# Mac Robertson Travel Scholarship Report

About me

My name is Yu Wei Chua. I am a second year multidisciplinary PhD student at University of Strathclyde, based at the Laboratory for Innovation in Autism and School of Education. My research aims to understand the role of movement in early neurodevelopment from an information theoretic perspective, with an emphasis on the effects of preterm birth on brain development and movement differences in autism spectrum disorder. I was awarded £1360 from the Mac-Robertson Travel Fund which allowed me to make a two-month research visit to Nanyang Technological University, back in my home country Singapore.
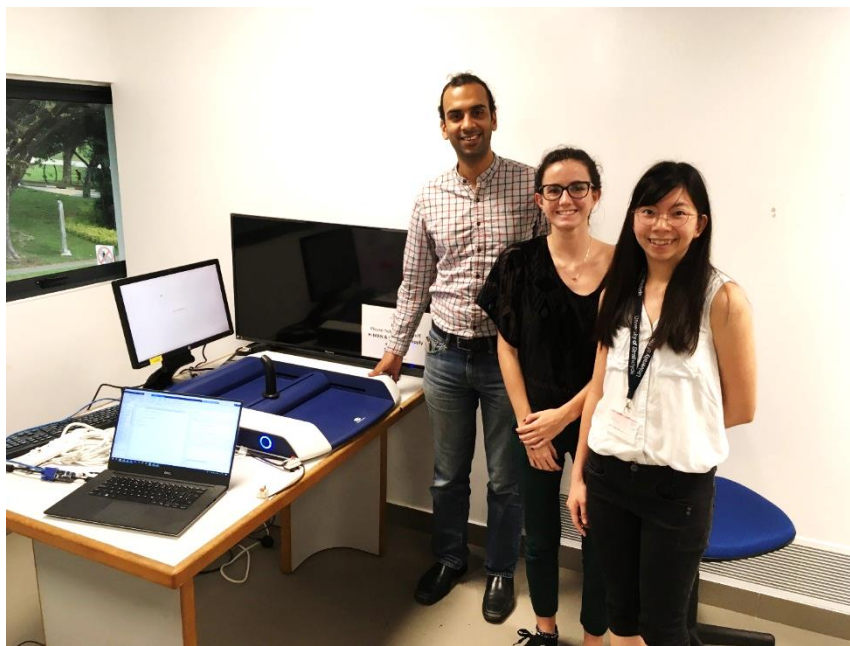

Programming the H-man robot. Photo with Asif (left most), Adele (middle) and me (right).

Why did I apply for the travel scholarship?

In the first year of my PhD, my analysis of iPad gameplay swipes for movement kinematics differences between autism and typically developing children got me interested in computational models of motor control, describing how sensory information could be transformed in the brain to produce motor output. As research in motor control in the last decade have suggested that motor learning in autism uses visual and proprioceptive information differently, I was interested in learning about biomedical applications of robotics, how we could use these tools to understand motor learning in autism better and the possibility of designing motor training tool.

I got to know Prof Domenico Campolo just before starting my PhD. Prof Domenico Campolo, a collaborator of my supervisor at University of Strathclyde, is Director of the Robotics Research Centre at NTU Singapore, and co-founder of a spin-off company Articares, commercialising the H-Man robot which can provide haptic feedback using motors as users explore a planar workspace. As well as having an ideal environment for robotics research, NTU is a technologically-oriented university that would allow me to be exposed to the translational and industrial side of research. These were the reasons I picked NTU in my application.
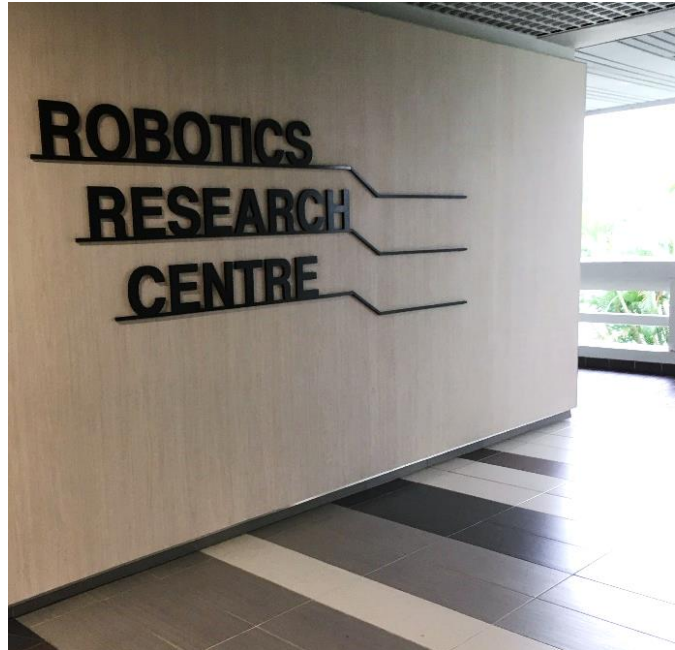
View of the road leading to NTU on a quiet morning taken on my commute. Singapore is renowned to be a "City in a garden"

Details of my visit

I spent two months at the Robotics Research Centre and Articares in January and February 2020. During this time, I developed an experimental paradigm using the H-Man robot. I was supervised by Prof Domenico Campolo and worked closely with Articares co-Founder Dr Asif Hussain, biomedical researcher Adele Cherpin at Articares and a second-year PhD researcher Rakhi Agarwal, who were based in Articares, just across the building from the Robotics Research Centre in the "North Spine" of NTU.

I conducted an extensive literature review to inform development of a psychologically relevant robotics paradigm, while getting to interact first-hand with the haptic feedback that H-Man provides. In the early weeks of my attachment, I was also introduced to the Matlab Simulink programs that H-man was programmed on, before the development of software to streamline programming for using H-Man in clinical and rehabilitation settings. Having read scientific literature investigating how movement adapts to new force-fields environments, my understanding of the different types of environment deepened through experiencing how it feels like to move under novel "velocity-dependent" or "position-dependent" force environments. It was also enlightening to learn how these environments were implemented physically by specifying current to the motors.

Last coffee break with members of the Robotics Research Centre at our regular lunch spot at North Spine, where there was no lack of food options!

I had originally come to NTU with a basic idea, but over the course of literature reading, this evolved into a more elaborate task to use the H-man to control the type of information received during motor learning. I discussed my ideas of implementing a circular "force channel" with Articares colleagues and learnt that the engineering and programming aspects to do this was much more complicated than a straight channel.

Following interesting discussions with Prof Campolo about laws discovered in robotics, I settled on a straightforward, yet interesting paradigm to investigate sensorimotor representations of the two-thirds power relationship between movement speed and curvature. Many phenomena follow a power law and this two-thirds power law appears to be maintained in the human motor system. In the last three weeks of my visit, I worked with Rakhi and Adele to discuss the idea and program the task on the H-Man and collected some pilot data. We came up with a paradigm that warps the relationship between movement of the hand and movement of the cursor to create conflict between maintaining the "two-thirds power" relationship in proprioceptive space (hand movement) or visual space (cursor movement).
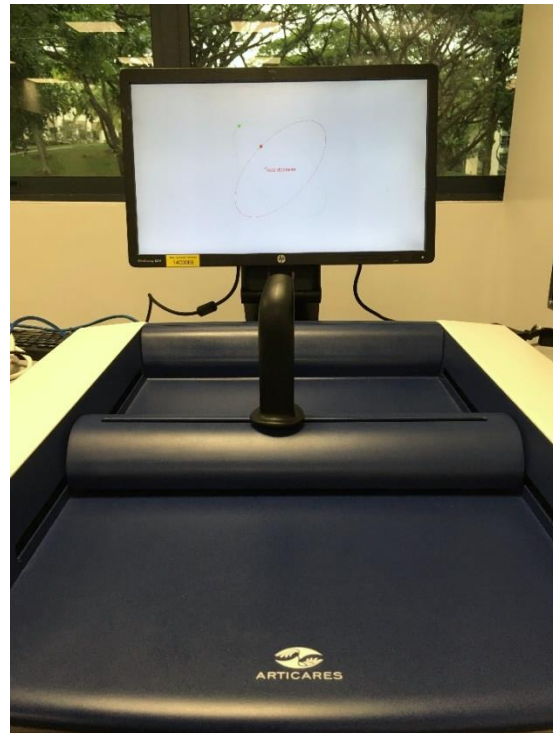
The H-man robot with the task displayed on the monitor. Current specified to motors can change the tension and viscous force experienced by the user when operating the handle to control cursor movement

Apart from research activities, I joined other members of the Robotics Research Centre in badminton sessions after work on campus. I also played ultimate frisbee, a sport I got involved in studying in the UK and got to meet new people who play the sport in Singapore. Singapore is a small island city where wide-open spaces are rare, so I was pleasantly

surprised that the frisbee community here found a suitable spot with the iconic Marina Bay Sands as a backdrop.
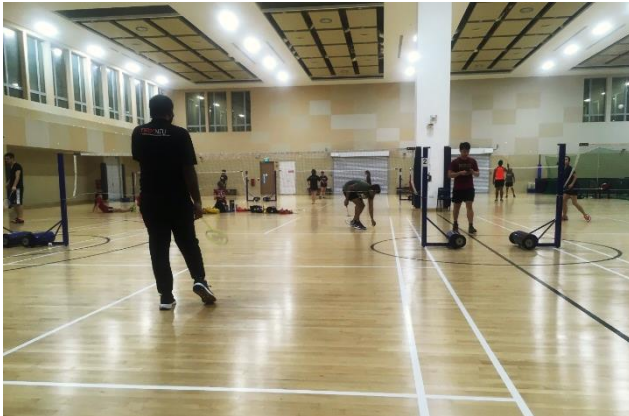
Badminton with new friends from the Robotics Research Centre: second year PhD student Harsha and research assistant Sreekanth.

Playing ultimate frisbee on a field right next to a busy road, with iconic Marina Bay Sands (to the left) towering over

My visit also coincided with Chinese New Year, the biggest festive season in Singapore. Night markets right next to the MRT (subway in Singapore) was alive with stalls selling bright red new year decorations and street snacks from different cultures. At Articares, we had a Chinese New Year celebration organised by Kenneth and Eunice, the two Singaporeans in the team. It was the year of the rat and we made origami using traditional red packets and ushered the new year in with *lo hei* or a "prosperity toss" with shredded vegetables and sauces which is meant to bring good luck!

Trip to the night market

Impact of the scholarship

The scholarship enriched my multidisciplinary PhD by enabling me to experience the translational aspects of research to industry, and at the intersection of robotics and psychology. I got to experience first-hand the robotics experiments I read about in the movement literature and learn about the engineering components of H-man, as well as how H-man is currently being used for stroke rehabilitation in clinical settings. I had the opportunity to discuss cross-disciplinary concepts, the two-thirds power law which is interesting from in the design of control systems and in human movement. With some pilot data, I hope to continue the collaboration with the new connections made here. One line of work we have discussed is to improve and implement the experimental task in parallel, both in NTU and using new equipment currently being designed in the lab in Strathclyde. This would allow me to explore biomedical applications of movement science in improving understanding, identification and treatment of neurodevelopmental disorder.

Having a background in psychology and neuroscience, I had never seen myself as an engineer and graciously thank the Mac Robertson Trust for this opportunity to widen my perspectives, connect with and work closely with researchers in a field other than my own.

Articares team during Chinese New Year celebrations

Acknowledgements

I would like to thank Prof Domenico Campolo and Dr Asif Hussain for being extremely welcoming and ensuring I settled into Robotics Research Centre and Articares well, and for the many stimulating discussions. I am also especially grateful to Adele Cherpin and Rakhi Agarwal for taking time to patiently explain and demonstrate how the H-man works (both the prototype and industry version), making sure I had all the software needed to program the H-man as well as giving me helpful tips for programming.