ASHA: A Tele-operated robot nurse

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Abstract

With the increasing technical capabilities of robots, it is becoming equally important to design and build them with social aspects to integrate in various domains of life. We present ASHA, a tele-operated humanoid robot capable of assisting healthcare providers in a post-pandemic world, demonstrating a use case as an attendant.

I. The Need for Tele-robotics in Post-Pandemic Healthcare

Using tele-operated robots for providing medical care in remote areas is one of the domains in which India is leading the path. The first tele-operated robotic cardiac surgery in India was conducted from a distance of 32kms in the state of Gujarat, India in 2018 [1]. Tele-operated humanoid robots have seen applications in the tele-health domain since the early 2000s [2]. It is believed that robots with a human-like structure will easily be able to strike a rapport with patients [2], [3]. Humanoid social robot Grace, a product of Hanson Robotics, has been developed specifically to support healthcare providers as a robot nurse [4]. Here, the humanoid robot ASHA has been developed as a tele-operated nurse to address the requirement of professional nurses in India.

II. ASHA: The nurse Avatar robot

The prospect of social robots working in a natural environment and interacting with humans is increasingly possible with the advent of recent technologies such as a range of cheap sensors, mobile computing, machine intelligence in language, speech and vision etc. ASHA is a *social humanoid robot* developed by utilizing these cutting-edge technologies that *can be tele-operated remotely*. Developed on the SOPHIA [5] robot platform created by Hanson Robotics, ASHA serves as a remote robotic avatar onto which actions of a human operator can be projected in an immersive manner. ASHA can be particularly helpful in providing delivery of valuable services such as nursing through human experts from remote locations paving the way for efficient and rapid medical services without physical barriers coming into play. Owing to its form factor, ASHA's mobility, sensing and manipulation capabilities are suitable for gaining perception of the environment and objects being interacted with, *safely* carrying out a wide range of tasks in an unspecified environment such as guiding a person to a visiting area, offering refreshments, recording temperature etc. Apart from the mobility, sensing and manipulation abilities ASHA also possesses the capabilities to have conversations and convey emotions. The operator, through ASHA, can engage in compassionate communication with a wide range of emotions such as smile, sorrow, concern, surprise etc as well as facial and eye-based expressions appropriate for the situations. Both these abilities allow for a *richer natural interaction and coordination* between ASHA and humans, in situations such as *COVID-19 innovative response*, while performing patient assessment and assisting healthcare providers.

III. Description of the scenario (s)

In the linked video, we are demonstrating a coherent set of capabilities of ASHA in a scenario where she acts as a health attendant operated remotely by a human. Through teleoperation, ASHA is demonstrated to perform communication, remote visual reading of sensor outputs, grasping of objects and mobility towards desired area.

The scene is set up in a visiting room at a hospital. ASHA waits near the entrance to greet and provide assistance to visiting patients. There are refreshments on a table placed nearby. ASHA is holding an infra-red thermometer in one hand.

A patient enters the room. The operator through ASHA greets the patient with a smile and requests for the purpose of the visit. The patient expresses that he

needs to see the doctor because of flu-like symptoms he/she is experiencing. The operator instructs the patient to hold out their hand, measures their body temperature and expresses relief on not having fever. The operator, through ASHA, picks up a refreshment from the nearby table, hands it over to the patient and guides him/her to the waiting area pointing to a seat where the patient can wait for their turn.

IV. Technical Details of the Robotic Platform

A stereoscopic camera, ZEDmini, is mounted on top of the robot's head and is used to capture the remote scene the way it would look from the robot's perspective. The live video stream from the camera is projected onto a VR headset, the HTC VIVE PRO EYE, which the operator wears so that they are completely immersed in the remote scene.

Using the HTC Vive facial tracker and the IR cameras present in the VR headset, the operator's eye and lip movements are captured. These facial landmarks are used to interpolate the position of the motors on the robot's face enabling it to blink, wink, smile, frown etc. The ability to use facial expressions makes the robot seem more sociable and creates a more natural experience for the operator, as well as the person interacting with the robot.

The operator's hand position and orientation is determined using HTC Vive trackers, one of which is placed on the chest and one is placed over each wrist. The data received from these three trackers are fed to the Inverse Kinematics engine, Trac-IK, to translate this position data to the appropriate motor angles so that the robot best imitates the operator's pose.

To create a fully immersive experience for the operator, the Bebop haptic gloves are used so that the operator can sense when the robot has come in contact with any surface or object. The pressure sensor on the robot's fingertips are used to convey haptic feedback to the operator allowing them to sense when something as light as a letter is being held.

ASHA also has a speech and audio based interface to enable natural two way communication between the operator and the human being interacted with. The audio interface captures the sound in and around ASHA through arrays of microphones mounted on her, enabling the operator to remotely perceive ASHA's end auditorily. Similarly, the operator's voice is transmitted and played on ASHA with required modifications such as converting male/female voices to female/male voices by formant and pitch adaptations to account for the desired voice in relation to the operators' voice and ASHA's embodiment. Additionally, voices are also generated and played in sync for a realistic lip movement on ASHA's end.

V. Conclusion: Looking Forward

So far, the use of telerobotics in rural settings has been limited due to the lack of high-end technology availability. Even then there have been notable successes in telemedicine, with telerobotics still in its nascent stage in rural settings. In the present scenario, telerobotic nurses like ASHA can be used to provide quality healthcare services to such areas. Currently Asha is capable of taking basic patient assessment and assisting healthcare providers deliver treatment. However, in the coming years ASHA's application might be expanded to fulfil complete caregiving requirements of isolated patients in remote areas.

Acknowledgements:

We thank the Robert Bosch Center for Cyber-Physical Systems at the Indian Institute of Science for its funding and laboratory support. We also thank the Department of Science and Technology, Govt of India for their funding support. We thank the TCS Innovation Labs team and Hanson Robotics Team along with Mr Avneesh Mishra of ARTPARK/IIITH and Sagar GV of (IISc/Google) for their technical help.

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