INTUITIVE

INnovative Network for Training in ToUch InteracTIVE Interfaces

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Deliverable reporting document

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Description:
Report on the research schools, workshops, & tutorials organized the second year of the project

Deliverable text:

Second year research schools, workshops, & tutorials

Shortly after the start of the Intuitive project with a kick-off meeting in Lund 2019, the Covid-19 pandemic struck. This had a major impact on the INTUITIVE project during the start-up of the project, and therefor covered Deliverable D6.2 the first two years of the project. The recruitment of the ESRs that suffered from the pandemic in the form of major delays and dropouts wasn't completed until 11 October 2021, which also made it advisable not to arrange any workshops or tutorials during the first one and a half year of the project.

The Covid-19 pandemic continued through the INTUITIVE project's third year and made it difficult to have in person meetings during the first half of 2022, we arranged the activities online to allow participation of all members of the consortium

This deliverable will report the activities that were arranged for the ESRs from M25 to M37.

The INTUITIVE project's journal club

The INTUITVE journal club started on 10th September 2021 and continued until 8 April 2022. Bi-weekly, one of the ESRs selected an educative article and uploaded it on the journal club repository. When the journal club ended in the spring 2022, all the ESRs had presented an article. This was a journal club between the ESRs but the presenting ESR was free to invite PIs to participate which led to a better in-depth discussion.

Workshop: Haptic Perception in Robotic Systems, 3 November 2021

BMW and Lund University had a digital workshop in the subject "different perspectives on how to implement biological principles in visuo-haptic integration in robots.

Research School 2, 26-30 September 2022

The second Research School took place in Genova, Italy in September 2022. This was a co-organisation with another ITN project, NeuTouch. Since this was the first time all the ESRs were able to meet in person, a lot of interesting conversation took place and possible collaboration

were discussed.

The theme of this Research School was biomimetic and flexible electronics technologies. It included invited lectures on flexible electronics, electronic design, soft-MEMS, as well as lectures on soft skills such as social media.

The agenda of the Research School is found in appendix 1. In the following we give a short presentation from a selection of the invited lecturers and activities performed during the research school. We paid attention to a mix of formats and allowing active participation of the ESRs. Overall, the ESRs found the Research School interesting, informative and an insightful experience and believed that the interaction with fellow ESRs was very useful.

Training

Jamie Gallagher (award-winning communicator and engagement professional)

Social Media for Researchers: Getting your work on social media may be easy – but making it popular is more challenging. This workshop takes you through the main social media channels and looks at how to create share-worthy content messages. Discover how to use social media to foster meaningful interactions and share your work with as many people as possible. Form tweets to live streams this interactive session is packed with ideas of how to maximise your use of social media as a researcher.

Beyond the Lab: Researchers need to have a diverse skillset, from the ability to manage long and complex project to being able to form collaborations outside your field. This workshop will guide you through some of the most useful and important skills to have at your disposal. We will explore everything from efficient working through to impact beyond the academic.

Lectures (by selection)

Maurizio Valle (University of Genoa) – ***Electronic-Skin Systems for Robotics and Healthcare***.

The talk introduced artificial skin systems based on piezoelectric polymeric materials. Basic features of PVDF and P(VDF-TrFE) and of the dedicated interface electronic circuit solutions will be highlighted. Distributed pressure sensing systems based on arrays of piezoelectric polymeric transducers and two examples of applications in robotics and healthcare was detailed.

Ingrid Graz (Johannes Keppler University) - ***Skin-Inspired Stretchable Electronics and Adjustable Soft Structures for Damping.***

The human skin not only is the largest human organ, but it also serves as large area sensor and

as protective layer. Inspired by the ingenious design of the skin, stretchable sensor and electronic circuits have been developed. Tackling the interfacing issues of soft-to-rigid- active material interfaces, silicones and novel silicone composites with a gradient in stiffness were developed. In addition, skin-inspired damping structures were investigated for adjusting their stiffness/damping properties. Combining these two approaches we aim at creating soft skin like damping structures with sensing capabilities.

Mohsen Kaboli (BMW & Radboud University) - ***Active Visuo-Tactile Interactive Perception and Deep Cross-Modal Learning for Object Grasp and Manipulation Robotics*.**

For robots to execute tasks in unstructured environments, visuo-tactile plays a key role. The vision-based technologies have become essential for an effective analysis of the scene, path planning, and observing the behaviour of humans in the robot workspace. However, vision alone is often not enough to achieve sufficient perception capabilities of robotic systems in unstructured environments, due to variable light conditions, occlusions in cluttered scenes, and a requirement for contact information between robot and environment. Tactile perception is of fundamental importance for robots that physically interact with the external environment. Wisely leveraging tactile information provides robots with enhanced perceptive capabilities. For these reasons, interactive tactile perception is becoming important research directions to support visual perception. Even though tactile and visual perception has gained a great deal of interest, the field of active visuo-tactile interactive perception and cross-modal learning have not been profusely explored in robotics. A robotic system with active visuo-tactile perception and cross-modal learning capability can leverage a prior knowledge acquired with one modality and efficiently use it with other at execution time. In this talk, I will present our recent developed full-fledged active visuo-tactile perception and deep-cross modal learning framework for the robotics systems to efficiently localize cluttered objects in an unknown workspace and to recognize object, previously inspected with one modality like vision, via tactile modality.

Nitish Thakor (John Hopkins University) - ***Tactomorphics for Prosthetic****.*

Prostheses improved in their motor performance with the development of dexterous multifinger manipulators. However, most modern prosthesis lacks the sense of touch and how that information is relayed back to the amputees is even less understood and developed. Tactomorphics utilizes design of tactile sensors that mimic the receptors in the skin and encodes the information by modelling the receptors in the skin using the spiking neural code. Once this

neural code is implemented, algorithms are developed to address conditions encountered in palpation. This talk will present the model, neuromorphic encoding, and then how primitives of palpation, edge, shape, texture, and functions of slip and grasp can be implemented. For Feedback, we will explore two options, vibration and electrocutaneous stimulation. Computational modelling results and experimental results with able-bodied and amputees will be presented. Further work would involve developing machine learning methods (preferably embedded) and feedback techniques (preferably non-invasive) for enhancing touch perception.

Franceska Santoro (RWTH Aachen/Forschungszentrum Jülich/Istituto Italiano di Technologia Napoli) - ***Coupling Living and Artificial neurons Beyond Conventional Neuromorphic Devices.***
The interface between biological cells and non-biological materials has profound influences on cellular activities, chronic tissue responses, and ultimately the success of medical implants and bioelectronic devices. The optimal coupling between cells, i.e., neurons, and materials, is mainly based on surface interaction, electrical communication and sensing. In the last years, many efforts have been devoted to the engineering of materials to recapitulate both the environment (i.e., dimensionality, curvature, dynamicity) and the functionalities (i.e., long- and short-term plasticity) of the neuronal tissue to ensure a better integration for the bioelectronic platform and cells. On the one hand, here we explore how the transition form planar to pseudo-3D nanopatterned inorganic and organic materials have introduced a new strategy of integrating bioelectronic platforms with biological cells under static and dynamic conditions. On the other hand, we investigate how organic semiconductors can be exploited for recapitulation electrical neuronal functions such as long term and short-term potentiation. In this way, both the topology and the material functionalities can be exploited for achieving in vitro biohybrid platforms for neuronal network interfacing.

Giacomo Valle (University of Chicago) - ***Somatosensory Neuroprostheses for Sensing with Bionic Limbs.***
In the recent past, several research groups are studying the fascinating and futuristic research of connecting the human nervous system with bionic limbs. Striving to close the gap between humans and machines, this research is now working to create prosthetic limbs that utilize the direct neural stimulation of the nervous system to restore sensory-motor functions lost after an injury or a disease. Decades of technological developments have populated the field of brain-machine interfaces (BMI) and neuroprosthetics with several replacement strategies, neural

modulation treatments, and rehabilitation strategies to improve the patients' quality of life. The neuroprostheses are implantable device es designed to replace or improve the function of a disabled part of the nervous system. The different approaches for the restoration of sensory functions through neuroprostheses based on electrical neurostimulation will be presented. This field is now quickly expanding thanks to advances in neural interfaces, machine learning techniques, and robotics. In the next future, the neurotechnologies will continue to grow thanks also to faster and more advanced computer simulations allowing to test and validate these technologies even faster. The transformation of neurotechnologies blurs the boundaries between human and machine.

Paul Marasco (Cleveland Clinic) - ***Multisensory Cognitive and Perceptual Integration with Advanced Bionics.***

Prosthetic interventions are showing increasing levels of sophistication and autonomy. As the complexity of advanced systems continues to grow so does the complexity of human-machine relationships. Natural bi-directional communication between bionics and their users is essential to provide seamless integrated control, a cognitive sense of ownership for the physical device, and a cognitive sense of agency for its actions. This talk will cover many facets of neurorobotic control and feedback, innate behavioural strategies, systems-level adaptation to sensory restoration, and embodied cognition for prosthetic limbs. Neurorobotics and human-machine interactions are beginning to provide insight into understanding the complexities of how humas interact with their own intrinsic embodied cooperative systems and the brain circuitry that underlies the cognitive sense of self.

Matteo Lo Preti (Soft Biorobotics Perception Lab – Instituto Italiano di Technologia) - ***Interacting with the Unknown: the Soft Sensing Way***

A variety of tasks and behaviours result from a manipulator interacting with an unknown environment. Sensorization required for an artificial system to gather tactile data and make autonomous decisions, with many examples concerning resistive, inductive and capacitive sensors. Embeddable sensors must be compliant with the environment and conformable with the agent. Optical sensors are appealing because of their wide sensitivity range, reliability, and resistance to EMI. These characteristics can be exploited to cover wide regions with distributed sensors instead of integrating several sensors into arrays. However, the tactile reconstruction becomes trickier when a direct correspondence between electronic components and taxels is

missing. Indeed, in complex soft systems, e.g., manipulators, etc., the computational effort should be balanced between the processing (brain) and the morphology (body). Morphological computation highlights the significance of the body's passive adaptability. The main challenge in limiting the robot complicity is understanding the trade-off between morphology working parallel to the control or being functional.

ESR contribution to the Research School

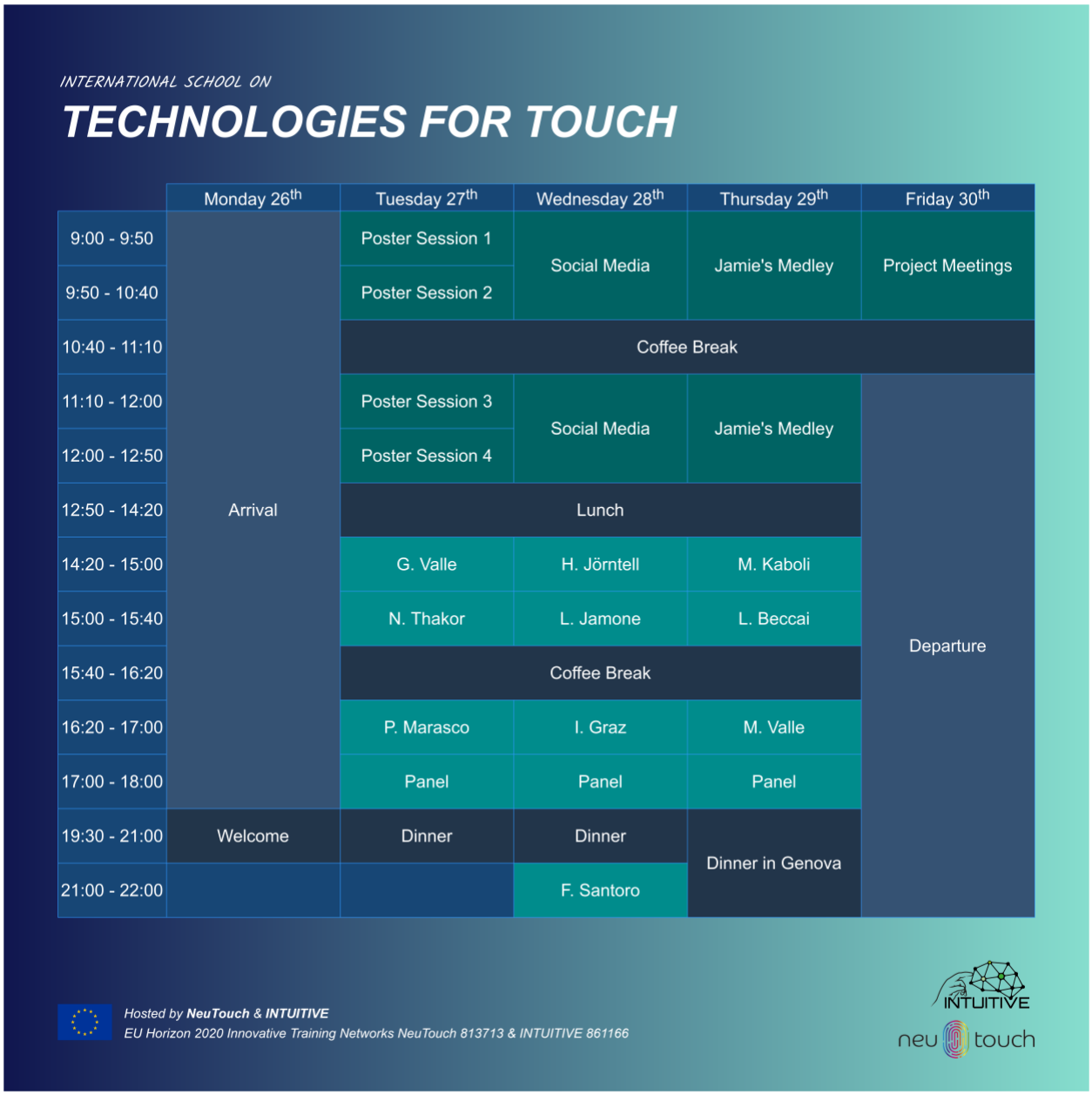
There were points in the agenda that were designed to foster active participation, contributions, and interaction from the ESRs.

Poster session: The ESRs were encouraged to present an interesting experiment and/or result in a poster. This was a chance for the ESRs to showcase their work to their peers and the invited lecturers, since the poster would be displayed throughout the Research School.

Panel discussion: An ESR from INTUITIVE was, together with an ESR from NeuTouch, in charge of organising and chairing the panel session (one per day).

RoboTac 2022, 23 October 2022

RoboTac is a highly collaborative Research Lab and every year they arrange a workshop where internationally known speakers are invited. This year the title for this workshop was "Vasio-Tactile Predictive Coding and Active Inference for Grasp and Manipulation" and it took place 23 October. The workshop was co-organised under the INTUITIVE project and some of the PIs were invited as keynote speakers. The shortened version of the program for RoboTac is found in appendix 2.


INTERNATIONAL SCHOOL ON
TECHNOLOGIES FOR TOUCH
Monday 26th
Tuesday 27th
Wednesday 28th
Thursday 29th
Friday 30th
9:00 - 9:50
9:50 - 10:40
10:40 - 11:10
11:10 - 12:00
12:00 - 12:50
12:50 - 14:20
14:20 - 15:00
15:00 - 15:40
15:40 - 16:20
16:20 - 17:00
17:00 - 18:00
19:30 - 21:00
21:00 - 22:00
Arrival
Welcome
Poster Session 1
Poster Session 2
Social Media
Jamie's Medley
Project Meetings
Coffee Break
Poster Session 3
Poster Session 4
Social Media
Jamie's Medley
Lunch
G. Valle
H. Jörntell
M. Kaboli
N. Thakor
L. Jamone
L. Beccai
Coffee Break
P. Marasco
I. Graz
M. Valle
Panel
Panel
Panel
Dinner
Dinner
F. Santoro
Dinner in Genova
Departure
Hosted by NeuTouch & INTUITIVE
EU Horizon 2020 Innovative Training Networks NeuTouch 813713 & INTUITIVE 861166
INTUITIVE
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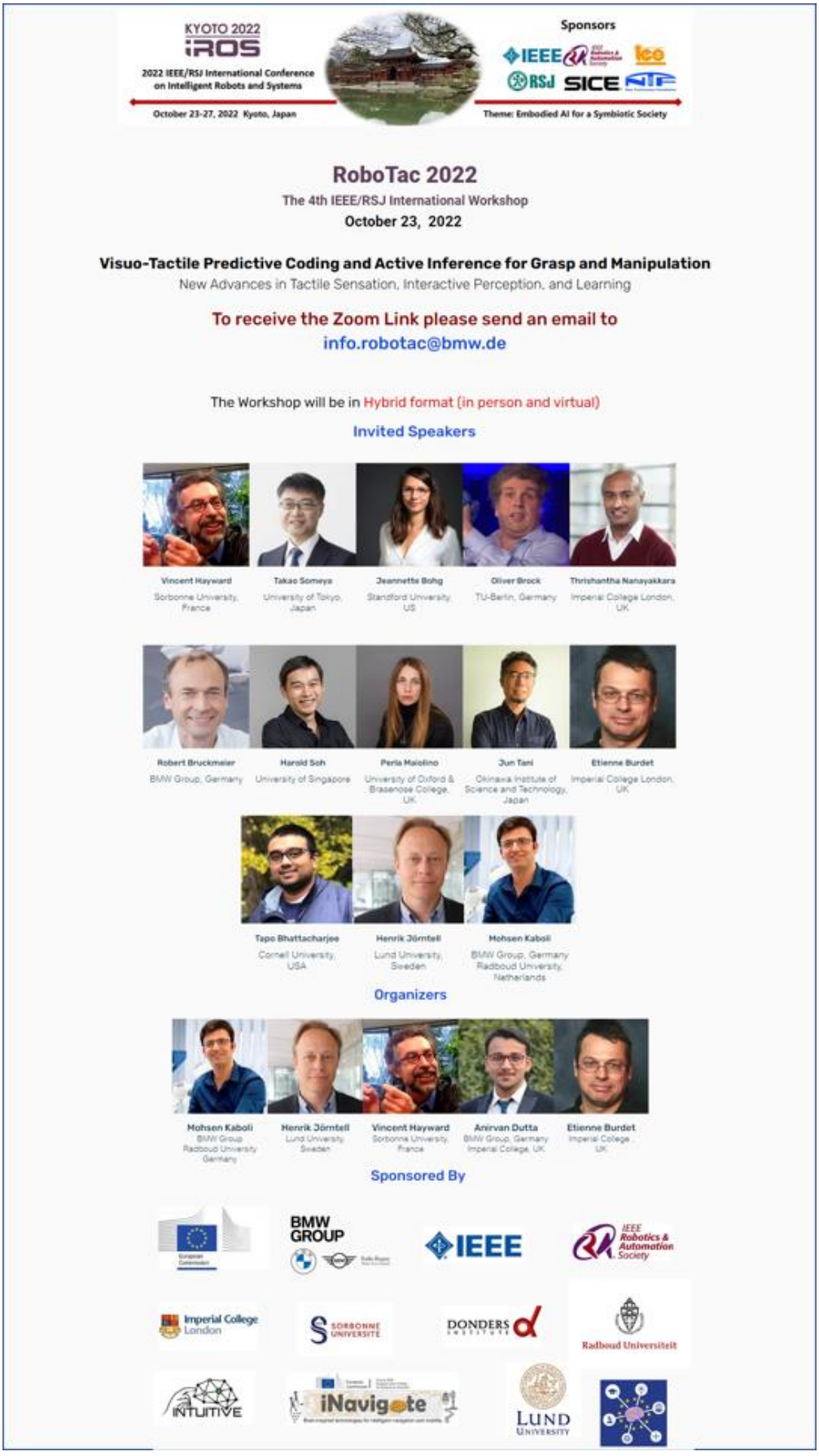
KYOTO 2022
IROS
2022 IEEE/RSJ International Conference on Intelligent Robots and Systems
October 23-27, 2022 Kyoto, Japan
Sponsors
IEEE
RSJ
SICE
Theme: Embodied AI for a Symbiotic Society
RoboTac 2022
The 4th IEEE/RSJ International Workshop
October 23, 2022
Visuo-Tactile Predictive Coding and Active Inference for Grasp and Manipulation
New Advances in Tactile Sensation, Interactive Perception, and Learning
To receive the Zoom Link please send an email to
info.robotac@bmw.de
The Workshop will be in Hybrid format (in person and virtual)
Invited Speakers
Vincent Hayward
Sorbonne University, France
Takao Someya
University of Tokyo, Japan
Jeannette Bohg
Standford University, US
Oliver Brock
TU-Berlin, Germany
Thrishantha Nanayakkara
Imperial College London, UK
Robert Bruckmeier
BMW Group, Germany
Harold Soh
University of Singapore
Perla Maiolino
University of Oxford & Brasenose College, UK
Jun Tani
Okinawa Institute of Science and Technology, Japan
Etienne Burdet
Imperial College London, UK
Tapo Bhattacharjee
Cornell University, USA
Henrik Jörntell
Lund University, Sweden
Mohsen Kaboli
BMW Group, Germany
Radboud University, Netherlands
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Radboud University
Germany
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Lund University
Sweden
Vincent Hayward
Sorbonne University
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Anirvan Dutta
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