WESTERN SYDNEY
UNIVERSITY

Brain, Behaviour and Development

SUITABLE FOR MASTER OF RESEARCH

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SUITABLE FOR MASTER OF RESEARCH OR PHD

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Decoding the Neural Basis of Object Perception

Dr Tijl Grootswagers: t.grootswagers@westernsydney.edu.au

Research area: Cognitive neuroscience

Humans can recognise an object within a fraction of a second. This is a remarkable feature of the brain, given that the input on the retina varies greatly with viewing angle or distance. The brain also effortlessly organises objects into different categories, which requires complex generalisation rules. How our brains achieve this impressive capacity is still not understood.

This project will advance our understanding of the neural mechanisms underpinning object recognition in the human brain. During the project, the student will receive world-class training in cutting-edge methods, such as neural decoding, human neuroimaging, and artificial intelligence (deep learning). These advanced methods will give new insights into theoretical questions about object recognition, and will allow the student to make a significant contribution to our understanding of the human brain.

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Unsupervised Learning for Event-based Cameras

Dr Bharath Ramesh: b.ramesh@westernsydney.edu.au

Supported by: Professor André Van Schaik

Research area: Computer vision, Machine learning, Pattern recognition

What better way for machines to sense than to emulate the human senses? Event-based cameras belong to a novel family of asynchronous frame-free vision sensors whose principle of operation are based on abstractions of the functioning of biological retinas. These event-based sensors acquire the content of the scenes, i.e., the changes in scenes asynchronously. Every pixel is independent and autonomously encodes visual information in its field of view into precisely time stamped events. In the last few years,

processing this unconventional output has been a research task undertaken many labs around the world. A key problem that remains unexplored is mid-level feature extraction from events, and this project aims to address this gap.

Many successful computer vision models for scene recognition transform low-level features such as Gabor filter responses into richer representations of intermediate or mid-level complexity. This process can often be broken down into two steps: (1) a coding step that transforms the features into a representation better suited to the task, and (2) a pooling step that encapsulates the coded features over larger receptive fields. Thus, extracting mid-level representations is a useful intermediate step for various other intermediate vision tasks, such as accurate flow estimation, macrofeature extraction, and subsequent high-level vision tasks. This is especially of significance to the visually sparse, motion dependent and often disjoint information recorded by event cameras.

From a biological vision perspective, there is evidence that much of the ventral stream organization in our brain can be explained by relatively coarse mid-level features without requiring explicit recognition of the objects themselves (Bria Long, Chen-Ping Yu, Talia Konkle, PNAS 2018). This property is neatly demonstrated by the intermediate layers of a deep convolutional neural network that support extraction of the mid-level representations from standard RGB data. However, this aspect remains relatively unexplored for event cameras. At the initial stage of this project, the student shall carry out a survey of existing event-based learning algorithms, not limited to deep learning works, in addition to a potential idea being explored by our team. Then allows us to evaluate specific techniques that looks most promising as well as workable for a graduate thesis.

The applications of mid-level feature extraction include projects that offer a unique opportunity to access exciting real-world neuromorphic systems developed at ICNS, like the Robotic Foosball table and the Robotic Pinball system. In these cases, tracking fast moving objects that are locally consistent is potentially made easier using richer, intermediate representations.

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SUITABLE FOR PHD

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Research on Conversation by Young and Older Adults

Professor Chris Davis: chris.davis@westernsydney.edu.au

Supported by: Professor Jeesun Kim

Research area: Psychology, Linguistics

The project aims to investigate changes in the perception and production of social behaviours that may occur in old age. The specific research goals of the project include: constructing profiles of older and younger adults' speech and non-speech conversation behaviours; measuring older and younger adults' conversation-based social perception skills as well as sensory, perceptual and cognitive skills; examining the relationship between the profiles and evaluations of the various social, cognitive and sensory skills.

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