CeTI Centre for Tactile Internet with Human-in-the-Loop

Symposium on
Human Active Perception & Action
(Feb. 11.2020)

Symposium Venue: TU Dresden Barkhausen Bau
Rm. **BAR I-15** (Helmholtzstraße 18, 01069 Dresden)
https://navigator.tu-dresden.de/etplan/bar/01/raum/141501.0110

9:10 – 9:20 **Brief welcome & introduction**

9:20 – 10:00
Speaker: **Dr. Jakub Limanowski (University College London)**
Title: **Re-learning body models in the human brain**

To control action, the human brain maintains an internal model of its 'own' body by continuously integrating sensory inputs with model predictions. In the past few years, I have investigated these processes using bodily illusions and virtual reality. This work suggests a tight link between prediction, attention, and multisensory integration in the construction of the neuronal body representation and the experience of 'body ownership'. Here, I will present a research project aimed at revealing the cognitive-computational processes underlying the 're-learning' of a body model, using virtual reality and a multi-methodological approach – centred on computational modelling of brain activity, behaviour, and experience; as manipulated by experimental design or through causal interventions. The project builds, firstly, upon the idea that bodily self-identification and self-other distinction rely on adequately weighting various sensory cues depending on the current context; i.e., on the control over sensory attention and attenuation. Secondly, I propose that immersive virtual reality technologies (or cyber-physical systems in general) often present adults with problems very similar to those that have to be solved throughout human development; i.e., the (temporary) adoption of a new body model and, as true 'immersion' into an alternative (virtual) reality requires actively ignoring the physical reality, 're-learning' the weighting of seen (virtual) and felt (physical) bodily information. Based on these assumptions, the proposed project will investigate how people adopt a new (virtual) body, whether and how this requires 're-learning' the body model – including sensory attention and attenuation – in the brain, and how these changes affect the representation and experience of the physical body.

10:10 – 10:50
Speaker: **Dr. Guido Maiello (University Giessen)**
Title: **Visually guided grasping & its effects on perceptual representation**

In everyday life, we effortlessly grasp and pick up objects without much thought. However, this ease belies the computational complexity of grasping. To pick something up, our brains must work out which surface locations will lead to stable, comfortable grasps, so we can perform desired actions. Additionally, we configure our hands in many distinct ways to pick up and interact with objects. To thread a needle, one might grasp it up using a delicate precision grip, taking care to avoid the sharp end. To screw a lightbulb into a lamp, one might grasp the bulb with all five fingers. Thus, to pick up and manipulate objects we must select both the hand pose (i.e. the number and arrangement of fingers) and the contact locations on the surface of the object. We heavily rely on vision to identify objects and the properties that determine how we should grasp them, yet how visual features are combined to guide grasping is unknown. To investigate this, in behavioral experiments we employed the high-precision Optotrak motion tracking system to measure precision grip contact locations on 3D printed objects of different materials with both common and novel surface geometries. We demonstrate that human grasps are highly constrained, and we develop a computational framework capable of predicting 2-digit contact locations with striking fidelity. Moving onto multi-digit grasps, we had human participants grasp novel and everyday objects varying in size and material, while wearing a data glove. Hand pose data was recorded continuously during the grasping movement, and object identity was already decodable one full second before participants touched an object. This demonstrates the critical role of vision in selecting the correct hand pose for grasping. By combining behavioral measurements of hand pose and finger contact locations with detailed computational modelling we can thus fully characterize human visual selection of multi-digit grasping.

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11:10 – 11:50

Speaker: **Dr. Georgiana Juravle (Lyon Neuroscience Research Center)**

Title: **Tactile perception for naturalistic goal-directed action**

A wealth of demonstrations is available regarding the impact of perceptual deficits to the appropriate execution of action (i.e., the perception-to-action link), as well as on the cardinal influence of action execution for perceptual modulations (i.e., the action-to-perception link). In the first part of this talk, I will focus on tactile perception and I will describe how this is modulated during the various temporal phases of goal-directed actions, underlining the mechanisms of tactile attention and tactile attenuation, or tactile suppression. In the second part, I will present a study investigating how the tactual qualities of an object we reach for and grasp affect our action, with a focus on perceptual priors and perceptual surprises. I will finish with a series of recent experiments designed to test, in a naturalistic haptic number estimation task, how the different senses inform our actions, by specifically concentrating on meaningful pairings between sensory information and actions. Overall, my research argues in favour of sensorimotor integration as a bidirectional process, with the motor prediction being adjusted online based on available sensory input and sensory priors. These recent findings on naturalistic action demonstrate that the sensory information intrinsic to the action performed guides goal-directed movement, defines the meaning of our action, and thus informs cognition.

12:00 – 12:40

Speaker: **Dr. Dimitris Voudouris (University Giessen)**

Title: **The two dimensions of action**

Movement is the cornerstone of successful interactions between humans and their complex world. To perform a meaningful movement, appropriate motor commands are generated on the basis of acquired sensory signals. Two key dimensions are identified in this sensorimotor process: First, humans rely on the sampling of sensory information that is relevant for the desired action. Second, this sampled information is merged with a sensorimotor prediction of future sensory states, which is based on previous knowledge about the prevailing dynamics. In my talk I will first present work on human sensory sampling for human-world interactions. I will then also show how and why sensorimotor predictions for action influence the associated sensory sampling. The last part of my talk will look into the future. I will propose approaches to address open theoretical issues on human sensory sampling and predictions, such as the role of serial sampling in sensorimotor learning and the influence of uncertainty in the two dimensions of action. These approaches will further provide a firm ground to develop attainable implications that enhance human-machine cooperation. The emphasis will be given on how devices learn to cooperate with humans and on how to further democratize skills, especially across ageing and populations with special sensorimotor abilities.