



GEARHEAD

by David Geer

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Artificial Intelligence Brings Humanoid Robots to Life

Researchers have a variety of goals for artificial intelligence. Some scientists are examining human biology together with artificial intelligence in an effort to create robots that are as humanlike as possible. Still others examine AI from an engineering perspective, begging the question, what can robots be enabled to do?



Nao robot shown with human hand (for scale).

The mere building blocks for advancing AI for humanoid robots are many and highly technical. Robotic vision via web cams and machine vision, natural language processing and machine learning, common sense reasoning and knowledge, robotic agility and motion, and robot-to-human-to-robot interaction are a few of the areas of research that will move us closer to more human-like robots. What research areas will have to emerge to take us there? Will we know before we get there?

**Let there be light!
Robot machine vision leaps forward thanks to real time image processing.**

Ten years ago, processor speed was not fast enough to enable real time video image processing. Today, it is. "Real time processing of video images means we can now put cameras on robots and have them understand the world through video images," says Professor Peter Stone, Department of Computer Sciences, University of Texas at Austin.

A decade or more ago, roboticists could only use sonar range finders in a single dimension to discover how far the robot was from the nearest wall. This gave the robots no information about faces for face recognition, no information about

people's location relative to the robot, and no information about color.

Robots moving from legacy sensors to real time machine vision is like asking people to walk around a room with their eyes closed, illustrates Professor Stone. People would likely use their hands as bump sensors to sense objects and feel their way around the room.

This would make moving around slow, complex, and herky-jerky. Humans can do a lot more if they are allowed to open their eyes and process vision in real time. So can robots.

Robot machine vision has made a lot of progress, though not all the problems surrounding it have been resolved. At the same time, there has been progress accomplishing vision tasks using a new three-dimensional laser range finder that retrieves more than 1M range points per second. This gives the robot 3D range pictures of the world around it, according to Professor Stone. "We are researching this here," he comments.

Velodyne is making this range finder — the LIDAR HDL-64E. The 64-element sensor offers 360-degrees of HFOV (horizontal field of view) and 26.8 degrees of VFOV (vertical field of view), according to Velodyne. It reads 1.3M data points per second.

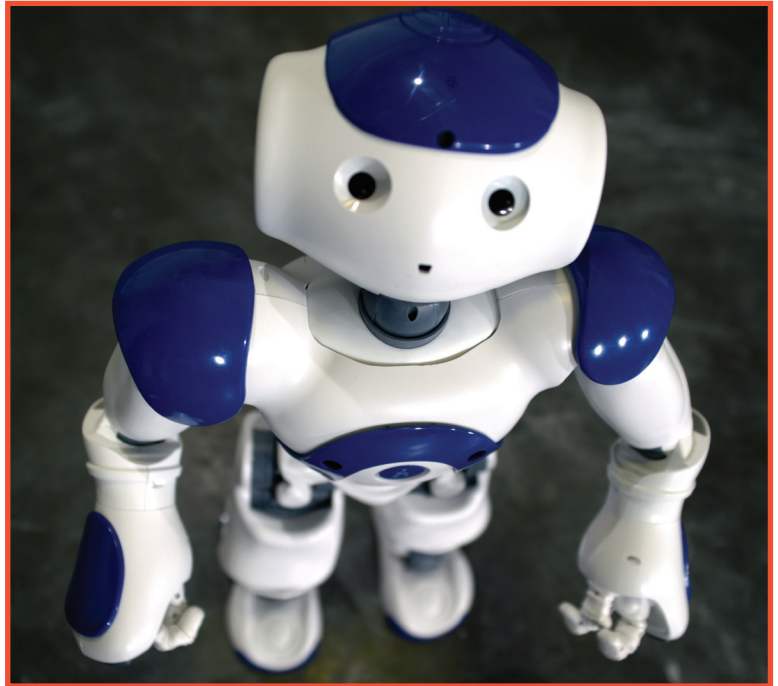
This provides the distance and intensity data about the environment that are necessary to achieve a 3D view of the world.

While the HDL-64E is too big for a small humanoid robot, it might fit onto a full-sized humanoid robot, according to Professor Stone. "We have an HDL-64E on one of our autonomous cars. We are able to get a much richer stream of information than was ever possible before," he continues.

Learn the Language

For humanoid robots to become as intelligent as people, they will have to be imbued with the ability to understand natural human language. This is called natural language processing. "Right now, if you type a question into Google search, it won't simply answer your question. It doesn't understand language in the way that people do," explains Professor Stone.

With robots, the idea would be that they could hear or read natural human language, understand it, and respond with learning, communication, or obedience to a command. With computers, people could stop using keyboards and simply talk to their computers. The computers would be able to listen, parse the



Here's lookin' at you, Nao.

words and sentences, and understand and respond by typing out words in a word processor or initiating computer commands.

"You could just tell your computer, open my browser and search for directions to the nearest restaurant, rather than having to go and do what we do in Google maps," says Professor Stone.

Machine Learning

When robots learn by doing, they no longer need to be instructed or controlled quite so much by an outside intelligence (man's). "With machine learning — which is one of my areas of expertise — the goal is to write and develop algorithms that

News: Humanoids Beat Humans in 2050

Professor Peter Stone of the Department of Computer Sciences, the University of Texas at Austin, is dedicated to the goal of the RoboCup Federation, which is to build a humanoid robot team that can defeat the best human world cup team on a real soccer field by 2050. According to Dan Burrus, founder of Burrus Research Associates, Inc., and a long-time roboticist, it is more likely that Professor Stone will reach his goal by the 2030 to 2040 time frame.

Accomplishing Professor Stone's goal will solve many important challenges and problems around AI for humanoid robotics. Examples include the robot agility problem (having robots run quickly and manipulate their motors in a very granular way so that they can kick a soccer ball), planning, teamwork, and higher level cognitive functioning. "The robots need to be able to reason about their opponents and not fall for the same trick over and over," Professor Stone explains.



Front view of a Nao robot, like the ones Professor Stone and others are experimenting with for RoboCup soccer.

allow computers and robots to improve their performance over time without being explicitly told how to accomplish their tasks,” says Professor Stone. Rather than Professor Stone and his students programming their robots to walk faster, to move their legs a certain way, to move into certain joint angles, they programmed in a machine learning algorithm that gave them the ability to experiment with walking; to try different leg motions and joint angles. With this, the robots can record the movements that enable them to walk faster. They can then experiment with combinations of these movements, to see which of those help them to walk faster. In this way, the robots can improve the quality of their behavior in relation to the desired goal.

Processors, Sensors, and Bandwidth

The more powerful the building blocks — such as processing power and speed, sensor capability, and bandwidth — the more scientists are able to think in new and different ways about solving problems about AI. Here, Professor Stone draws an analogy with man’s attempt to use computers to play chess:

“When computers were first developed, the notion of a computer that had the speed of Deep Blue really wasn’t imaginable. But, at the time, people were trying to figure out whether computers could be made to play chess using the types of processing speeds that people had back then, in the 1970s, which is just orders and orders of magnitude different from what is available today.”

“Once you get to the point of being able to do the kinds of search operations that computers can today, then a more or less brute force type of approach, searching billions of chess board positions every second, is made possible, and it opened up completely different ways of thinking about the problem,” says Professor Stone.

AI Today

Today, artificial intelligence is good at all the things that modern day computers are good at, such as searching through databases of information looking for the most relevant records. “Humanoid robots really are computers,” says Professor Stone. Robots are not better than people at physical motion, though that is what we primarily think of robots as doing.

Robots do not yet have the same degrees of freedom that humans have. Researchers are working on this, including robots with degrees of freedom in their backs, through use of spines that mimic the capabilities of human spines, according to Professor Stone. “But, giving robots spines is difficult and expensive.”

Conclusion

In order for truly humanlike humanoid robots to model the capabilities of people, they must be instilled with intelligence for a number of individual tasks and accomplishments. Taken together, however, these different types of intelligence will form building blocks for more fully humanlike behaviors and thinking. **SV**

Video of Nao robots used in RoboCup
www.cs.utexas.edu/~AustinVilla/?p=nao