Eurohaptics 2016 Workshop

Haptic illusions: chance, challenge or nuisance for applications?

July 4, 2016; 14:00 - 18:00
Imperial College London, UK

Abstract

Haptic perception is susceptible to illusions and is very often not veridical. In this workshop we will question whether and if so how this has or should have any consequences for the design of applications. If we think that it is important to correct for misperceptions (for example, because it makes interacting with applications less inuitive) this is a real **challenge**. On the other hand, if due to illusions or misperceptions, we convey exactly the perception that we want to convey (although very different from the real physical stimulation), it provides us with a big **chance**. But we might also see these misperceptions as just a **nuisance**: in general, humans have a very steep learning curve, so why bother if at first their perception seems to be at odds with what they are supposed to perceive? They will adjust quickly and that's much easier than correcting. During this workshop, ten speakers will present their views on this topic. The audience will be encouraged to participate in the discussions.

Organizer

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Speakers

Gabriel Baud-Bovy	Italian Institute of Technology, Genova, Italy
Femke van Beek	Cal State, LA, US & Vrije Universiteit Amsterdam, The Netherlands
Edward Colgate	Northwestern University, Evanston, US
Ophelia Deroy	University of London, Institute of Philosophy Centre for the Study of the Senses, London, UK
Vincent Hayward	Université Pierre et Marie Curie Institut des Systèmes Intelligents et de Robotique, Paris, France
Hsin-Ni Ho	NTT Communication Science Laboratories, Kanagawa, Japan
Lynette Jones	Massachusetts Institute of Technology, Boston, US
Ilana Nisky	Department of Biomedical Engineering Ben-Gurion University of the Negev, Israel
Eric Vezzoli	Lille 1 University, France
Yon Visell	University of California, Santa Barbara, US

Registration

Interested attendees must register through the Eurohaptics conference portal.
http://www.eurohaptics2016.org

Program Haptic illusions: chance, challenge or nuisance for applications?

14:00 - 14:10	Astrid Kappers	Opening and introduction
14:10 - 14:30	Lynette Jones	Misperceptions and reality in tactile sensory processing
14:30 - 14:45	Hsin-Ni Ho	Averaging or contrast? Haptic illusions resulting from two crossmodal integration strategies
14:45 - 15:00	Femke van Beek	It depends
15:00 - 15:15	Eric Vezzoli	Reproduction of fine texture in surface haptic devices
15:15 - 15:30	Ilana Nisky	Haptic illusions - Fool the mind or the hand?
15:30 - 16:00	Break	
16:00 - 16:20	Edward Colgate	Haptic Illusions for Fun and Profit
16:20 - 16:40	Yon Visell	Haptic Illusions - That's Reality!
16:40 - 17:00	Gabriel Baud-Bovy	Plato's cave and haptic space perception
17:00 - 17:15	Vincent Hayward	Fooled by one's predictions, not by the world 1 The invariants behind tactile illusions
17:15 - 17:30	Ophelia Deroy	Fooled by one's predictions, not by the world 2 A metacognitive interpretation of (tactile) illusions
17:30 - 18:00	General discussion	

Abstracts

Lynette Jones — Misperceptions and reality in tactile sensory processing

Haptic illusions, particularly those that involve tactile space-time interactions, have been used to enhance the information presented in tactile displays. Such illusions represent a fundamental aspect of perceptual processing and so the challenge is to determine how stimulus presentation can be optimized to convey the perceptual cues of interest. There is often an assumption by designers of haptic displays that by manipulating the temporal parameters of stimulation an illusion will emerge and be perceived reliably by users. However, experimental research has clearly demonstrated that many tactile and haptic illusions are subtle and critically depend on the spatial and temporal parameters of stimulation. Moreover, even illusions that are considered relatively robust are often not experienced at all by some users. It is therefore important to consider both the robustness (how many people experience the illusion) and strength (the magnitude of the change in perception) of an illusion when implementing it in a display. Perceptual effects that require significant attentional resources will always be problematic in the context of active users of display technology.

Hsin-Ni Ho — Averaging or contrast? Haptic illusions resulting from two crossmodal integration strategies

It is known that our brain integrates visual and haptic information in estimation of a property of an object explored by the hand. Therefore, when designing a multimodal interface, it is important to take the effect from crossmodal integration into consideration. It has been shown that the brain uses two different strategies for this crossmodal integration. One is an averaging effect, which biases the final haptic perception toward the expectation from visual information. This effect has been demonstrated in the cases of estimating surface texture and size of an object. The other is a contrast effect, which makes the final haptic perception opposite to the expectation. The famous size-weight illusion is one example of this type of integration. However, the problem is that it remains unclear why crossmodal integration is an averaging effect in some cases, while a contrast effect in other cases. Thus, it is difficult to predict the effect of crossmodal integration on haptic perception in applications. In this talk, I will introduce crossmodal illusions resulting from both integration strategies and our recent finding of a contrast effect for the integration between color and object temperature. Feedback from the attendants is welcome to discuss about what are the possible factors that influence the way our brain integrates crossmodal information.

Femke van Beek — It depends

When designers of haptic devices ask a psychophysicist to provide them with information on human perception in order to obtain design specs for their devices, they usually want one answer that fits all humans and all situations. However, reality in human perception is different, and the most complete answer is always: "it depends". There usually are large differences between people in terms of sensitivity and priors, between tasks, between strategies, etc.

I would like to argue that the answer ‘it depends’ also applies to the question of biases in human perception. Some biases are very robust, so they would allow for easy ‘correction’ of human responses when used in haptic devices. However, even for very robust biases, the magnitude can be very different between participants or specific task parameters. So, it all depends… but that does not mean that we have to stop here! Even for participant-dependent biases, solutions can be sought in individualizing devices for each user. As long as we keep building a thorough understanding of the basis and mechanisms of perceptual biases, we should be able to turn this nuisance into a chance, which probably requires individualizing devices to meet the individual user’s perception.

Eric Vezzoli — Reproduction of fine texture in surface haptic devices

A fundamental difference in the perception of coarse and fine textures by humans was suggested, namely the duplex theory of texture perception, stating that coarse textures are encoded by slowly adapting mechanoreceptors, whereas fine tactile sensations are mostly driven by skin vibrations, called vibrotaction, encoded by the rapidly adapting receptors. This finding has a straightforward consequence: even if finger perception is impaired, the subject’s ability to discriminate texture is preserved. The reproduction of spatialized texture sensations in surface haptic devices was always driven by updating of haptic signals in function of the finger position, leading to the perceived spatialized texture. In this talk, we show that the absence of localised stimuli under the fingertip characteristic of the surface haptic device leads to the illusion to touch a localised periodical pattern for a non-localised periodic haptic signal. This is proven even when the density of the stimuli is comparable with the human fingertip contact area, which is probably due to the encoding of coarse surface haptic texture as vibrotaction stimulation. The repercussion of this result for the simplification of the control scheme of surface haptic devices will be discussed.

Ilana Nisky — Haptic illusions - fool the mind or the hand?

Perception and action are tightly coupled in the sensorimotor system. For example, perception of the mechanical properties of the environment is important in planning future actions, and at the same time, natural haptic exploration of the environment is active – we move and probe the environment to create haptic perception. Interestingly, inconsistencies between perception and action are evident in many tasks and especially in the context of illusions (Goodale and Milner, 1992, Aglioti et al., 1995, Goodale and Humphrey, 1998, Flanagan and Beltzner, 2000, Carey, 2001, Ganel and Goodale, 2003, Brayanov and Smith, 2010). Even adaptation to force fields (Shadmehr and Mussa-Ivaldi, 1994) may be thought of as a form of an illusion: participants report that by the end of training, they can no longer feel the field, and when it is suddenly removed, they report that they begin to feel a sensation of an opposite force even though the robotic device is not applying any forces.

I will present recent examples of such inconsistency in the effect of delay on perception and action. For example, in tool-mediated interaction with elastic objects, delay causes an illusion of a softer object, but in the same time, after several probing movements, the grip force that participants apply on the tool is adjusted to the correct timing and the correct stiffness level of the elastic field (Leib et al., 2015). Such inconsistencies present a challenge but potentially also an opportunity for designing non-ideal haptic interfaces for teleoperation or virtual reality by taking advantage of the inconsistency between perception and action as an additional design parameter. They also highlight that in the evaluation of haptic interfaces it is important to assess the effectiveness of the devices in presenting the desired perception and also in allowing for desired actions.

J. Edward Colgate — Haptic Illusions for Fun and Profit

Everyone loves a good illusion. Think of the Necker Cube, rabbit/duck ambiguous figure, spinning dancer or McGurk Effect. Besides being fun, these illusions are remarkably powerful tools for understanding cognitive processes. But are they of engineering value? For instance, do they inform the design of display technologies? In the visual and auditory domains, the answer would seem to be, for the most part, no. Instead, visual and auditory displays strive for veridicality: they attempt to recreate as much of the physical stimulus as the sensory system is able to resolve … and this seems to work pretty well. Ah, but what of haptics? Here, the story is quite different. My thesis in this presentation is that we, the designers of haptic displays, must not only understand, but in fact rely upon illusions because veridicality is simply not an option with existing or foreseeable technology. With all due respect to the amazing technologies that our community has created, we are just not that close to displaying the sorts of things that our hands routinely encounter in daily life such as 3D objects having features both above and below the scale of a fingertip, as well as texture, compliance, and thermal properties. Absent miraculous new developments in haptic display, the stimuli we can present to the periphery will continue to fall well short of veridicality. Thus, it is central mechanisms – illusions – that must ride to the rescue. In this talk, I'll describe some of the work we and others have been doing to understand and exploit those wonderful illusions.

Gabriel Baud-Bovy — Plato's cave and haptic space perception

In the Allegory of the Cave, Plato argues that people see shadows projected on a wall and mistake these shadows for reality, the real thing that casts the shadows. He argues that education and enlightenment might lead to realize our errors. One might wonder whether there is something like the real thing when discussing haptic space perception. I will review "old" literature on short-term motor memory, position and distance cues. In the physical world, distance and position constrain each other. In our phenomenal world, distances and positions are not necessarily consistent. There are many

other examples of inconsistencies in the haptic modality demonstrating that spatial representations have little to do with the real space. Still, I would argue that Plato was not completely wrong.

Yon Visell **Haptic Illusions - That's Reality!**

The observation that haptic perception is illusory suggests that, when this occurs, there is a degree of veridicality that is not met, and a discord between what we perceive and what is real. Taken at face value, this could be taken to suggest that the mind constructs detailed representations that can conflict with the true state of the world. We know that this idea is fraught with difficulties. For example, it is easy to construct haptic tasks that show that the mind is nothing like a machine for storing features of the environment, but is instead very porous. Another interesting question is this: If there were an ideal observer that is free from illusion, what would it be? Another view of the peril that illusions pose to us is this: Empirical research on haptics teaches us that it is possible to construct simple experiments in which perception is at such great conflict with reality that the behavioral consequences would seemingly put the organism at risk in very common situations. I will discuss these issues in light of results from haptic experiments, and from the literature, including sources that set this question in a broader context.

Vincent Hayward **Fooled by one's predictions, not by the world 1**
The invariants behind tactile illusions

There are many tactile illusions, perhaps many more than visual, auditory, olfactory/gustatory, or vestibular illusions. This could be because mechanical sensing is even more highly ambiguous than other sensory modalities. One approach to discuss illusions is to identify the invariants with which they are associated. These invariants can then be used to attempt to decipher the underlying mechanisms.

Examples of such recently discovered invariants will be shown as they apply to mechanical sensing. In each case they can be used to clearly describe how, in touch, the brain copes with ambiguity. The practical value of these illusions will also be discussed.

Ophelia Deroy **Fooled by one's predictions, not by the world 2**
A metacognitive interpretation of (tactile) illusions

We will challenge the dominant understanding of illusions as 'incorrect percepts'. This follows from the fact that veridicality is not a useful standard to evaluate perception, once percepts are seen as likely interpretations of ambiguous sensory signals, generated on the basis of prior knowledge. Following this consideration, perceiving the moon as bigger on the horizon than at the zenith is as good a percept as any other percept called ‘non illusory’.

Using the examples of tactile illusions, we show that what is rather the case is that some percepts are more surprising than others and those that are really surprising (or even amusing), we often called them illusions. The discrepancy does not then arise from differences between stimuli and percept but between percepts and predictions. What singles out illusions is not the falsity of their content, but a metacognitive assessment that the confidence we place in some predictions is, in the context, inadequate. The ‘wrongness’ then applies to our predictions, not to the percepts. This leads to thinking about illusions not as perceptual phenomena but as phenomena having to do with the metacognitive assessment of the reliability of our predictions.

General discussion

All speakers and attendees are invited to participate in the general discussion. The topic of this workshop gives room for different opinions and it will be of interest to also hear the opinions of the audience.

Further information

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