied here to sensors of an altogether different kind. Eventually, the product may be enhanced with the addition of sail shape recognition and analysis capabilities by harnessing the lab's video imaging expertise.

The startup's product is a box that performs measurements of various external parameters, automated location finding and data storage, and an application that analyzes these parameters to produce a performance percentile calculation. This easy-to-use interface is aimed at both amateur sailors keen to improve their performance over the long run, and professionals, who can save precious time. This project was supported by funding from Innogrant, EPFL's entrepreneurship grant.



Logs recorded during an outing.

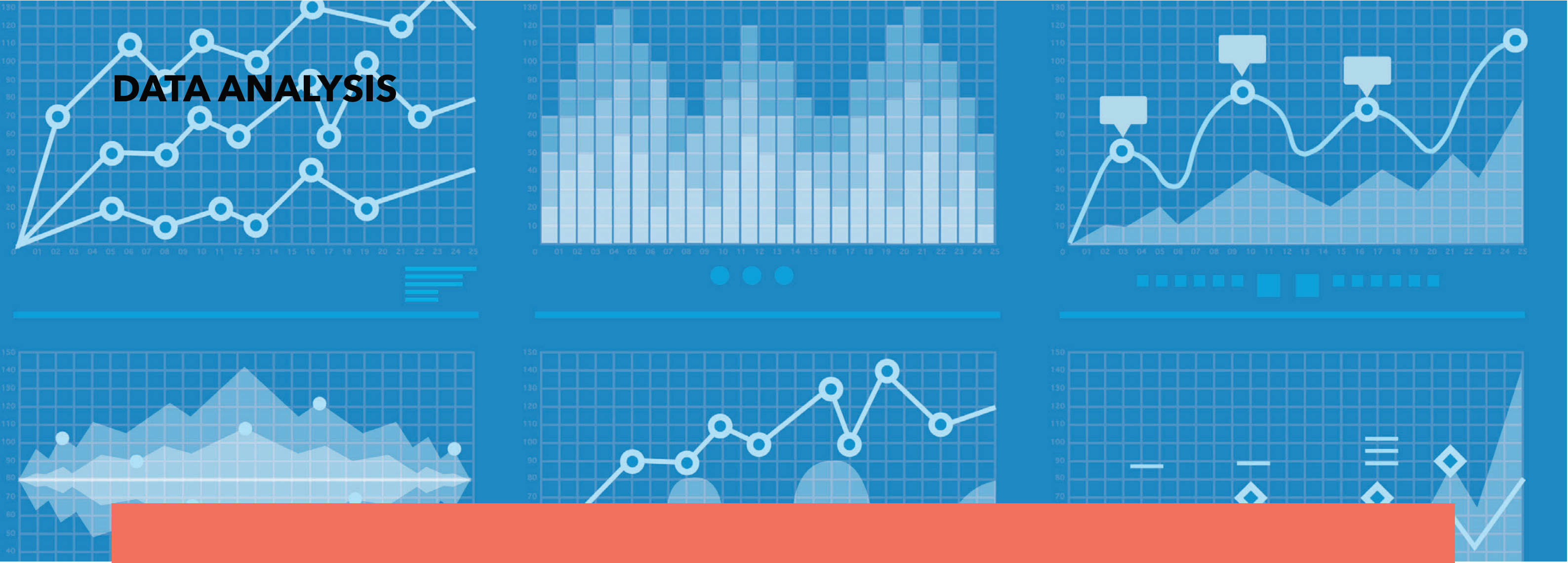


Interfaces providing an overview of performance at all times.

EPFL
Computer Vision Lab (CVLAB)
Prof. Pascal Fua – cvlab.epfl.ch

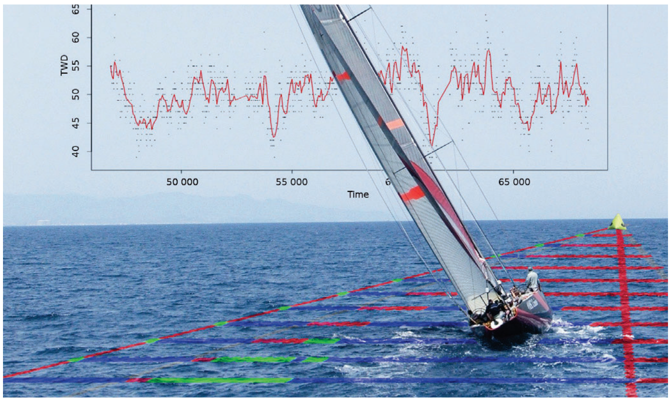
anemomind

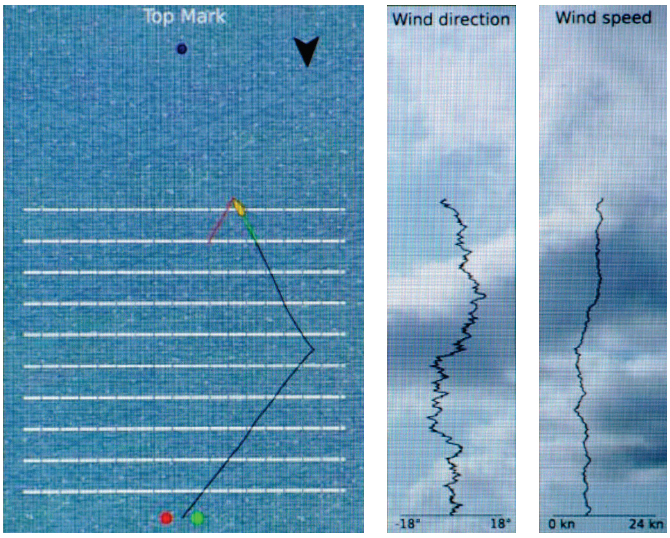
Startup spun out of the laboratory



DATA ANALYSIS

USING MATHEMATICS TO GAIN INSIGHTS FROM DATA





Trajectory simulation system based on changes in the wind.

STATISTICAL DATA PROCESSING

What are the most effective strategies for addressing unpredictable challenges? What are a team's strengths and weaknesses? How should you react in a particular situation to maximize your chances of ultimate success? What are a given team or player's chances of success?

Developments in new measurement technologies and the growing use of sensors in sports have created huge volumes of data. The problem for athletes and their coaches is how best to analyze this wealth of information and pick out the salient points to make the right decisions. The statistical approaches and the knowledge acquired by EPFL's Chair of Applied Statistics (STAP) can be used to extract meaning from raw data. Probability calculations can validate the quality of the information obtained, compare various game strategies and determine which is the best.

Under the partnership with Alinghi and the Chair of Probabilities (PROB), projects have addressed the issue of how to deal with the unpredictability of wind, drawing in particular on meteorological data. Another project has studied the on-court positioning of volleyball players. Statistical approaches provide an essential tool for handling the proliferation of data available and can turn raw data into valuable insights. The mathematical formulation of the problem at hand yields probabilistic methods and tools, which can be incorporated into software to automate analytical tasks. The end result consists of specific indicators that can be interpreted by athletes and coaches.

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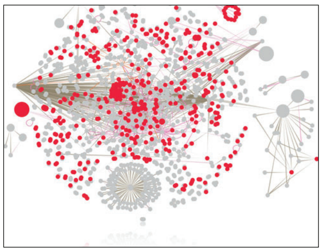
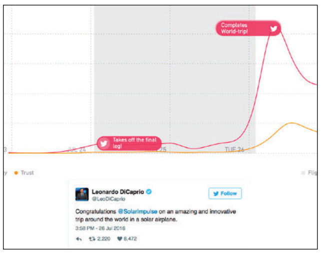
Probability and Statistics

Chair of Applied Statistics (STAP)
Prof. Stephan Morgenthaler – stap.epfl.ch
Chair of Probabilities (PROB)
Prof. Robert Dalang – prob.epfl.ch

ALGORITHMS FOR TRACKING AND ANALYZING EMOTIONS, OPINIONS AND VIEWS EXCHANGED ON SOCIAL MEDIA



Brexit: a chart showing the positions of both sides of the debate on social media and interconnections between key influencers.



Real-time tracking of the general public's emotions about the Solar Impulse project. Here, the explosion of joy at the end of its round-the-world flight in Abu Dhabi is evident.

Spectator sending a message at a game.

Messages sent by the public.

HORIZON, A TOOL FOR ANALYZING SOCIAL MEDIA CONVERSATIONS

How can we gain insight into the emotions, opinions and views expressed through the countless discussions and data exchanged on social media?

Sports generate a great deal of excitement and build strong engagement, resulting in a large volume of social media and web traffic. EPFL's Social Media Lab (ESML) is working on algorithms and a platform that can identify the various opinions present on the web and on social media. Horizon can provide a graphical representation of hot topics and pinpoint the most influential sources concerning a specific subject, such as a sports event.

This approach can provide a deeper understanding of an event's audience so that the right communication strategy can be adopted. It is also possible to:

- understand public opinion about a particular event
- measure the success of an event
- identify improvements
- characterize the general public's feelings
- identify emerging hot topics and track how they develop

In a world first, the Horizon platform has already proven its worth in analyzing events such as the Solar Impulse circumnavigation and the COP21 Climate Change Conference in 2015. It provides unique real-time insight into public opinion about events generating interest on the web.

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Development of text analysis algorithms
Social Media Lab (ESML)
Jean-Luc Jaquier – socialmedialab.epfl.ch

FAN EXPERIENCE

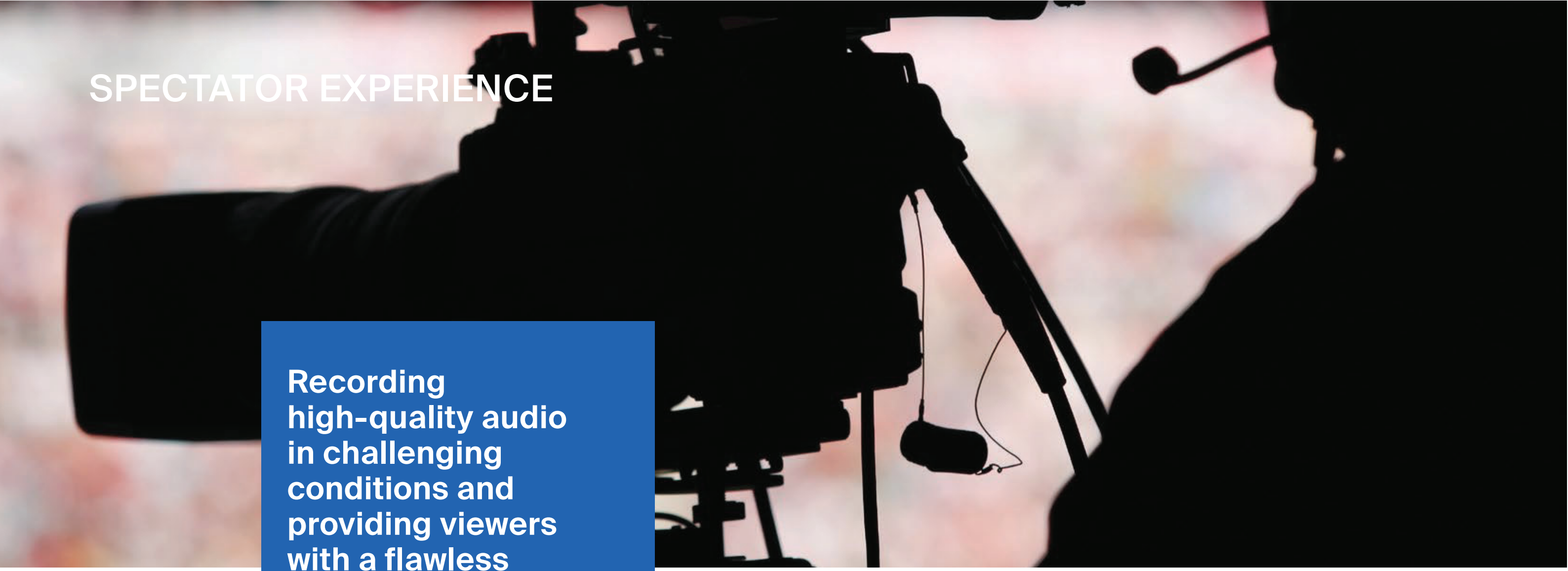
Sports are also a form of entertainment, and what the fans get out of it really matters.

Modern technology provides spectators with new experiences and gives them a fresh perspective on games, whether they are at the stadium or watching on TV.

Recent technological developments and increasingly high-performance connected personal devices can already deliver new applications and provide access to new types of data at the venue or at home.

Progress is constantly being made, holding out the promise of a whole new experience for fans and spectators in the coming years.

SPECTATOR EXPERIENCE



Recording high-quality audio in challenging conditions and providing viewers with a flawless broadcast

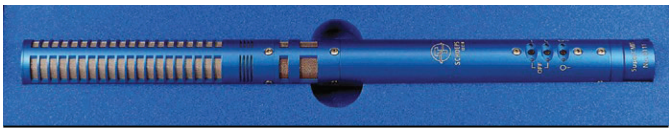
Beamforming audio processor for microphones

At sports games or in outdoor broadcast conditions, it can be hard to record sound to a high standard of quality. And yet sound is crucially important in sports coverage as it helps bring viewers into the heat of the action. The challenge is to record the sound of a live sports event with the highest possible audio quality alongside the video feed, with only limited equipment.

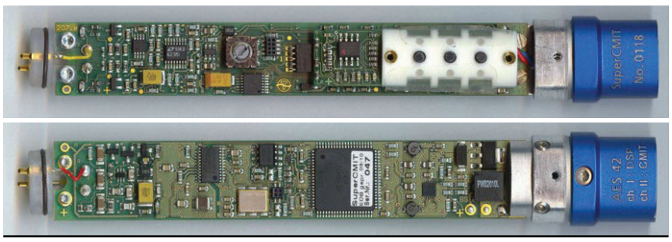
Illusonic, a startup spun out of EPFL's Audiovisual Communiations Laboratory (LCAV), has produced a processor that can deliver high-quality sound live in challenging conditions and an excellent audio feed. Christof Faller, Illusonic's founder, drew on LCAV's expertise in processing acoustic signals to design this processor, which is used in Schoeps' SuperCMIT microphone among others. The processor employs beamforming technology and has two built-in microphones – one at the front and another at the rear. They provide an optimum recording of all frequencies, including low frequencies. The recording process is highly direction sensitive, and when placed directly on cameras, the microphone can be used to record very high-quality audio together with the images. We can thus hear the sound made when a ball is kicked at the same time as we see the player kicking it.

The microphone and its processor were used for the first time at a major sports event in South Africa. The microphone is now widely used for TV coverage – in sports such as soccer and tennis – as well as by the film industry.

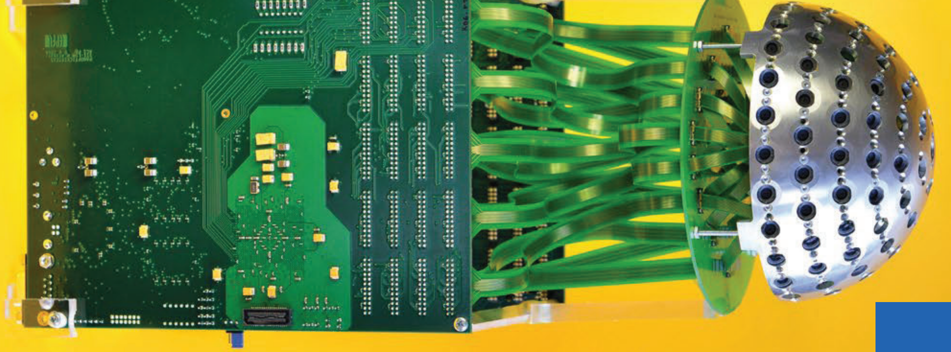
The two SuperCMIT microphones.



Schoeps' SuperCMIT microphone in its packaging.



SuperCMIT printed circuit boards, including the DSP (digital signal processor), are programmed by Illusonic.



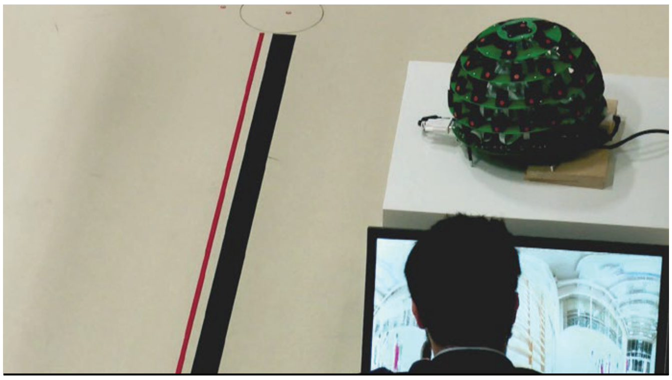
A 360-degree camera enabling every viewer to choose their own view

Panoptic: a 360-degree camera in real time

Imagine if every viewer could choose their own camera angle, no matter how large the audience, and if they could do so individually and in real time. And imagine if viewers could be drawn into the action in a compelling yet perfectly natural way. Thanks to the combined efforts of the Microelectronic Systems Laboratory (LSM) and the Signal Processing Laboratory 2 (LTS2), these ideas are now a reality.

The labs have developed a camera that is inspired by a fly's eyes. The system, which consists of multiple lenses across a spherical surface, can capture its entire environment through an array of linked images. A hardware system is used to synchronize the images captured from the many cameras, and algorithms link the pictures from various sources together. What really stands out is the system's ability to compile all the information needed for real-time broadcasting. Navigation within the reconstituted image is handled by an interface enabling each user to select a different viewpoint.

In sports, this technology has numerous potential applications. It could provide viewers with a new experience or deliver additional information to coaches. In addition, the personalized choice of live pictures and archive images offers fresh perspectives for following sporting events.



On-court image capture.

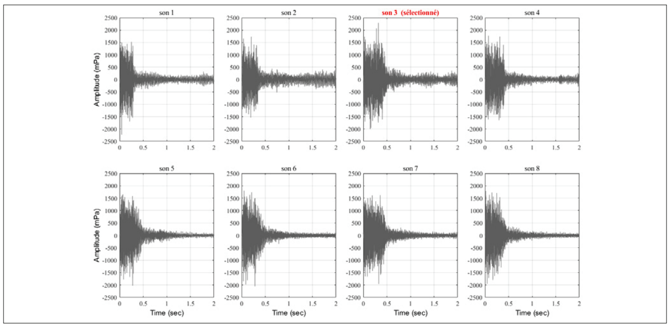
Remote visualization on a tablet.

EPFL

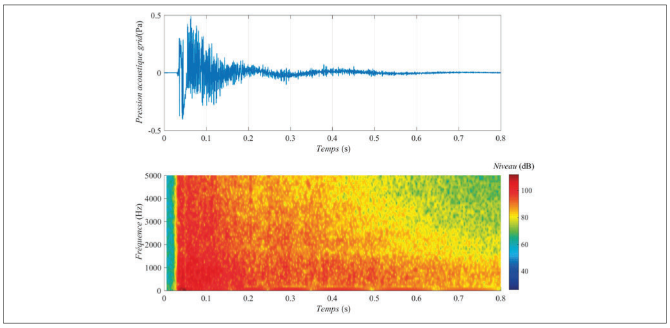
Microelectronic Systems Laboratory (LSM)
Prof. Yusuf Leblebici – lsm.epfl.ch
Signal Processing Laboratory 2 (LTS2)
Prof. Pierre Vandergheynst – lts2.epfl.ch

panoptic
Startup associated with the laboratory

REPLACING THE TRADITIONAL STARTER'S GUN WITH A STARTING SIGNAL THAT MEETS THE ATHLETES' NEEDS AND DOES NOT CHANGE THE SPECTATORS' EXPERIENCE



Recordings of 8 sounds created and broadcast at the Pontaise stadium using the electronic pistol system.



Recording of an actual starter gun and spectogram (time, frequency and sound level analysis) of the sound.

ELECTRONIC START SIGNALS THAT MIMIC THE SOUND OF THE STARTING GUN

Officials at track meets are no longer able to use conventional starter guns. For security reasons, they have been replaced with electronic pistols. The audio output needs to be optimized to make sure that it corresponds to what the athletes are expecting, and that the spectator experience is not impaired.

The Signal Processing Laboratory 2 (LTS2) specializes in both acoustic signal processing and loudspeaker and microphone design. Sound signals are created, they propagate and they are heard. Expertise in these three phases of the process is required to come up with solutions for a variety of situations. This includes generating a particular sound using an electronic tool, controlling its propagation – to either attenuate it or ensure that remains audible – or to use the noise to locate an impact.

Swisstiming turned to the LTS2 lab to work on the sound made by electronic starter guns. After firearms restrictions were tightened, alternative starting-signal solutions needed to be found for track meets. In this project, the laboratory's challenge was to replicate the sound of a firearm being discharged as closely as possible in terms of how it is perceived, while making sure it is audible for the competitors and the general public. The laboratory had to work with the existing sound systems, taking into account the properties of the loudspeakers and electronic components to ensure that the signal satisfies the competition guidelines.

The laboratory's broader expertise can be applied to other aspects of sports coverage. For example, it could be used to tone down the crowd noise at an indoor swimming pool, locate the impact of a projectile or enhance rebroadcasts by recording sounds more accurately.

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Isolation, propagation, creation, perception and elimination of acoustic signals

Signal Processing Laboratory 2 (LTS2) Acoustics Group
Dr. Hervé Lissek – lts2.epfl.ch

hidacs Acoustic Technologies — aer Acoustical Engineering & Research

Startups spun out of the laboratory

In partnership with

SWISS TIMING

Organization of the firing competition