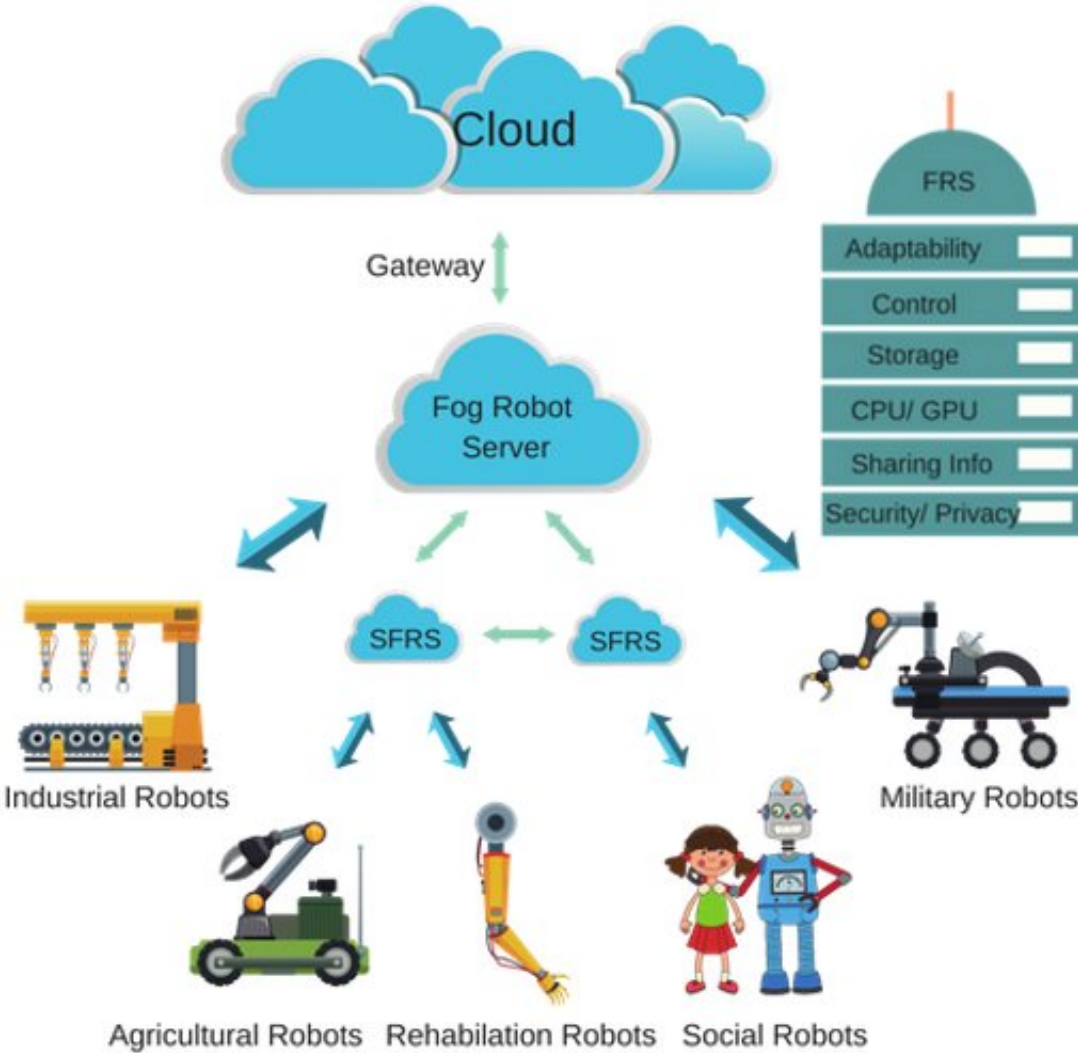


Fog robotics: A new approach to achieve efficient and fluent human-robot interaction

November 30 2018, by Ingrid Fadelli



Credit: Chand Gudi et al.

Researchers at the Innovation and Enterprise Research Laboratory (The Magic Lab) of the University of Technology Sydney have proposed a new robotics architecture called fog robotics (FR). Their approach, outlined in a paper pre-published on arXiv, leverages the strengths of fog computing, a decentralized computing structure in which resources and data are placed between their source and the cloud.

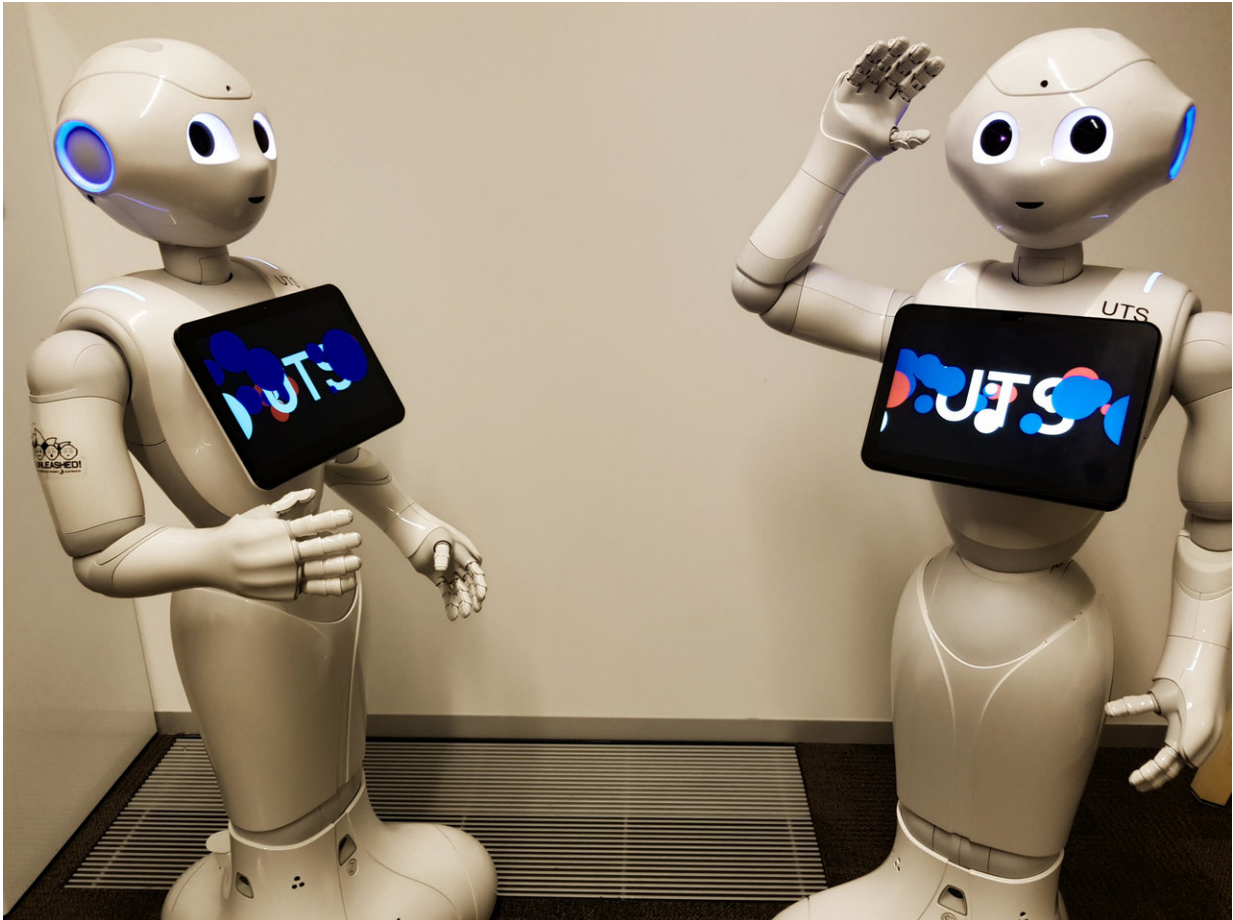
In years to come, robots are likely to reach widespread adoption in a variety of settings, including homes, healthcare facilities, and several industries. Active communication is a key factor behind effective human-[robot](#) interaction and researchers worldwide are thus trying to devise new strategies that could improve the way in which robots communicate.

Cloud robotics (CR) allows robots to perform extensive computations in the cloud by sharing maps, images, data, activities, processing power and other resources online. However, due to its vast data and traffic demands, CR entails serious latency issues, particularly in robot-human interactions.

"The idea of fog robotics came to mind after seeing a high latency in a robot's communication, both in its answers and in reaching its goal," [Siva Leela Krishna Chand Gudi](#), one of the researchers who carried out the study, told TechXplore. "We wondered what might happen in the near future, when robots will serve everywhere, as this lag is likely to increase. By inheriting the features of fog computing and making cloud robotics our companion, we introduced and coined the term fog robotics, first at the IROS 2017 conference."

The main objective of the study carried out by Gudi and his colleagues was to deliver robust, fluent and efficient human-robot interactions with low latency. The researchers also wanted to allow robots to communicate and collaborate with humans while simultaneously performing tasks,

sharing their outcomes or activities within the same family of robots. This would ultimately turn robots into partners that understand the needs of humans they interact with, responding quickly and efficiently.



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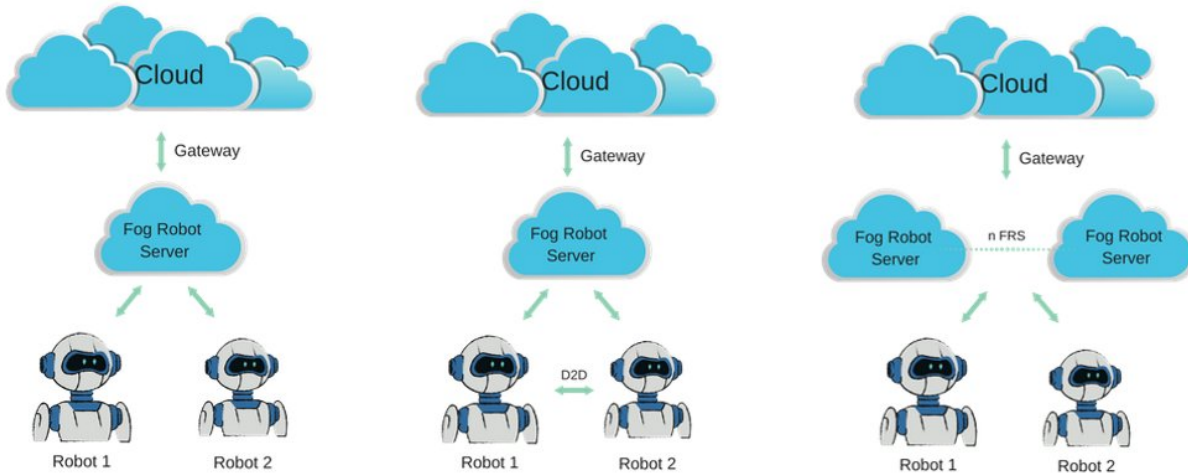
To address the issues associated with CR, the researchers proposed and defined a new robotics architecture dubbed fog robotics (FR), consisting of storage, networking functions, and decentralized computing that is closer to robots. FR has three main components: the sub fog robot server, the fog robot server, and the cloud.

A robot sends a request for information to the FR system, initially requesting handovers to the sub fog robot server. If this server can effectively tackle the request, it passes the requested information to the robot; if it cannot, it seeks assistance from the fog robot server. If this server is also unable to process the request, it asks for help from the cloud, which typically solves the request and passes the information to the robot.

The advantages of this approach include a fast response rate, low latency, improved computing capabilities, lower energy consumption, cheaper hardware, and less security or privacy concerns. In other words, FR could lead to robust and faster human-robot interactions, while also enhancing the robot's battery life.

"Based on the average delay received by a social robot pepper and a setup of FRS/Cloud, we considered a value of latency," Gudi said. "We later examined our current methodologies on a simulation platform, evaluating their potential effects when the number of robots increases. We proved that FR provides low latency and could play an essential role in the future, becoming an addition to CR."

In a series of initial evaluations, FR achieved much faster response rates than CR approaches. The researchers believe that it could be used independently or integrated with CR, reducing the burden on the cloud and improving quality of service (QoS).



Credit: Chand Gudi et al.

"We humans seek help from others whenever we are in need of information, but robots are limited to the tasks they are pre-programmed for," Gudi explained. "FR also allows a robot to share its data with another robot."

To better explain this point, Gudi offered an example of how multiple robots might assist humans inside an airport. In the scenario described by him, a traveler would ask a robot the location of his/her departure gate. The robot would guide the traveler to the escalator and then hand the task over to a second robot, who would be waiting at the other end of the escalator.

To recognize him/her as they approach the other end of the escalator, this second robot would require information about the person's name, identity, gender and what they look like. In this situation, FR would allow these two robots to collaborate on the task and communicate with each other, rapidly exchanging the information necessary to complete the task.

"Similarly, FR techniques could be applied in universities, subways, industrial robots, and the list goes on, reaching different areas of robotics," Gudi said. "Ultimately, FR leads to robust human-robot interaction with low latency, while also securing personal data by saving it within the fog robot server."

The researchers have carried out a number of additional analyses, which they will soon be publishing online. They are also planning to test the effectiveness of FR at RoboCup in Sydney, where several robots will be competing in the wild.

More information: Fog robotics for efficient, fluent and robust human-robot interaction. arXiv:1811.05578 [cs.RO].
arxiv.org/abs/1811.05578

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