'24

前期日程

小論文

（医学部医学科）

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（ 余 白 ）

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以下の文章は、日本におけるロボット工学(robotics)の研究開発に関する現状と課題について論じた文章の一部です。

これを読んで、以下の問１－５に対して、特に指示がない場合は日本語で解答しなさい。*のついた語句にはページ下に注釈があります。

Japanese robotics lags as AI captures global attention

The country's automation research might need a renewed focus to rekindle* past successes.

For decades, Japan has been synonymous with* developing cutting-edge* robots. Yet the country's reputation as a leader in the field might be outdated*. Although Japanese roboticists do still produce "amazing papers*" and "are very present" in the research community①, says Manuela Veloso, head of artificial intelligence (AI) research at investment bank JPMorgan Chase, and a professor emerita* of computer science at Carnegie Mellon University in Pittsburgh, Pennsylvania, an expectation that they would be the global leaders in robotics has not been fulfilled.

Data support this view. The Nature Index* ranks Japan fifth in the world for its overall Share* — a fractional count of author affiliations in index publications — but when Share in only AI and robotics research is considered, Japan falls to

注釈	
rekindle: よみがえらせる	Nature Index: 国際科学誌「Nature」が作成した研究に関するデータベース
synonymous with ～: ～と同義の	Share: 国や研究機関の研究能力を示す指標
cutting-edge: 最先端の	
outdated: 時代遅れの	
paper: 研究論文	
professor emerita: 名誉教授	

seventh. None of Japan's research institutions make it into the top 30 for AI and robotics, based on Share from 2015 to 2021, and Japan is also increasingly being outperformed by its neighbours in east Asia. South Korea, for example, increased its Share in AI and robotics in the Nature Index by 1,138% between 2015 and 2021, whereas Japan's increase was 397% over the same time frame.

Although much of this trend could reflect Japan's sluggish* performance in the rapidly growing field of AI, rather than pure robotics, Japanese robotics experts are well aware of these discouraging statistics. But they also think that opportunities still exist for Japan to climb back to the top for certain specialities. Doing so, however, will require deep understanding of what went wrong in the first place, and a focus on harnessing* Japan's unique cultural and scientific strengths to make up for those shortcomings.

One of the nation's natural advantages in robotics is an abiding* love of machines, Veloso says. Japan also has a long history of animism — the belief that objects, places and creatures possess a spiritual essence. "Many Japanese people think that everything has a soul — why not robots?" says Minoru Asada, an emeritus roboticist at Osaka University. Robots are frequently viewed with scepticism* and even fear in the West, Asada continues, but in Japan they are often seen as "partners and family members". This view is reinforced by robots featuring in decades of popular manga and anime — Japan's world-famous style of cartoons and animation — including classic works such as Astro Boy, Doraemon and Phoenix. These have inspired many of Japan's leading roboticists over the years. "Phoenix predicted a future symbiotic* society with robots and was very, very influential for me," Asada says.

注釈	
sluggish: 不振な	scepticism: 懐疑的な態度
harness: 利用する	symbiotic: 共生的な
abiding: 不変の	

Early adopters

Japan began developing industrial robots in the 1960s. By the 1980s, numerous large companies were involved in the industry and Japan had come to be regarded as a "robot superpower", says Yasuyoshi Yokokohji, a mechanical engineer at Kobe University. In 1983, a group of robotics researchers also established the country's first robotics society to advocate* for the creation of a new academic discipline* for their speciality. This solidified Japan's place as "a pioneer in robotics in both the industry domain and academia", Yokokohji says.

Japan next set its sights on* humanoid robots, most famously with Honda's ASIMO, unveiled in 2000. Around the same time, Sony's Aibo, a programmable robotic dog, could also be found in homes around the world. "Nobody else was producing any robots at that time, but Japan was making them," Veloso says.

Fast forward to* the 2010s, however, and Japan was falling behind. Boston Dynamics, a robotics company in Massachusetts, had pulled ahead* in developing humanoid robots, and Universal Robots, a firm based in Odense, Denmark, had released industrial robots with a user-friendly programming interface and more flexible applications. "Compared to that, the programming interfaces made by Japanese robot companies were only for experts," says Akihiko Yamaguchi, founder and director of FingerVision, a robotics start-up based in Tokyo.

What changed everything, however, was the rise of AI technologies such as

注釈

advocate: 主張する

academic discipline: 大学の学科

set one's sights on ～: ～を目指す

fast forward to ～: ～まで話を進めると

pull ahead: 先んじる

deep learning and neural networks around 2012, Ishiguro* says. AI research began requiring "very big computers and huge amounts of data", he says, which in turn required investment. Japan lacks the mega-company equivalents to Google or Amazon that could provide support for working with big data, and the Japanese government could not provide the necessary funds for such research either.

Need for innovation

Most Japanese scientists continued to pursue pure robotics research, but internationally the application of advanced AI technologies had begun to merge with robotics. "AI and robotics are not separable," Asada says. "Big changes happened, and we could not catch up."

Against a backdrop* of mounting external pressures, internal factors in Japan had also begun to hinder the country's robotics research and development. Most of Japan's university robotics laboratories belong to schools of mechanical engineering rather than computer science, Yamaguchi says, and universities typically do not offer the option of double degrees. This structural problem perpetuates* knowledge gaps among Japan's up-and-coming* roboticists about machine learning, computer vision, statistics, data science, programming and more — all integral skills for working with AI, says Yamaguchi.

Language is also an issue. Not all robotics experts in Japan are proficient* in

注釈

Ishiguro: 大阪大学教授(ロボット工学研究者)石黒浩氏

backdrop: 背景

perpetuate: 長続きさせる

up-and-coming: 新進気鋭の

proficient: 堪能な

English, Ishiguro says, making it difficult to keep up with a rapidly growing, international field. Unless Japanese research is translated, it also tends to stay in Japan. "It can be difficult because a lot of really good research in Japan is written in Japanese," says Woodrow Hartzog, an expert in technology law at Boston University in Massachusetts who frequently works in Japan.

Compared with most other countries, Japan's universities are also less internationalized, primarily thanks to the fact that almost all faculty* meetings, documents and classes are in Japanese. "The number of foreign students has been increasing, but still, we treat them as foreigners," Asada says. Japanese students, conversely, are less present at top universities abroad. "I've been at Carnegie Mellon for 30 years, and we've had a handful of Japanese PhD students," Veloso says. "How many Chinese students have we had? Hundreds."

Many robotics labs* in Japan are also focused on "developing robots simply because they want to develop robots, without thinking about applications", Yokokohji says, which can limit the scope of the research they produce. On the other hand, roboticists who are interested in creating practical innovations face obstacles, because Japan's national universities usually have policies barring* professors from becoming company chief executives*.

Academics* in general typically do not collaborate with researchers in industry, Asada says. This division is primarily the result of a top-down, conservative corporate culture that is averse to* change, says Tetsuya Ogata, director of the Institute for AI and Robotics at Waseda University in Tokyo. "We need original innovation, but Japanese companies basically lack that."

注釈	
faculty: 学部の	executive: 経営幹部
lab: laboratory の略語	academic: 大学の研究者
bar: 妨げる	averse to ～: ～を嫌って

Cultural strengths

The same old-school* model also applies to many universities. Young professors are usually not allowed to be principal investigators*, and are expected to be deferential to superiors* — a power dynamic that hinders progress at the expense of the entire field, Yamaguchi says. In 2018 and 2019, for example, Yamaguchi was working as an assistant professor* at Tohoku University and was tasked with teaching a class on Fortran — an old computer language with little, if any, practical application for today's students. "No AI and robotics researchers use such an old language," he points out, yet there was nothing he could do about it. "Young professors do not have many rights, so it's difficult to change such an old-fashioned situation."

Some experts see Japan's fall from the top of the robotics field as an opportunity for positive change. "Maybe we need to have the experience of being the loser, of feeling the risk," Asada says. "Then we can say, 'OK, we have to fight.' "

Japan is still a leader in producing complex mechanical parts, for example, but most AI researchers around the world currently work in the digital realm*. Japan could be key to bridging that gap between software and hardware, Ogata says, becoming a leader in making intelligent, humanoid robots and other types of interactive devices.

Japanese consumers would be likely to embrace such technologies and integrate them into their daily lives, and that national proof of concept could pave

注釈

old-school: 保守的な

principal investigator: 大学や研究機関の研究室主宰者

deferential to superiors: 目上の人・上司にうやうやしい

assistant professor: 助教

realm: 分野

the way to* international adoption, says Ishiguro. "The key point is how can we use our cultural background for developing a new world with robots?" he says. "I think this kind of challenge is good for the Japanese."

Rachel Nuwer, Nature 615, S92-S94 (2023)
https://doi.org/10.1038/d41586-023-00668-z より改変

注釈
pave the way to ～: ～への道を開く

問 1　文脈を考慮して、下線部①の意味を適切に説明しなさい。

問 2　西欧と日本ではロボットに対する考え方がどのように異なるか、本文に即して80字以上120字以内で説明しなさい。

問 3　日本人のロボット観に影響し、日本の一流のロボット工学研究者たちにも大きな影響を与えた日本の文化は何か、本文の表記のまま英語で答えなさい。

問 4　以前は日本の独壇場だったロボット工学が、現在では他の国々に追い越されてしまっている。

a）本文ではその主たる理由をどう考えているか、50字以内で説明しなさい。

b）今後、ロボット工学の分野で日本が再び世界をリードできるようになるにはどうしたらよいか、本文の内容に触れつつ、あなたの考える解決策を2つあげ、300字以内で説明しなさい。

問 5　将来、日本の医療分野において、AIやロボットの利用をどのようにすべきか、以下の点に留意して、400字以内であなたの考えを説明しなさい。

・AIやロボットの医療応用への賛否の立場とその理由を説明すること

・本文で記述されている内容に言及すること

（以下　余白）