# Susumu Tachi The Scientist Who Invented Telexistence

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Susumu Tachi is a Professor Emeritus at the University of Tokyo and the scientist responsible forintroducing

the world to the concept of telexistence (i.e., remote existence): Humans experience the real-time, immersive sensation of being in a different place from where they presently exist, and being able to interact with the remote environment.

Born in Japan in 1946, Professor Tachi has had the special privilege of a career spanning the entire history of the technological and computational fervor of his country. He is still actively conducting research for the advancement of telexistence by leading several research projects. He kindly agreed to speak with me about his professional life and the series of events that led to him stumbling upon the realization and subsequent advancement of telexistence.

### GETTING ON THE ACADEMIC TRACK

"I was born in Tokyo just after WWII, and at that time Tokyo had been reduced to ruins as far as the eye could see. The city has been growing from the ruins as I grew up," he shared. The most influential figure in his upbringing, who pushed him toward intellectual pursuit, was his grandfather. Tachi's grandfather was the nephew of estimable Dr. Sankichi Satō, who was the first Japanese professor of surgery at the University of Tokyo, a position in which he succeeded German professor Julius Karl Scriba. After his great-grandfather's death, Tachi's grandfather was taken in and brought up during the Meiji era by Dr. Satō in a deeply academic home atmosphere,

which left a long-standing impression on the values of his family.

Upon enrolling at the University of Tokyo at the age of 18, Tachi confessed, as per university regulations, he was initially signed up for liberal arts and spent the first year and a half deciding what he should pursue for his major. He was very much in favor of mathematics and physics, but was also interested in human beings, and had trouble reconciling the two. The moment of enlightenment came when he first heard a reading of Norbert Wiener's Cybernetics on the radio. At that moment, Tachi understood cybernetics was what he had been looking for. He chose the Department of Mathematical Engineering and Information Physics, where he could study cybernetics alongside measurement physics, control theory, bionics, logic circuit theory, pattern recognition, and other subjects. There was no computer science curriculum back then, and a lot of its modern consecrated subfields were in their infancy. "Pattern recognition was in an elementary state back then. No backpropagation, no deep learning, just linear perceptron-

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type models. It was all very new and very attractive in 1966," he pleasantly reminisced.

Through his studies and developed vision, Tachi became convinced that we could have a better world by augmenting humans with cybernetic machines. He stayed on at the University of Tokyo to pursue a master's and a Ph.D. with Prof. Takashi Isobe as his supervisor, the latter of which he was awarded in 1973 at the age of 27. After earning his PhD, he decided to stay at the university for two more years, and moved labs in order to initiate a new project: A robotic guide dog that would aid visually impaired people.

"I first proposed the concept of the guide dog robot in 1975, performed theoretical research regarding engineering methods by which these ideas might be realized, and finally demonstrated the feasibility of the proposed method to the development of the robot called MELDOG, named after the Mechanical Engineering Laboratory (MEL)," Tachi recalled. After a preliminary study, the project

was conducted on a six-year plan that established technology related to the intelligent navigation of mobile robots, such as routing with the use of landmarks and obstacle detection. This work led to the development of the idea of intelligent disobedience. Tachi continued, "Right now there are very good navigation systems, but back then there weren't any, so we had registered landmarks and searched for a route. Sometimes, it might be very dangerous for a person to walk straight due to various kinds of obstacles, at which point we realized that it would be better for the guide dog robot to disobey the commands of the master and thus, to protect him. We called that intelligent disobedience."

According to Tachi, the project had other important outcomes, and in particular it confronted them with thinking about the problem of human-machine interaction, as there was a need for the guide dog robot and the human to constantly exchange information about the environment.

## VISIT TO MIT, AND THE BEGINNINGS OF TELEXISTENCE

In 1979, Tachi joined the famous
Professor Robert W. Mann's lab at
MIT as a Japanese Government Award
Senior Visiting Scientist in order to do
joint research on the guide dog project.
He felt privileged to work at the same
university where Wiener had initiated
cybernetics. After what turned out to
be an extremely productive year, he
returned to Japan in 1980 thinking

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about ways to further advance his work. His aim was to create a simulator device by which humans could work freely in an environment with obstacles without putting themselves in danger, which in turn led him to conceive the idea of telexistence.

"I came up with the idea of telexistence in the early autumn of that year. When walking down the corridor, I was suddenly reminded that all of human vision is just based on two images projected on our retinas, and we build the 3-D world by moving our heads and exploring the world. So if we replace that with a virtual image, what we experience is a kind of virtual world. Since we perceive the environment through sensors and reconstruct the world in our brains, if we gather that information from a robot and present it to the human, we can live through the experience of being embodied within the robot, existing in its specific environment. I immediately went back to my office and wrote everything down, and simultaneously came up with the idea of how to design the visual display to do that. 1980 was the beginning of telexistence," Tachi explained.

Despite the simplicity and elegance of his revelation, Tachi confessed his ideas regarding telexistence were at first met with skepticism, and only after developing a prototype did his peers truly understand the out-ofbody experience he had been talking about. "I was immediately impressed when I saw myself for the first time using the system I had built. It's not like a mirror. When I saw myself from the third person using that system, I began questioning whose consciousness I really was, allowing me to perceive my body like that," he said. Tachi also observed in the age of the Internet, webcams, and mobile devices, it's very easy for a person to understand these notions, but back then the only way to explain these concepts was to invite people to the lab and have them experience the prototype system that was built. Only then did they truly understand what he meant by telexistence.

He rejoined the University of Tokyo as a professor in 1989 and has continued his research in telexistence with more than a hundred research members and students in the Tachi Laboratory. Since he believes only experience can make people understand the true meaning of telexistence, he has constructed TELESAR (TELExistence Surrogate Anthropomorphic Robot) to demonstrate the advancement of the technology. He has invented several innovative technologies in 3-D, virtual reality, augmented reality, and haptics, which have in turn advanced telexistence.

### NEW DIRECTIONS IN TELEXISTENCE

According to Tachi, building technology that is capable of telexistence will have a definite positive impact on our rapidly aging, transportation-reliant society: "If we could succeed in transmitting haptic sensations, then society will change, so that real work can be done remotely, in environments which would otherwise be hazardous or hard to reach. We could do international timeshare, and we could allow disabled or otherwise old people to continue working. In Japan, for example, we have a very aged society, but in many cases old people can still work, and would like to keep contributing to society even if they get somehow physically impaired with age. They have lifelong experience, and this experience is very valuable. Telexistence would liberate them from old age, and maybe even change the way we socialize."

On a final note, Tachi remarked the holy grail of telexistence is to have robots connected to the Internet and spread all over the globe, with people able to log on and off to them as they please. He emphasized telexistence is in a sense the ultimate form of cyborg: "Using this technology, human beings can obtain an augmented superhuman body without losing anything of their own. They could even be free of location and timezone. That is, through the use of their avatar robots all over the world, human beings would become virtually ubiquitous."

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