european training network on full parallax imaging

676401 – ETN-FPI

D4.2

Training school on human visual system and 3D vision

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Abstract:

Report on the first Training school of the Network, "Training school on human visual system and 3D vision", organized at University of Newcastle 27th June – 1st of July 2016.

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Summary

"Training school on human visual system and 3D vision" was organized at University of Newcastle Upon Tyne 27th June – 1st of July 2016.

The aim of this school was to provide all ETN-FPI network members with the necessary background of the human visual system, visual neuroscience and psychophysics research. The course material began with the anatomy and physiology of the eye, moving on to the detailed properties of eye movements and the brain areas involved in vision. Stereoscopic vision was discussed in particular depth.

There was a practical session on techniques for measuring perceptual experience, e.g. perceived distance. Signal detection theory, which underlies much of psychophysics, was treated in detail. A recurring theme was that perceptual experience is an active reconstruction rather than a passive experiencing of the world. Later lectures covered depth cues in detail, including focus/accommodation and how the brain responds when different cues conflict. Towards the end of the school, lectures considered different types of 3D display, including their use in surgery, and touched on practical aspects of achieving full-parallax imaging.

Network members stayed together in the hotel where the school took place and took part in evening activities together, encouraging bonding as a team and the development of personal relationships to facilitate subsequent collaboration throughout the duration of the network.

After the school, slides and professionally filmed/edited videos of most presentations were made available online as a permanent learning resource for network members and the wider community: http://www.full-parallax-imaging.eu/TS1/?page_id=11.

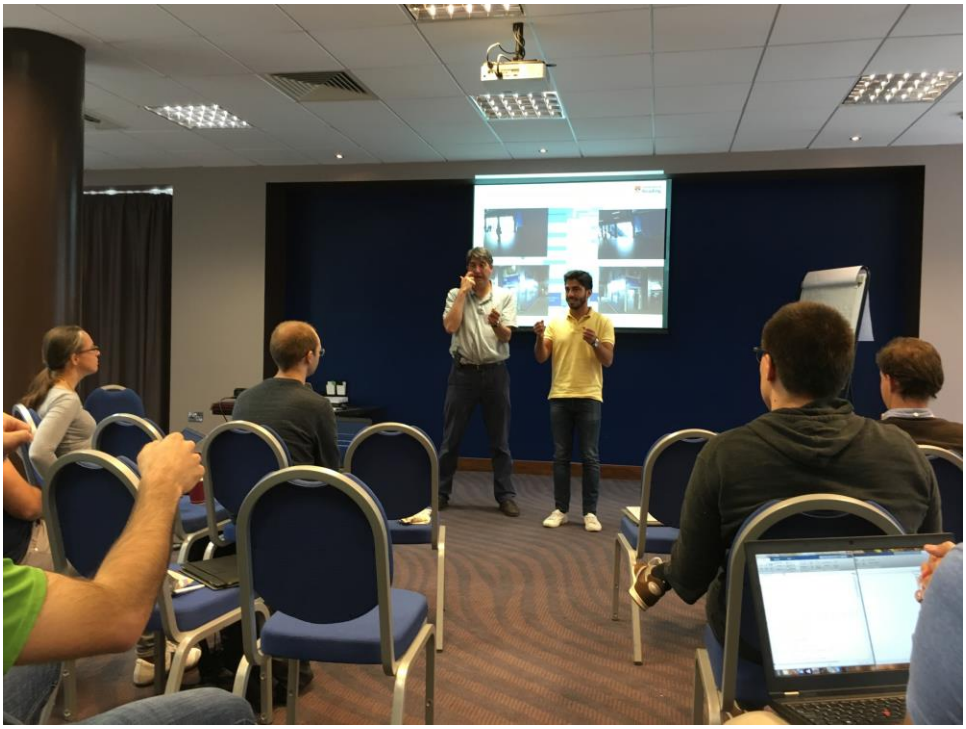

Photo: Robert Bregovic

Eight of the network's already recruited Early Stage Researchers attended to the first training school (see Annex 1 "Participants"). They had a complementary MSCA-ITN info with project managers Robert Bregovic (TUT) and Maria Salomaa (TUT) on Monday 27th June at 18:00.

The local organizer UNEW gathered ESRs' feedback on the training event, which is summarized briefly in the "Feedback" section.

Programme and teaching material

Day 1: Monday 27th June: Basic anatomy & physiology of visual system

1.1 Jenny Read: The eye
Basic anatomy / physiology of the eye. Photoreceptors, retina, pupil, lens, cornea. Rods, cones, colour perception. Dynamic range, cone adaptation.
Slides
Video

1.2 Bruce Cumming: Eye movements
Eye muscles. Saccades, fixation, pursuit, microsaccades. Measuring eye movements. Vergence.
Slides
Video

1.3 Bruce Cumming: The visual brain
Basic anatomy /physiology of brain areas involved in vision. Techniques for studying brain, e.g. single-unit recording, multi-electrode arrays, fMRI, PET, EEG – pros & cons. Brain areas involved in perceiving 3D; ventral/dorsal streams: difference between "perceiving" and "acting".
Slides
Video (part 1)
Video (part 2)

1.4 Jenny Read: Stereopsis
Disparity, stereopsis. Stereoacuity and stereoblindness. Binocular vision disorders: amblyopia, strabismus. The correspondence problem. Issues with mobile eyes; epipolar lines, search zones. Different forms of human stereopsis: fine/coarse, contour vs RDS. Demos: measure your stereoacuity with different clinical stereotests such as Randot, Titmus, ASTEROID.
Slides
Video

Day 2: Tuesday 28th June: Introduction to psychophysics

2.1 Simon Watt: Measuring perception of the 3D world?
Using tape, marker pens, and string to explore different ways to measure the magnitude and precision of perceptual estimates—something that turns out to be surprisingly challenging.

2.2 Ignacio Serrano-Pedraza: Signal detection theory
Dprime; decision criterion; hits, misses, false alarms, correct rejects. ROC curves.
Slides

2.3 Jenny Read: The human contrast sensitivity function
Spatial and temporal frequency. Difference between band-pass luminance CSF and low-pass chromatic CSF; applications to encoding of colour. Fourier spectra of images. Models of the CSF.
Slides
Video

2.4 Ignacio Serrano-Pedraza: Channels and the human disparity sensitivity function
The human DSF and its poor spatial/temporal resolution compared to contrast. Stereo anisotropy. The idea of channels and the masking/adaptation approach to studying them.
Slides

Day 3: Wednesday 29th June: Reconstructing the world in 3D

3.1 Simon Watt: Why the visual system isn't a measurement device
Perception as inference, Emmert's law, the 'problem' of multiple cues, sensory integration (a.k.a. optimal way of combining different depth cues), combining sensory inout and prior knowledge of the world (Bayes Theorem as a general mechanism).
Slides

3.2 Andrew Glennerster: Visual cues to depth
Optic array, sampling the optic array by moving your head around in it, motion parallax cues to depth; optic flow; conceptual similarity between flow/motion parallax and disparity. Visual stability. Task-dependency in vision versus reconstruction.
Slides
Video

3.3 Andrew Glennerster: Perceiving depth & distance
Absolute vs relative disparity, metric depth. Size and slant perception. Vertical disparities.
Slides
Video

3.4: Simon Watt: Focus cues
Accommodation and retinal blur. Differences between real-world and stereoscopic 3d displays, cause of vergence-accommodation (V-A) conflict, effects of V-A conflict, tolerance to V-A conflict.
Slides

Day 4: Thursday 30th June: Current and future 3D displays

4.1 1 Ignacio Serrano Pedraza: Adaptive psychophysical procedures
Bayesian staircase procedures, threshold and slope estimation.
Slides

4.2 Andrew Glennerster: Head-mounted displays and immersive virtual reality.
'Reconstructing' the D world around us (or not). Navigating, pointing. "Fictional stable world" as an example of cue combination. 'Correct stereo for all head positions' versus stereo as a sub-sample of possible views.
Slides
Video

4.3 Simon Watt: Focus cues in S3D
Specific and general solutions, compensation for small disparities, eye-gaze-dependent approaches, volumetric displays, fixed-viewpoint volumetric displays (a.k.a. multi-focal-plane displays), evaluation studies of these.
Slides

4.4 Gordon Love: Replicating accommodation cues with technology
Multi-plane, birefringent, lightfield displays.
Slides

Photo: Robert Bregovic

Day 5: Friday 1st July: Applications of 3D technology

5.1 Nicolas Holliman: Visit to The Core to see 3D Decision Theatre

5.2 Naeem Soomro: S3D displays for laparoscopic surgery

5.3 Panel discussion: What would the ideal 3D display system look like?

Speakers

Bruce Cumming – Chief, Laboratory of Sensorimotor Research, National Eye Institute, National Institutes of Health, USA
Andrew Glennerster – Professor of Visual Neuroscience, Reading University, UK
Nicolas Holliman – Professor of Visualization, The Digital Institute, Newcastle University, UK
Gordon Love – Professor in the Department of Physics, Durham University, UK
Jenny Read – Professor of Vision Science, Newcastle University, UK
Ignacio Serrano-Pedraza – Profesor Titular de Universidad, Universidad Complutense de Madrid, Spain
Naeem Soomro – Honorary Professor of Urology, Newcastle University, UK
Simon Watt – Senior Lecturer, School of Psychology, Bangor University, UK

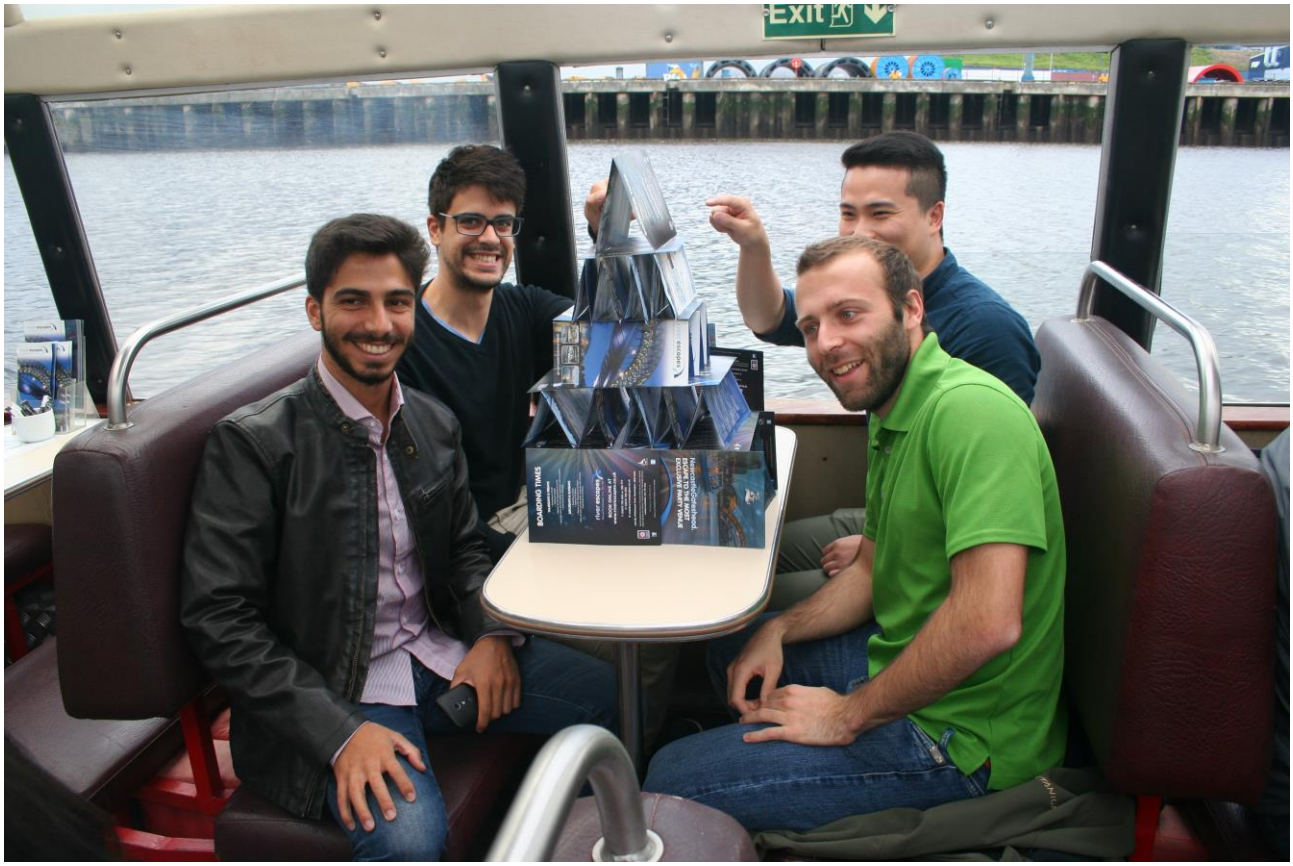

Photo: Robert Bregovic

Feedback

Seven out of the eight Early Stage Researchers, who attended the training event, responded to UNEW's feedback questionnaire after the training school. On the scale from 1 to 5, all the lectures scored 3,8 points (Md 4), interaction with teachers and other participants 4,43 points (Md 5) and the social programme 4,25 points (Md 4).

In the "Free comments" section the ESRs stated that their different backgrounds could have been taken better into account in some of the lectures, since quite many ESRs study in the light field camera area instead of 3D visualization technology: "presentations related to the HVS were more complex and difficult to understand than those related to 3D displays." Therefore, some of the ESRs suggested that more pre-reading material, articles closely related to the lectures, could be provided beforehand.

There was also some imbalance in the quality and content of the lectures, but nonetheless "all topics were useful to understand the connection between the human visual systems (HVS) and 3D display".
The ESRs especially appreciated good communication and organisation of the event.

Photo: Robert Bregovic

Annex

1 Participants

Lisa	Alcock	Newcastle University
Stacey	Aston	Newcastle University
Robert	Bregovic	Tampere University of Technology (TUT), Finland
Carla	Black	Newcastle University
Bruce	Cumming	National Eye Institute, National Institutes of Health, USA
Filipe	Da Graca Gama	Tampere University of Technology (TUT), Finland / ESR
Elijs	Dima	Mittuniversitetet
Oleksii	Doronin	Holografika Kft / ESR
Nabeel	Fattah	Newcastle University
Maydel	Fernandez Alonso	Newcastle University / ESR
Yuan	Gao	University of Kiel / ESR
Andrew	Glennerster	Reading University
Naomi	Gross	Newcastle University
Miles	Hansard	University of London
Nicolas	Holliman	Newcastle University
Jess	Hugill	Newcastle University
Christos	Kaspiris-Rousellis	Newcastle University / ESR
Thomas	Le Couteur Bisson	Newcastle University
Lisa	Li	Newcastle University
Gordon	Love	Durham University
Sergio	Moreschini	Tampere University of Technology (TUT), Finland / ESR
Luca	Palmieri	University of Kiel /ESR
Jenny	Read	Newcastle University
Maria	Salomaa	Tampere University of Technology (TUT), Finland
Gabriele	Scrofani	University of Valencia /ESR
Ignacio	Serrano Pedraza	Universidad Complutense de Madrid
Naeem	Soomro	Newcastle University
Laurens	Van de Perre	KU Leuven
Simon	Watt	Bangor University
Jeff	Wu	Princeton / NCL
Yiwei	Zhang	Glasgow University
Matthias	Ziegler	Fraunhofer IIS Germany