CentraleSupélec within

IETR, UMR CNRS 6164

INSTITUT D'ÉLÉCTRONIQUE ET DES TECHNOLOGIES DU NUMÉRIQUE

IETR, Institute of Electronics and Digital Technologies, is a joint laboratory between the CNRS (INSIS), Rennes and Nantes universities, INSA of Rennes and CentraleSupélec. It also hosts researchers associated through the hosting agreement between the University of Western Brittany, ESEO, IFSTTAR-Nantes.

The laboratory has about 380 people, faculty members, PhD students and technical and administrative staff, located on several sites in Brittany and Pays de la Loire. The IETR has a large set of technical platforms to carry out life-size experiments.

The Rennes campus of CentraleSupélec houses 4 of the 13 teams of the laboratory.

Teams

AUT TEAM (Automation)

The aim of the Automation team is to develop algorithmic control and analysis solutions for large and interacting systems. Anticipating known reference trajectories and disturbances as well as taking into account constraints and multi objectives, most activities are based on Model Predictive Control. From a methodological point of view, the work focuses on:

- The distribution and hierachization of the analysis, identification, control and state estimation of dynamic systems, particularly hybrid ones that involve both continuous and logical behaviors.
- Consideration of the safety and robustness of distributed control applications when one of the cooperating actors becomes non-cooperative.

Based on its methodological and application knowledge, the team contributes to the development of Intelligent Energy Systems, in particular through its works on:

- Energy efficiency of systems,
- Energy management and integration of renewable energies in positive energy buildings,
- Integration of active buildings into energy distribution networks,
- Active management of distribution networks and micro-grids to ensure optimal operation and flexibility.

AIMAC TEAM (Artificial Intelligence for Multimodal Affective Computing)

In the area of Affective Computing, we analyze, synthesize and track emotions. We develop tools drawn from Artificial Intelligence (Auto-encoders and GANs) applied to the fields of image, voice and text.

The team offers a new way of representing emotions that makes it possible to follow a person's emotional state over time. This real-time analysis of a user's emotions is multimodal: it exploits the voice, speech, context, gesture and facial expressions. Current work focuses on stress detection and micro-expressions spotting and analysis in a medical context. The tools developed come from Deep Learning mainly: GAN, VAE, CNN and auto-encoders mainly. The research work of the AIMAC team has been enhanced through the creation of three startups: Dynamixyz (Performance Capture), 3D Sound Labs (Binaural Reproduction) and Immersive Therapy (Tinnitus App.).

SIGNAL & COMMUNICATIONS DPT. (SC)

The Signal and Communications (SC) department is composed of two thematic teams: the SIGNAL team, which brings together skills in signal processing, algorithms and digital communications, and the ASIC team, which brings together skills in embedded electronic systems and architectures.

The two teams, which are multi-site and multi-institutional, are highly complementary and are based on cross-disciplinary skills ranging from circuits and architectures to signal processing algorithms for communications systems.

For the IETR, the SC department deals with signal processing, algorithms, digital communications and embedded electronic systems and architectures, including the creation of prototyping platforms to meet the needs of future radio transmission systems. Thus, four transversal axes to the two teams SIGNAL and ASIC ensure thematic coherence:

- Axis 1: Digital communication systems,
- Axis 2: Embedded and secure communicating systems,
- Axis 3: Communicating electronics,
- Axis 4: Networks and communication infrastructures.

Each of these axes is found in both teams and is broken down into scientific and technological locks.

HIGHLIGHTS 2022

- New **organization** of the laboratory and of the Departments.
- Visiting stay (4 months) of **Pr. Sayantan Hazra** from Mahindra University – Ecole Centrale School of Engineering)
- Celebration of the **twentieth anniversary** of IETR laboratory in CentraleSupélec (June 2022)

❑ Anticipate the future behavior of the system using its dynamic model

Prediction Model:

$$\begin{cases} x_{k+1} = f(x_k, u_k) \\ y_k = g(x_k) \end{cases}$$

❑ Define the objectives of the control on an H prediction horizon

Criterion:

$$J_g = \sum_{k \in \mathbf{H}} (J_{\text{eco}} + J_{\text{inconf}})$$

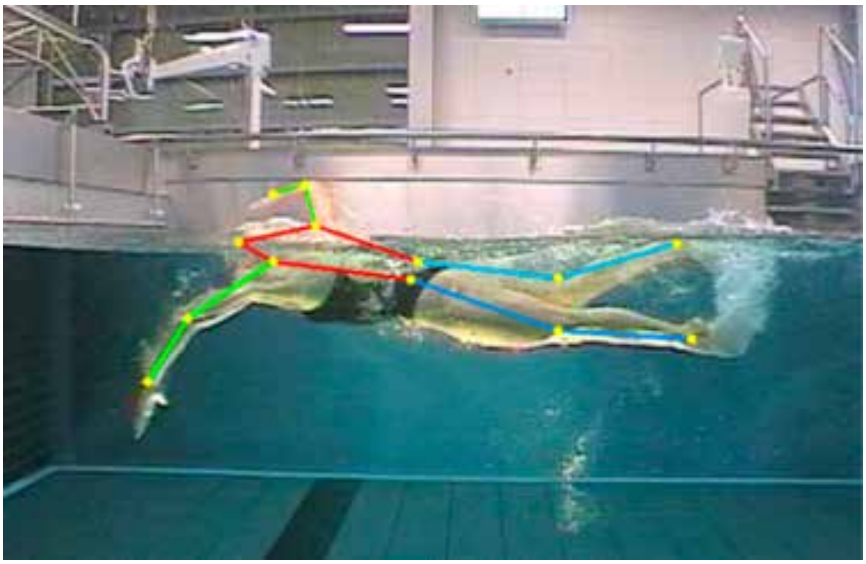
❑ Formalize the constraints of the system

Constraints:

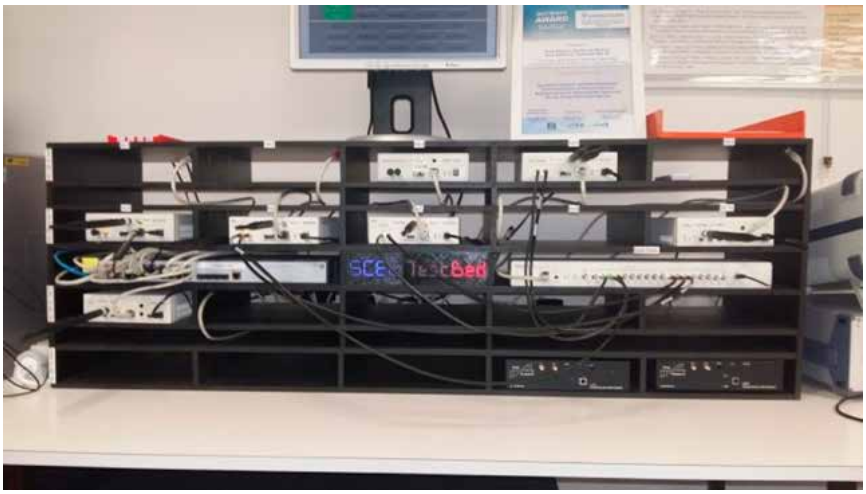
$$\sum_{m \in \mathrm{M}} \mathrm{p}_m^{\max} u_{m,k} \leq \mathrm{p}_k^{\text{global max}}$$

❑ Find the future control sequence to apply to the system in order to optimize the criterion

Predictive control



The SWIMXYZ project, labeled by DigiSport, focuses on capturing and analyzing a swimmer's movements in order to improve his performance



SC Test Bed

- *10 Universal Software Radio Peripheral (USRP) Boards*
- *2 Windows stations*
- *1 Linux station*

Industrial Partners

- Bouygues,
- Delta Dore,
- Enensys,
- GDI Simulation,
- Orange,
- SAFRAN,
- Siradel,
- Thales.

Academic Partners

ITMO University, French hospital research laboratories (Rennes, Angers), EUR Digisport, IIIT Delhi, Liège University, , Patras University, Poznan University of Technology, Zhejiang University, Mahindra University, Patna University

Key figures*

Professors, Associate Professors & Researchers	17
PhD Students	16
PostDoc	1
Visiting Professor	1
Publications of the year (WoS)	29

*CentraleSupélec only

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