Sensory Systems in Telepresence Robots

by Cindy Coles

The NAO robot, by shenzhen's Luckystar Technologies Co. Ltd.

If robots could be classified into just two categories, those categories might be industrial and humanoid. Humanoid robots resemble human beings in appearance, or interpersonal behavior, or both. Industrial robots function with autonomy in a factory or workplace, performing work that a human might have done.

Telepresence humanoids

Telepresence robotics involves an operator site where the human is located, and a remote site where the robot is located. In the past, telepresence robots were primarily industrial. With developments in IoT and robot control platforms, they can be either.

In Build your own Avatar, we looked at the Project Avatar case study, where hardware hacking team at TNG Technology Consulting GmbH put together an avatar – a telepresence humanoid robot – using off-the-shelf hardware. The goal of Project Avatar was to build a system that could create an out-of-body experience like the one Jake Sully experienced by incarnating as one of the Na'Vi in James Cameron's movie Avatar.

The hacking team's avatar system was defined by the following functional requirements:

- The human operator controls the movements of the teleoperator
- The human operator receives 3D visual feedback using a head-mounted display
- The human operator's head movements will result in corresponding head movement of a teleoperated humanoid robot
- The human operator receives tactile feedback when teleoperator is touched on head
- The data between the human controller and the teleoperator gets transferred without any cables
- Signal delays should be minimal for a pure out-of-body experience

To build their avatar system, the team chose a programmable robot, NAO from Softbank, as their humanoid. NAO is an interactive companion that recognizes speech in 20 languages. It stands 58 cm in height, and has opposing digits and joints with 25 degrees of freedom like a human. The off-the-shelf humanoid is built with NAOqi OS and is WiFi-Ethernet connected.

Shenzhen's Luckystar Technology Co. Ltd., founded in 1999, is a product design, research, and development enterprise for computer peripherals. Their core products are smart tablets, PCs, smart home devices, smartphones, and intelligent equipment. They also make VR/AR virtual reality equipment, intelligent robots like NAO, and intelligent drones.
To get a production quote, contact representative Rachel Cen on the HWTrek platform.

As an avatar, NAO's functions were:

- Delivering sensory experience to the human operator, including 3D field of view using RGB stereo cameras
- Gathering environmental, including touch events using tactile sensors
- Full body motion

In this case study examination, we'll look at the sensory experience of the robot, and consider suppliers for both a fully functional humanoid and the individual sensors for anyone considering a custom build.

The sensory functions needed in this case study were

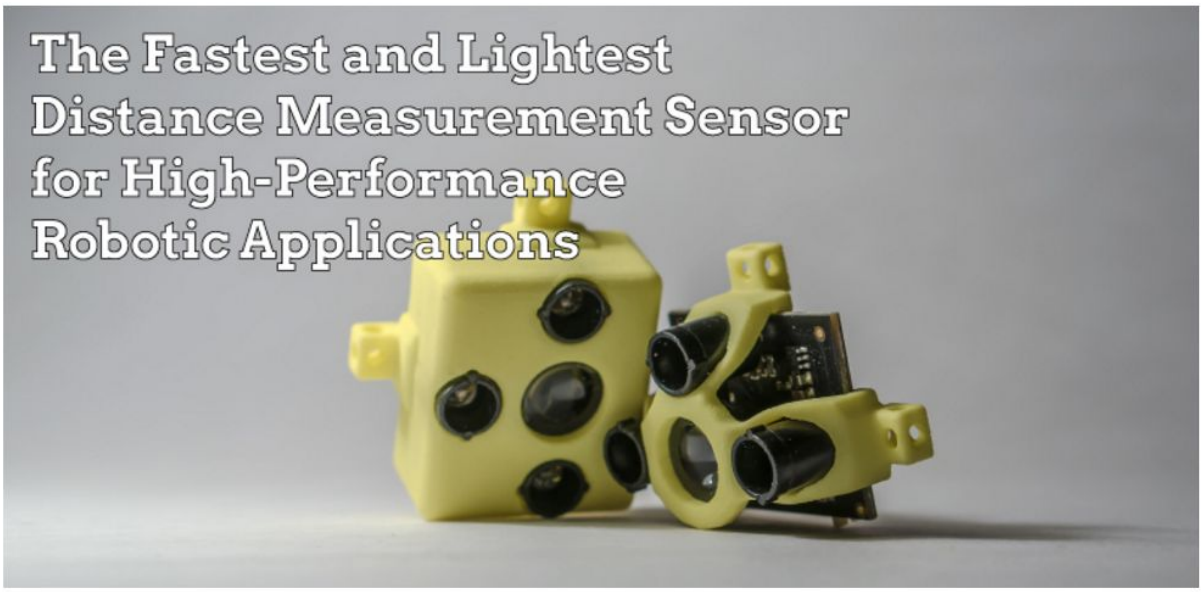
- vision
- touch (tactile)
- balance (kinaesthetic)
- acceleration (kinaesthetic)

Vision and autonomous navigation systems

For vision, NAO is equipped with two high-resolution RGB cameras to allow for stereo vision. The telepresence robot relays visual information to the human operator, but also uses the visual input for its own purpose – to move around the environment according to the motor commands it receives. Autonomous navigation systems, which use vision, balance, and acceleration, achieve this for the robot. Some of these systems also include simultaneous localization and mapping.

Shenzhen Smalon Electronics Co., Ltd. is an entity enterprise with R&D, supply chain, production, and marketing services. They offer PCB assembly services for IP camera modules, and have launched a variety of 360°panoramic cameras. Their video marketing center is the PCBA solution provider for video surveillance products.
Contact Xiang Liu on the HWTrek Hub for more information.

Qfeeltech provides the essential technology and hardware components for visual navigation robotics. Their systems use simultaneous indoor localization and mapping, navigation, exploration and MLD dynamic objects. They also make ULBrain, a set of solutions for rapid development of smart robots and drone applications.
Contact Yiming Zhang on the HWTrek Hub for more information.



Terabee provides innovative measuring and sensing solutions for autonomous navigation in robots. Their surface detection and distance measurement technologies use ultrasound, infrared, and LiDAR. Small, lightweight, low-power Terabee sensors provide faster readings and better accuracy.
For more information, contact representative Greg Watts on the HWTrek Hub.

Tactile sensors

In Project Avatar, the human operator received tactile feedback when the teleoperator was touched on the head. The touch event data was collected by tactile sensors at the remote site and represented to the human operator using a control system similar to force feedback. The AR/VR headset provides haptic feedback by visual display.

Thundersoft creates total IoT mobile chipsets and OSes for drones, VR products, IP cameras, and robots. Their innovative technologies bring image latency to less than 19 ms for an immersive VR experience. The ThunderVR SoM core processing module provides an open platform with a dedicated VR OS. It also supports dual-band Wi-Fi, Bluetooth 4.1 and offers an SDK that enables fast apps and games development.
For more information, contact Pier Zhang on the HWTrek Hub.

Royole develops innovative display technologies and related electronic products, including the most advanced flexible displays, flexible sensors, and wearable consumer electronics. In 2014, they introduced the world's thinnest full-color flexible displays with a thickness of 0.01 mm and a bending radius of 1 mm. In September 2015, they announced the world's first foldable Virtual Mobile Theater.
Contact Way Luo on the HWTrek Hub to make inquiries.

ALPS Electric makes many kinds of sensors, and specialize in mechano-electric devices. They make position control sensors and haptic feedback devices, both of which provide functions that a mobile robot would need. Their environmental sensors detect light, temperature, and humidity.
For more information, contact Matsui Hisao on the HWTrek platform.

Kinaesthetic-related sensors for mobile robots

Kinaesthetic sensors measure aspects of weight, directional weight, and change in weight to evaluate the environment and provide feedback about a robot's motion.

- shock sensor – measures stress acceleration as mechanical shock, such as the "hardness" of a landing
- accelerometer – measures acceleration of the object in motion
- inclinometer – detect the gravitational acceleration of the earth to measure surface gradient
- gyro sensor – uses 3D MEMS technology to measure angular velocity

This information is used by the motor control system to satisfy high-level motor commands from the human operator.

Murata is a global leader in the design, manufacture, and supply of electronic components and high-density modules. Monolithic ceramic capacitors and piezoelectric components are core products. High-performance shock sensors and MEMS devices are built in-house, and can be used for consumer equipment, in-vehicle TPMS technology, and industrial systems. Contact Murata China representative Yuji Mitsui on the HWTrek Hub.

Learn more about how sensory information and motor commands are represented between a telepresence robot and a human operator with Build your own Avatar.

Designing robots and avatars with NAO

NAO continues to develop through programming. The opportunity for new creative models is aimed at developers, but is open to everyone. NAO's initial programs were developed by Softbank, and Softbank offers a robotics community for anyone wanting to customize an intelligent robot for applications in performance art, graphic design, linguistics research, or customer service.

Introducing the +Style program from Softbank

If you're building a consumer robotics application, or if you simply have a great idea that you'd like feedback on, check out **+Style program at Softbank.** This program is for SMBs and specialists in IoT who want to do business in the Japanese market. Softbank's program combines three important elements to product introduction:

Participatory product planning – Post your IoT products and ideas, then invite people to share their opinions and experiences regarding these new inventions.

Crowdfunding – Raise money for a project or product through online donors.

Retail distribution – Give consumers the chance to purchase your products online, including advance sales, built-to-order sales, and limited-quantity sales.

To find out more, contact representative Masato Furuno on the HWTrek platform.