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研究課題名	Robotic Design and Construction Culture: Ethnography in Osaka University's Miyazaki Robotics Lab				
研究成果の概要	研究目的、研究計画、研究方法、研究経過、研究成果等について記述すること。必要に応じて用紙を追加してもよい。				
<p>Introduction</p> <p>According to Professor Takuro Morinaga of Dokkyo University, the world is “on the threshold of the fourth industrial revolution, a paradigm shift caused by robotics and artificial intelligence. A country that has a hold on the revolution will control the world.” (Watanabe, 2016) And so, Japan is banking on that robotic revolution to alleviate several of its problems – from revitalising its economy to bringing up the birth rate. While there is research covering the macro level of robot development and social acceptance in Japan, the purpose of this study is to explore robot development on the micro level. Inspired by the ethnography of MIT Robotics labs by Professor Kathleen Richardson (2015), the specific objective of this research is to study the relationalities between robots and their designers by conducting fieldwork in the Miyazaki robotics lab in Osaka University. How does Japanese society and culture influence Miyazaki robotic researchers and their research? How do they conceive of robots, artificial intelligence and their place in wider Japanese society? If robots are conceived to be the answer for Japan's problems, an examination of the creators and creation process of these machines, present and future, is fundamental to understanding the potential implications and relations with wider Japanese society.</p> <p>Methodology</p> <p>Mixed methods research was employed to achieve research objectives. The research is split into roughly three parts. The first part examined existing quantitative, media and historical sources regarding technological development of robots in Japan. The second part of this research is qualitative fieldwork. Through ethnographic approach, I examined the relationships between robots and their designers. The ethnographic research entailed observation, interview and group discussions of the projects of</p>					

participants from the Miyazaki Robotics Laboratory. This last part of this research is an overall analysis. The results of my research will examine how the culture of the lab affects the strides researchers make into robotics, while also noting their reactions towards recent robotic advances.

Japan's Robot-Friendly Culture: The Role of Media & Shintoism

Since the latter half of the 20th century, Japan has been considered a leader in the robotics industry – frequently labeled a ‘Robotics Superpower’ for its advanced development in robot production and manufacturing. While Japan is the largest market for operating units of industrial robots, humanoid robotic development has also received national attention due to widespread media and academic coverage.

When asked to explain the predominantly positive popular image of robots in Japan, as well as a seemingly unique propensity to accept robotic companions, scholars point to specific cultural factors, such as Shinto animism and favorable media representations of robots. (Kitano, 2006) Popular portrayals of robots playing a variety of functions in society, from ideal love interests (CLAMP's *Chobits*, Yuu Watase's *Absolute Boyfriend*) to fighting machines (see the Gundam series), have furthered a sense of familiarity in the public consciousness to the possibility of robots integrating into Japanese society. Many scholars also cite the role of Shinto as playing a part in the dominant Japanese perception of robots as benign, benevolent, living entities. (Robertson, 2010, Hornyak, 2006, Sabanovic, 2014) Shinto, with its native animistic beliefs about life and death, believe that vital energies or forces, called *kami*, are present in all aspects of the world and the universe. Robots, humanoid or otherwise, are living things within the Shinto universe that are, in a sense, part of a “natural” world. (Morioka, 1991)

A History of Robotic Development in Japan

Industrial robot production began in Japan in 1968, when technical association between Kawasaki Heavy Industries and Unimation Inc. worked to produce a robotic arm that would allegedly save workers from difficult and dangerous work. Shortly after, the Japan Robot Association (JARA) was formed, and their active promotion of robotics eventually resulted in a robotisation rate of 25% in the manufacturing sector – notably the highest in the world. Their research and development activities are known for being the cornerstone of robotic development in Japan, bringing together industries, companies and government organisations. (JARA, 2016, Sabanovic, 2014) However, while the widespread implantation of industrial robots can be partially attributed to JARA, another factor was paramount to the success of robotisation – the educated nature of the Japanese workforce. The compulsory and rigorous education system in Japan produced a workforce that could be trained to be technically educated.

Japanese educational institutions have also played an enormous role in the development of other forms of robotics. In 1973, Waseda University professor Ichiro Kato developed the first full scale humanoid robot, the *WABOT-1*, who had two arms, could walk on two legs and see through two cameras functioning as eyes. Akin to the wide range of robots in Japanese media, Kato's development would lead to the production of various types of robots in various shapes for various purposes. From robots that can operate power shovels and forklifts (Enryuu), patrol premises and extinguish fires (ReBorg-Q, Guardrobo D1), replace human service sector employees (Actroid, ASIMO, Pepper), babysit and tutor

children (PaPeRo, Wakamaru), housesit (Nuvo), nurse the infirm and elderly (Ri-man, Paro), provide companionship and entertainment (ifbot, Pino, Posy, Robovie) to even providing sex (Kaori) or replacing your children (Kirobo Mini).

Recent Official Robotic Policy in Japan

While popular media, JARA, industrial and academic interest have facilitated the development of various robotic fields in Japan, in recent years, the government has taken official measures to ramp up the creation and production process. Alongside the establishment of the Robotics Policy Office, the METI announced the launch of the Robot Revolution Initiative (RRI) whose overarching goal is to alleviate the twin issues of Japan's aging population and shrinking labour force. (METI, 2015) Backed by 200 companies and universities and chaired by Mitsubishi Electric's Tamotsu Nomakuchi, the council aims to expand robotics throughout Japanese industry, with a goal of growing sales from 600 billion yen a year to 2.4 trillion yen by 2020. Thus, Japan's long-held reputation as a 'robotics superpower' would finally culminate into this first explicit policy push to integrate robots into wider society.

Osaka University Miyazaki Laboratory

As a result of this robotic wave, the Robotics and Mechatronics Miyazaki laboratory at Osaka University has received plentiful funding and prestige from academic circles. Part of the division of Mechanical Engineering, under the Graduate School of Engineering Science, this lab is considered one of the most prestigious robotic labs in the country. The whole laboratory spans six rooms on the third and fourth floor of the mazelike Engineering Science building on Osaka University's Toyonaka campus, for the three professors and 22 students.

Ethnographic Process

a. Culture of Miyazaki Laboratory

When asked to describe the laboratory, two descriptors that frequently came up were "everyone gets along" and "freedom". However, this "freedom" proved to be both a strength and a source of tension. Due to the abundance of funding available in the lab, researchers only had to ask to be provided resources – regardless of price. This availability of supplies resulted in a friendly, collaborative lab culture with no competitiveness or conflict for resources. This was evidenced by how researchers would openly share the progress of their research during weekly laboratory meetings, and would often ask for comments or advice. Furthermore, researchers would often participate in the experiments of fellow researchers, even if it lasted several hours or was on the weekend.

bi) Researchers H & F: Second Year Master Students

Even in a lab of unique individuals, H was unusual. Most projects in the lab focused on healthcare or mechanical robotic systems, but H was working on machine intelligence systems for the finance sector. His primary objective was to work on algorithms that could make accurate predictions on potential investments. This was aided by his great interest in FOREX, and I watched him spend a significant amount of time in the lab scrutinising or trading on market trends. Nevertheless, H identified himself not as a roboticist but as a budding financial expert. He was interested in how he could be the first wave of Japanese investors to generate wealth through machine intelligence.

F, unlike H, had research under Hirai-sensei was typical of the lab. Inspired by his love for

playing tennis, he was looking into how the movement of shoulder joints could be replicated or aided by robotic equipment. F was also highly optimistic about Japanese technology, often explaining to me the mechanical ingenuity behind everyday items, and was working on a small mechanical robot as a side project.

bii) Researchers N & L: First Year Master Students

N and L were two first year Master students who had a close relationship. N was focusing on the movement and structure of lower leg muscles, using electrical nodes to record their movements before replicating them in a model. L was doing similar research studying hand movements and musculature. Despite identifying as non-roboticists due to their research interests, they displayed a high awareness of robotic developments. While L was more accepting of robotics in new sectors like service, N would often be skeptical of public acceptance and possible integration. L and N would also explain their research to me in a way that was almost identical to Richardson's (2015) MIT researchers. As she described in her ethnography (p94), a roboticist's lived existence acts as the reference point for the machine, and L and N would often demonstrate using their own body parts. L would flex her hands and ask me to look closely to examine the movements, and N would base the drawings of musculature on her legs before identifying points to attach electrical nodes.

biii) Researcher S: Final Year Undergraduate

S he was the only undergraduate fourth year that had not only decided his research topic, but was also making significant progress. Under Professor Uemura's guidance, S's research was to make a bipedal robot using angular momentum instead of calculations of the zero moment point (ZMP), commonly seen in robots like ASIMO. S was using angular momentum calculation so that the bipedal robot would be able to rebalance itself effectively and continue walking even when jolted. While S was not particularly interested in robot media, he enjoyed figuring out how to build them. This passion stemmed from his love for LEGO, and he found designing robots to be the most useful professional outlet for that creativity. His long experience as a LEGO builder transferred into an almost intuitive capacity to build.

Results and Analysis

It became quickly apparent that while researchers were familiar with Japanese robot media, the main influences on their research would be societal issues – particularly the pressing population problems. Many of the researchers shared their discomfort at the prospect of having themselves or their children bear the cost, whether monetarily or in care hours, of a large elderly population. The fact that many of them were athletes, who viewed their body as a physical tool that could be trained or augmented, played a part in to offer “biotechnical solutions” i.e. embodied intelligence, whether to fill in the gap of a weakened body or to offer a new body.

a. Researchers Complicated Responses to Robot Technology

Despite the embrace of principles of embodied intelligence, researchers often expressed negativity towards certain forms of robotics. In focus groups, I would often present photos of certain robots or plans for robots, and would ask them to make comments. Their immediate responses proved that Masahiro Mori (1970) hypothesis of the Uncanny Valley often held true. As shown in the above

diagram, industrial robots, while accepted, provoked no emotional response, while humanoid robots (Kirobo mini) were often found cute. However, robots that were too lifelike (Erica) were often met with negative responses. However, these were immediate reactions. Their later impressions would form or change when discussing the intentions behind these robots, and their opinions would prove to be quite complicated. While many liked the giant fighting robots (or “Gundams”) that were being built by Japanese roboticists, they were against the idea of them being used for any practical combat purposes. “Robots should not take the place of people, rather they should augment their capabilities,” N stressed. Thus, despite being creators themselves, the relationship between robot technology and researcher was complex. Instead of whole-hearted acceptance, there were many doubts and questions about the role robots would take in society, of superhumanisation and dehumanisation, which these researchers seemed to only have started to grapple with.

Conclusion

In conclusion, this study hopes that by placing observations of the Miyazaki Robotics Laboratory into the wider study of Japanese robotics, there can be a deeper context of the purpose of the RRI initiatives, and further understanding of the implications of the actions of the Japanese actors and their robotics investments. While the historical development of robots in Japan has always seemed economic or academic, there has been a recent turn to robots as a political and social tool that can solve a growing population crisis. As seen in the ethnography, despite their lack of full knowledge of the state’s intentions, robotic researchers feel a call of duty to act to help solve these problems, albeit in their own personal contexts and interests.

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