Wheel appeal

A robot expert on wheels offers remote support

ELINA VARTIAINEN, VERONIKA DOMOVA – In nearly every branch of industry, expert human resources are becoming spread ever more thinly. The question then arises as to how to make the best use of the resources available. One innovative approach that is rapidly gaining popularity is the telepresence robot. Located on an industrial site, this robot provides a virtual expert presence by channeling content-rich two-way communication between a remote expert and local personnel. ABB has developed a concept for an industrial telepresence robot called “expert on wheels.” This robot aims to make ABB experts more effective in solving maintenance and service tasks in collaboration with local field-workers at customer sites.

1 The robot has a sturdy base mounted on rubber-covered wheels, which provide excellent traction. Vents prevent overheating.

Low-cost computing, wireless connectivity and high-quality real-time video capabilities have facilitated a significant growth in telepresence robots. These robots provide a sense of a physical environment – through video and audio feeds – to a person who controls the robot remotely. This can enable an expert to be "present" in distant locations, whether it be a conference, meeting or factory, without actually travelling there. The robots generally make remote workers more available by allowing them to steer the robot, look around with a camera and have a conversation with their colleagues.

Telepresence robots have a particular potential to establish collaboration sessions in industrial settings – for example, in situations where a local worker in the field needs guidance from a remote expert. Here, the expert can get a better situational awareness by using the robot to look around. If the robot also enables the expert to make virtual annotations for the field-worker, he has a good means of guiding the field-worker through complex maintenance tasks.

Title picture
The ABB "expert on wheels" provides a remote expert with a local footprint.

The expert controls the robot remotely from a Windows-based desktop application in which he can steer the robot and see the camera picture.

ABB has looked into this opportunity and has designed a first concept of a telepresence robot for the industrial environment. The concept aims to enable remote ABB experts to be more effective in solving maintenance and service tasks together with field-workers located at customer sites.

Design considerations

In order to develop a concept prototype, researchers at ABB studied similar solutions in other markets and research communities to determine practices, experiences and commonly agreed requirements for telepresence robots [1, 2]. Among other things, the findings showed that video streaming can improve the situational awareness of the remote expert when the developed system:

- Provides a wide field of view
- Clarifies what the shared visual space is
- Provides mechanisms to allow people to track one another's focus of attention
- Provides support for gesturing within the shared visual space

The robot is a stand-alone device that can move around on its mobile wheeled platform, show the environment using a video camera and project annotations onto the equipment under investigation using a projector.

2 The robot's projector displays the remote expert's annotations on the appropriate object.

Another common concern was the excess water, dust, etc. encountered in some industrial settings. To combat this, the outer design of the robot should be monolithic, and water- and dirt-proof. Further, the limitations brought about by poor Internet connectivity at some industrial sites should be tackled by automatic algorithms that adjust video quality accordingly.

The prototype

The design challenges were addressed in a telepresence robot proof-of-concept. The robot, dubbed "expert on wheels," is a stand-alone device that can move around on its mobile wheeled platform, show the environment using a video camera and project annotations onto the equipment under investigation via a projector. The expert controls the robot remotely from a Windows-based desktop application in which he can steer the robot and see the camera picture. He can annotate the video display with the symbols and text to be projected.

The process of offering remote guidance is implemented in a wizard-style application, which makes its use straightforward. The wizard-style approach was selected because the collaboration session requires a set of steps that usually follow one another in a certain order:

1. Position the robot
2. Select the target object or area of interest on the video
3. Match the projecting area with the area selected in the previous step
4. Draw the annotations

3 The anti-scratch cover has dedicated holes for the projector, camera, speaker and microphone.

In order to augment the reality with the overlaid annotation from the expert, the robot uses a compact projector embedded in its body.

Once the local worker has positioned the robot and switched it on, the remote expert takes over. He can reposition the robot to obtain a different view, if necessary. The field-worker's hands remain free. The robot also includes a speaker and a microphone so that the remote expert and the field-worker can converse with each other.

Implementation

The robot's base is a mobile platform built on wheels, which can be steered in any direction, rotated and instantly stopped → 1. The heart of the robot is a Windows-based minicomputer that contains a network card, memory and processor. The robot's software controls all the interfaces, enables connectivity, processes commands from the remote expert and streams 2-D high-quality video from the camera back to him. In order to augment the reality with the overlaid annotation from the expert, the robot uses a compact projector embedded in its body to "draw" on the equipment being inspected → 2. The system uses a semi-automatic algorithm to synchronize the coordinate system of the camera with the coordinate system of the projector. Future releases will feature a synchronization that will be done automatically and implicitly for both users. To support the wireless functionality and mobility of the robot, it has a rechargeable battery with a two-hour runtime capacity.

The outer shell of the robot has been designed for industrial environments. It has a protective anti-scratch plastic

The outer shell is a protective anti-scratch plastic cover with dedicated holes for the projector, camera, speaker and microphone.

cover with dedicated holes for the projector, camera, speaker and microphone → 3. It also has special openings for ventilation to protect the robot from possible overheating. The mobile platform has a metallic body with a load capacity of 20 kg and rubber-covered wheels for good traction.

Special attention was paid to the startup time of the robot since every second of waiting could be costly. At the moment, the robot starts or restarts with a single press of a button and takes no more than a few seconds to be up and running and ready for a remote collaboration session.

First impressions

The prototype was evaluated in a power plant to get initial feedback on the concept and its applicability to industrial settings. The overall impression was that such a concept could indeed be offered by ABB as a service to its customers. They could use such a robot when they need assistance or troubleshooting guidance for ABB equipment or other service-related issues.

The feedback also indicated that such a concept could offer significant benefits for general maintenance or service tasks. For instance, the robot would offer the field-worker an extra pair of eyes and ears. Furthermore, it could be used alone to supervise certain areas that are disagreeable for humans and flag issues that need special attention. The robot could also be used to project cumbersome-to-carry manuals when a field-worker needs to look at documentation.

The concept has also sparked ideas for future development. For example, a mobile platform faces terrain-related challenges – such as a rough environment, doors and stairs – so one consideration might be to replace the wheeled solution with an easily transportable tripod. Also, the audio should be connected to a wireless headset to improve sound quality, as a speaker is difficult to hear in noisy environments. Furthermore, the camera should have night vision to see better in the dark and perhaps thermal vision to monitor equipment and notice overheating problems.

Tomorrow's robot

The "expert on wheels" concept demonstrates a high potential to improve remote collaboration in maintenance and service tasks in industrial settings. The evaluation confirmed that remote collaboration between field-workers and ABB remote experts could significantly benefit from such robots. On the other hand, the concept still has a set of open questions that concern, for example, the look and feel of the robot and exact functional features. These open issues will be addressed in the near future by ABB in further investigations.

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