Use of Robots in Healthcare: the Japanese Experience and the Relevance of Culture

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1. Introduction

When a Japanese engineer, Takanori Shibata, invented the seal-like robot PARO which was invented for caring elder people, there began arguments for and against it in the Western world. On the one hand Danish government decided to introduce the robots into hospitals because of their curative effect for dementia; on the other hand Sherry Turkle held a warning for human's high dependence on technology quoting fifth graders words: "Don't we have people for these jobs?" In contrast, there were few arguments about the acceptance of PARO as a care-giving agent in Japan [Turkle, 2011].

Dr. Shibata hit upon an idea of "Robot Therapy", when he knew pet therapy was effective for dementia patients. Because medical facilities should have been kept clean, it was difficult to have pets in those facilities such as hospital. He thought that if they would substitute robots for pets, the patients could get profit from the pet-like robots [Shibata, 2011]. There is evidence that robot therapy is in fact effective for dementia patients [Takayanagi, Kirita, Shibata, 2014]. Currently, you can find many hospitals which decided to introduce the seal robot, PARO. So far, there is not big voice to make an objection against PARO in Japan.

Why did both of care-givers and care-receivers accept PARO without a sense of disconformities? You may think that many Japanese have got familiar with robot through *Manga* or *Animation*. In fact, there are a lot of works of subcultures, which treat robots as hero or companion. This kind of training by subculture may have created a mindset in which they never have fear against robots. However, nowadays, Japanese subculture has been exported to all over the world, and accepted generally in younger generation. That is to say, robots should be more acceptable in other countries. But, they are more conservative than Japanese. Why? The key to resolve this question should be found in the deep layer of culture of Japan.

The purpose of this paper is, through investigating Japanese traditional religion "Shinto-ism" and framing the world-view of it, to characterize Japanese robot culture. Probably, the world citizens will be interested in the following questions. At the last part, we will find the answers for these two questions.

Q1：Why Japanese don't fear robots?

Q2：To what extent will Japanese accept robot technology in healthcare?

2. Robot world in Japan

What kind of future image do Japanese engineers have? How will robot engineering, which began in industrial robot development, develop in the future? The Technological Strategy Report on Creating a Robot Society in the 21st Century, issued in 2001 by the Japan Robot Association, estimated that the market for robots would extend into the lifestyle, health and welfare, public safety (disasters, etc.), biotech, and manufacturing sectors, becoming an $80 billion industry by 2025. It was predicted that approximately half of that figure would be monopolized by robotic products for the "domestic sphere." While it is clear that in comparison with the actual size of the robot market at present (2013), this market failed to expand to such a size, predictions like this were common at the turn of the century, and accordingly large sums of money from the national budget were actually spent on these efforts. In other words, although examples of the development of actual products remain rare, the efforts have had the effect of speeding up the development of robot technologies capable of operating in the domestic sphere at the level of basic research at the start of this century.

In this context, the Japan Robot Association created an academic roadmap for engineering fields with an eye toward society in 2050 (2007). The social issues discussed in this document that cannot be ignored include (1) the decreasing birthrate and the increasing aging population: the population of young workers is decreasing at the same time as it is proving difficult to support large proportion of the elderly population; (2) energy problems: petroleum resources are being exhausted and low-consumption/high-efficiency equipment must be designed; and (3) environmental problems: global warming and carbon dioxide emissions must be reduced. Furthermore, three concepts—comfort (C), safety (S), and green (G)—were proposed as common ideals (CSG) to help solve these problems. Because the field of robotics is especially involved with (C), it is expected to fulfill an important role in helping Japan adapt to the problems caused by a decreasing birthrate and an aging population [Uchiyama, Kaneko, Kunii, 2008].

Under these circumstances, the Japan Robot Association, the Japanese Society for Artificial Intelligence, and the Japan Ergonomics Society, with the support of the

Ministry of Economy, Trade, and Industry (METI), collaborated to create an academic roadmap for the field of robotics, in which they proposed "30 Robot Challenges" to be overcome as themes for future research. The contents of the report reflect the type of technological developments that active robotics engineers are aiming at. This roadmap is organized around three themes drawn from the past 100 years of robotics history: (1) social systems and robotic intelligence; (2) systems for helping people; and (3) human and machine integration (human expansion). In other words, it paints a vision of the next 50 years in which we will see that robots increasingly approximate the human form, eventually merging with humans altogether. Indeed, the authors point to the necessity of considering the question of what form the relationship between humans and robots will take in the future as these trends proceed from the perspective of "Robot Ethics"; moreover, they predict that if and when the integration of human and machine begins, it will become necessary to debate "Cyborg Ethics" [Sato, Mizoguchi, Tomita, Uchiyama, 2008].

Turning our attention to the 30 Robot Challenges, we find the following:

- Challenge 9 – self-reference, evaluation, and repair systems: the development of "meta-cognitive" functions, that is, the awareness, interpretation, and evaluation of the contents of one's own cognition, condition, and behavior, and based on this, the ability to revise and repair oneself, maintaining consistency, lawfulness, and homeostasis
- Challenge 11 – cognitive development systems: the elucidation and realization of systems capable of improving their own cognitive ability and achievement while interacting with each other and the outside world
- Challenge 13 – the emergence and understanding of others' goals and intentions: the ability to understand the goals and intentions of others is dependent upon the ability to understand the meaning of others' actions and to make autonomous judgments about behavior in service of humans.
- Challenge 15 – autonomy: the ability to act by oneself without external commands and rules. This is the development of abilities for "understanding the meaning of information," the "recognition of importance," the "emergence and understanding of goals and intentions," "self-reference, evaluation, and repair," etc., all of which are two-step processes that require robots to decide what to do themselves and then act while remaining in control of themselves.
- Challenge 21 – BCI/BMI/Cyborg: direct integration of the human brain and computer or machine as an interface between humans and robots to allow more flexible interaction. Furthermore, by directly integrating humans and machines,

human abilities will not only be supplemented but also expand.

- Challenge 23 – robots for community building: development of robots to support the revitalization and maintenance of community and assist in the formation of community by bringing people together through some sort of commonality
- Challenge 30 – intelligent space: development of technologies capable of understanding intentional behavior from the use of all goods used in one's daily living space, grasp social movements, and help people and society

Such technologies are an index that reflects trends over 50 years, including many that are still quite far from realization. However, whether these trends come about as a result of their having been formulated thus is beside the point: it can still be argued that our society is slowly moving in the direction they indicate.

Now, if researchers are aiming at the technologies considered above, can we really say that there will be no problems in bringing them about as long as long as mere "safety" can be assured? The values expressed in the existing engineering ethics framework emphasize public safety and the protection of health and well-being. Based on this expertise, ensuring safety should obviously be considered a matter of course in robot development. However, the possibility exists that various types of ethical problems that do not fit into this framework will arise from robot development. Therefore, let us next turn our attention to these.

3. Use of Robots in Healthcare

You may find the future image of Japanese robot engineers. By the way, if they succeed to realize their robots, then for what kind of purpose do they use them? The answer is healthcare. Then, why do they rush into this field? The reason is Japan's severe social problem of falling birthrate and aging population.

Let us reckon up the future events in next 30 years, which would be highly possible [Kawai, 2017].

2020: Half of female population will be more than 50 years old.
2021: A lot of separated employee because of nursing care for their family.
2024: 33% of the population will be more than 65 years old.
2025: Population-shrinking will start even in Tokyo.
2026: The population of dementia will get over 7 million.
2027: Blood for transfusion will be scare.
2030: Big department stores, Banks, and retirement homes will retreat from provincial cities.

2035: 33% of male population and 20% of female population will live and die single.
2039: Serious lack of crematory.
2040: Half of provincial governments will disappear.
2045: Singularity will come (?)

Falling birthrate and aging population will obviously lead to a lack of labor force in nursing care activity. Robots are expected to play big roles in this field, to reduce human burden of nursing care.

Meanwhile, is using robot for nursing care the best answer for this problem? The answer is not obvious in fact and the discussion is not matured in Japan. Lay people have never aspired for using robots. It was robot engineers who raised his hand for using robots to cope with the social problem. They didn't reply social needs, but created new needs actually.

One reason of Japanese preference for robots comes from successful experience in 1970s and 1980s. At that time industrial robots backed up the economical growth of Japan. They invented robots for build up automobiles and IC chips, and the robots pushed down produce cost of products. Robots had created economical advantage for Japan. In the process of development of industrial robots, they store up basic technology for robots. After the high economic growth, robot engineers feared about losing their basic technology of robots. So they started to seek a new field where robots have a lot of roles.

In such a situation, they thought that "as younger people get their mobile freedom with having automobile, elder people will get their freedom of action with having humanoid in domestic area". They needed the reasons to introduce robots into domestic sphere. If they found the reasons, then they could dream to sell 1 million humanoids as they sold several millions of cars. They also thought that humanoid industry would make a big market of new services (such as parts production, maintenance services, software update service, and so on). It would promise another economic growth.

If robots take roles in healthcare, then they will win the social confidence. And healthcare gives monetary motives for engineers, too. In general, the patrons of Japanese engineers are MEXT (= Ministry of Education, Culture, Sports, Science and Technology) and METI (= Ministry of Economy, Trade and Industry). But if they are concerned with healthcare, they can get money also from MHLW (=Ministry of Health, Labor and Welfare abbreviation).

In this wise, Japanese engineers rushed into research and development of healthcare robots. The main reasons were two. The former was social problem of falling birth rate

and aging population. The latter was economical problem of maintaining the basic technologies of robotics and evolving them.

Let us show contemporary robots which have been already introduced for healthcare.

- Pet-Robot: ex) PARO. For robot therapy and alternative pet
- Companion Robot: ex) Pepper. For robot partner.
- Exoskeleton Robot：ex) HAL. For nursing-care and rehabilitation

In near future, we will introduce following robot.

- Tele-operated Android: ex) Geminoid. For remote area medical treatment
- Prosthesis Robot
- Artificial Body (including artificial organs)

4. Techno-animism

I live in Kanazawa, which is a historical city on the Sea of Japan side. In the center of the city, near Kanazawa Castle ruin, there is the city's oldest shrine "Ishiura Shrine". In that Shinto-shrine, you can find "a burial mound of Sushi" and "a burial mound of Fish Knife". You may think that a grave of Sushi sounds strange. In fact, this is not a grave of Sushi, but of fishes and rice which were foodstuff for Sushi. Sushi cookers sometimes gather in front of this mound, and offer a prayer for sacrificed life to express gratitude. You may also feel stranger when you see a grave of knife. Sushi cookers always entomb their fish knives, when they crock because of aged deterioration. They also offer a prayer for the "souls" of their precious tools. Why? Because Shinto-ism teaches us that everything has its own soul, as animate beings have it.

In this wise, every kind of favorite stuff can be sepulchered. Funeral ceremony for stuff is called "Mono-sogi"(= ceremony for things), and generally accepted in Japan. Especially the ceremony for dolls and toys is better known. This kind of psychomorphic[1] view comes from Shinto-ism. When Japanese people, who potentially have such a world view, come up on robots, what do they think of? Of course, they must think that the robots have souls.

The puppy-like robot "AIBO" was invented by Sony in 1995. Because it got very popular, instead of high price, the company sold 150 thousands of AIBO until the stoppage of production in 2006. AIBO had capacity to memorize its owner's voice, learn language, and react according to the owner's order. For many of owners could have

[1] This word was coined by Gabriel Tarde. Cf. Tarde(1895)

precious experience to "grow" their puppy-like robot, they eventually got to have heavy affection to their robots. After the stoppage of parts production, they could not repair their AIBO anymore. That situation made the owners very sad. In 2015, a Buddhism priest started to do a funeral ceremony for robots, there gathered so many broken AIBOs from all over Japan. AIBO owners naturally thought that they would like to see off the soul of their AIBO with having a funeral ceremony. Takuji Okuno, who is a Japanese anthropologist, suggests that the psychomorphic attitude, which contemporary Japanese have for electric devices such as robots, could be called "Techno-animism" [Okuno, 2002].

Is Techno-animism discriminative phenomenon in Japan? More likely than not, everyone has had a psychomorphic view in his/her childhood. For example, in every culture or religion, children do make-believe play using toys or dolls. It could be said that it is almost universal. How about funeral ceremony for dolls as well as robots? To my knowledge, it is characteristic in Japan. To understand this custom deeply, we should investigate the world view of Shinto-ism. I believe that such a quest will be helpful for you to understand Japanese robot culture.

5. View of the world in Shinto-ism

The oldest history book in Japan is called *"Kojiki"*, which was compiled in AD712. In this book, you can find the Japanese history from the beginning of the universe to the era of 33rd emperor (about AD600). The most popular story in the old mythology[2] is about male and female gods, whose names are *Izanagi* and *Izanami*. After tying the nuptial knot, the female god, *Izanami*, gave birth to all the islands, mountains, rivers, and all the things in Japan. But it is not an important part to understand the cosmology of Shinto-ism. The most important part is the introduction of *Kojiki*. In it you can find a story of the beginning of the universe.

Shinto-ism deems that the universe is a kind of life. So the god didn't create the universe. The god is the universe's spirit. So when the universe started spontaneously, at the same time the god started to exist. The first god's name was "*Amano-minaka-nushi*" (= the lord at the center of the universe) and it was impersonal deity. At first *Amano-minaka-nushi* deified two competences which were separated from the god. The former was *Takami-musubi*, which represented the force of expansion. The latter was *Kami-musubi*, which represented the force of centering. These two conflicting forces gave dynamics to the universe. Secondly, this dynamics gave birth to three

[2] Cf. Satow(1876)

elements of material. They were fluid, soft body, and rigid body. These were also deified. Shinto-ism deems every material is mixture of these three elements and each material has its own mixing rate of the three elements. Thirdly, in spiritual sphere, *Takami-musubi* brought forth the soul of courage (*Ara-mitama*) and the soul of intelligence (*Kushi-mitama*) on the one hand. *Kami-musubi* brought forth the soul of fraternity (*Nigi-mitama*) and the soul of love (*Saki-mitama*) on the other hand. Lastly, thankful that these 4 souls were bonded to the three elements, there began existent the eight forces in the universe: motion and stillness; agglomeration and diffusion; tension and laxity; fission and fusion. This 3-elements-4-souls-8-forces triggered creation and proliferation in the cosmos [Honda, 1883] [Suzuki, 1977].

All things are mixture of the 3 elements, and driven by 4 souls, consequently that means to say that they all act spontaneously. In the framework of Shinto-ism, even mineral substance has 4 souls as well as animals and plants. And when the materials and life get combined and interdependent to become an ecosystem, the ecosystem itself also has 4 souls collectively. When the ecosystem gets deified, it is called "*Ubusuna-gami*". That is why there are so many Shinto-shrines in all over Japan. Traditionally Japanese people have needed shrines to offer the prayer for ecosystem to which they have belonged.

Human being is also composed of 3 elements and 4 souls. By grace of *Ara-mitama* (soul of courage), people can take a decision and act bravely, and sometimes suffer through difficulty; by grace of *Kushi-mitama* (soul of intelligence), people can get interested in something, learn from nature and neighbors, and increase knowledge; by grace of *Nigi-mitama* (soul of fraternity), people can live in harmony with neighbors and conduct the affair of state; by grace of *Saki-mitama* (soul of love), people can love their partner and children and families.

But sometimes we lose the balance of 4 souls. In such a situation, only one soul goes out of control. Runaway of *Ara-mitama* leads to battle; runaway of *Kushi-mitama* leads to derangement; runaway of *Nigi-mitama* leads to enmity; runaway of Saki-mitama leads to rebellion. To maintain the balance of 4 souls, human being is gifted to have a spirit, which was divided from *Amano-minaka-nushi* (the spirit of the universe), named "*Nao-hi*" (=straight spirit). *Nao-hi* gives us competence of reflection. And it can find germ of runaway of 4 souls, and make a modification for the balance before runaway occurs. Shinto-ism says that only human being has *Nao-hi* in the nature. What does that mean? That means only human being is expected to support the god's will. People, as a matter of course, should keep balance of their own 4 souls. In addition, they should modify unbalance of 4 souls in the nature. If unbalance of 4 souls occurs in the nature,

there will be natural disaster. In the process of history, there has been a lot of natural disaster in Japan. Facing a natural disaster such as tsunami, earthquake, or eructation of volcano, people have prayed to quieten the runaway of 4 souls in the nature.

In Shinto-ism, being moral or ethical has been always related to being cleaned. If we got to be tempted by our bodily desire, which leads to stoppage of *Nao-hi*, then we lose the balance of the 4 souls. Finally we will get to commit a crime. In Shinto-ism, they have called the stoppage of *Nao-hi* or unbalance of the 4 souls "*Kegare*" (=impurity). If you want to do well, you have to get rid of the impurity accumulated in you. Shinto-priests do the ceremony to exorcise for people who want to be cleansed. Individually we can do simple ceremony to be cleansed by washing our mouth with fresh water or sprinkling salt on our body. If we want to be moral, we should take care of our body and keep it purified. The body is a kind of sacred place to enshrine *Nao-hi*. And *Nao-hi* and *Ameno-minaka-nushi* (the lord) are like mirrors set facing each other. If *Nao-hi* stands well, then we can receive the god's will. For being moral, we should let our *Nao-hi* function and make the will of god work in our mind and body. So worshiping our own mind is more important than worshiping deities in Shinto-shrine.

As mentioned above, in the world view of Shinto-ism, all the things are composed of the 3 elements and the 4 souls. Japanese old prayers "*Ooharae-no-kotoba*" says that, in old divine era, even stones as well as plants, fish and beasts had the verbal capacity. In addition, the old mythologem *"Kojiki"* says that the verbal capacity of 'creature' and 'thing' were expelled, when a man-shaped god: *Ninigi-no-mikoto*, who was ancestor to the Emperor's family in Japan, descended to earth. Nevertheless, the old memory of direct communication between human being and nature itself has been resonant again and again in the history of Japanese literature: not only in *Waka* or *Haiku* but also in modern literature such as Kenji Miyazawa. What kind of impression will this cultural identification of Japan provide its citizens when they first come up against robots? The answer is 'nostalgia'. This would be a clear difference of culture between Japan and other counties.

6. Discussion

You may have understood yet why many Japanese people accept robots in their domestic space. Even in stones, we can recognize their souls; why not recognize the souls of robots. And the verbal competences of things are getting unsealed by contemporary technology. When the robots start to speak, that invokes an old memory of co-existence and co-prosperity between human being and nature in Japanese people.

And now, in the western world, the concept of "Transhumanism" occurs. Transhumanism intends to fuse together human body and technology to make a new sapience which is beyond homo sapience. If we realize quasi-body with robotic technology, then will we soon move to substitute robotic body for natural body?

In Shinto-ism, it seems that Transhumanism cannot be accepted easily. Because in the framework of Shinto-ism, our bodies are a kind of shrine to worship our own *Nao-hi*, and they should be purified at all times. Shinto-ism thinks that people were the most purified when they came into the world. That is to say that the begging is the ideal state. In the process of our life, we accumulate impurities and they should be eliminated. Shinto-ism recommends you to get the first innocent spirit and souls with purification. And the purification is the condition to be moral. If we accept irreversible transformation of our body with machine, then we cannot get back to the innocent state. That is why it seems that Japanese will not accept Transhumanism in a general way.

For example, when Prof. Sankai tried to develop the exoskeleton robot-suit HAL, which is used in rehabilitation for neuromuscular intractable rare disease, he did never try to use invasive BMI (=Brain Machine Interface). Instead of it, he invented the device which can detect bioelectrical potential from surface of skin. For all I can see, he intuitively understood that detachable robot would be more acceptable for Japanese people. [Sankai, 2014][Nakajima, 2011]

The preference for Techno-animism in Japan must be advantage for Japanese engineers. They have more opportunity to make companion robots than in other countries where they have potential fear against robots. Japanese engineers will get a lot of trial-and-error, and soon offer an ideal social model where human being and robot can co-exist (Cf. Society 5.0) [Keidanren, 2016].

But there is a shade of anxiety. Can we let them go like fun? If our robots would start to rebel against human being, then can Japanese engineers find out the reason and cope with the situation? If we think it from the view of Shinto-ism, we would feel uneasiness. In the psychomorphic world of Shinto-ism, for example, when we confront an eruption of volcano, we would think that the volcano is getting angry. The mountain has its souls, and it explodes autonomously. In this case, the runaway of *Ara-mitama* (= the soul of courage) must make the eruption. To prevent the damage from spreading, what should be done is to pray and console for the mountain with altarage. As in the same way, if robots will make rebellion, then Japanese may offer prayer for rebelling robots to calm them down.

You may think that this is absurd. But you can remember that elite engineers in Japan avoided their own responsibility when the Fukushima nuclear power plants got

out of control in 2011. They justified themselves with saying that these events were "beyond the scope of assumption", even though they gave assurance to the security of the nuclear power plants with saying that nuclear technology was 100% safe.

It seems that, even when artifacts go out of control, Japanese people tend to think that the artificial products "autonomously get out of control", instead of thinking that they "had them get out of control" because of their faults. They may have the same emotion against robots as in front of eruption of volcano.

If we would like to make technology safe as possibly as we can, we should deal with the possibility of the worst case. But Japanese people are not good at imagine the worst. With Shinto-ism, thinking bad things means impurity of our mind. If we develop robots with impure mind, that impurity may infect the robots. So if they want to invent good robots, they should enfold positive image in their mind.

Japanese engineers must of course design their robots as friendly partners like our neighbors. And they innocently think that, because they don't have any bad intention to make robots, the produced robots also don't have any bad intention on people. But, if by any chance robots rebel against us, how do they think? Probably they will say again, "beyond the scope of assumption".

This attitude must disturb prudence for the worst. On this wise, to progress robot-technology, it is vital for Japanese people to collaborate and have a dialogue with other cultures; especially with Christian culture because they have fear against robots subconsciously.

7. Conclusion

Let us go back to the two questions which were upheld in the first part of this paper.

Q1：Why Japanese don't fear robots?

Because they dwell in the framework of Shinto-ism, and they believe subconsciously that every material has its own mind, which is composed of 4 kinds of soul. People, who can believe even stones and mountains have mind, easily believe that human-like robots have mind without any fear. And they have old mythologem *"Kojiki"*, which says that, in old divine era, human being could have verbal communication with things such as stones, mountains, rivers, plants, and animals. This original image of co-existence and co-prosperity makes robots comfortable for Japanese. That is why we find feeling of nostalgia when we meet speaking object in our lifeworld.

Q2：To what extent will Japanese accept robot technology in healthcare?

By grace of Shinto-ism, Japanese would not have much uncomfortable feeling to accept robots as pets, friends, or partners. But they will hesitate very much to use robot technology for transforming their own body. The reason is that they should purify their own body to enshrine their spirit divided from the Lord. Keeping our body healthy and purified is necessary to make our spirit function well. The essence of Shinto-ism is to have a dialogue with our own spirit and accept missions (= *"Kotoyozashi"*) from the Lord. If they accept mechanical parts in their body, then they accumulate impurity and let their spirit weaken with leading to the unbalance of the 4 souls. That means they cut down the way to the Lord. So we can anticipate that Japanese will have very conservative attitude against Transhumanism.

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