

# IMPLEMENTING KUKA IIWA ARM ROBOT INTO TELEMEDICINE



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2017 TRANSFER-TO-EXCELLENCE RESEARCH EXPERIENCES FOR UNDERGRADUATES (TTE REU) PROGRAM



## Abstract

Telemedicine has been established as a means to provide remote medical consultation and training. By using three-dimensional (3D) telepresence technology and robotic systems, it is possible to allow doctors or medical advisors to operate remotely in situations when physical presence is not achievable and time is crucial. The advanced KUKA robot is controlled, which is a model consisting of a seven-joints arm with built-in sensors and smooth edges that provides flexible collaboration with a human operator. A medical advisor, physician, or technician at the remote site can control and interact through this robot. The goal is to attach a 3D camera to the KUKA robot that will retrieve depth images to generate a 3D mesh reconstruction of the patient side and stream it to the remote medical advisor. The proposed solution emphasizes the importance of remote real-time robotic interaction as a solution to improve medical care in rural areas and assistance in emergency situations.

## Introduction

Telemedicine, or telehealth, is using telecommunication and technology to provide medical services in home-, office-, and rural-based locations. This research aims to provide advanced robot remote control for training and interaction between a medical advisor operating through the robot hand and the remote first responder. In addition, the doctor can deliver real-time medical consultation using 3D telepresence technology that can be life-saving by streaming audio, video and 3D image.<sup>1,2,3</sup>

## Materials

KUKA IIWA Robot

- 820 mm radius in range
- 14-kg payload
- Java Libraries
- Built-in sensors that detect torques and soft edges
- World Coordinate System<sup>4</sup>

INTEL REALSENSE 3D CAMERA

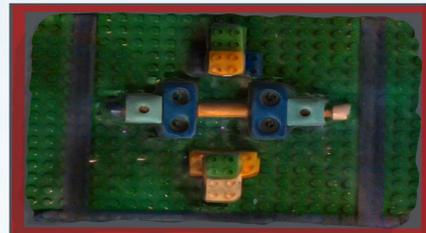
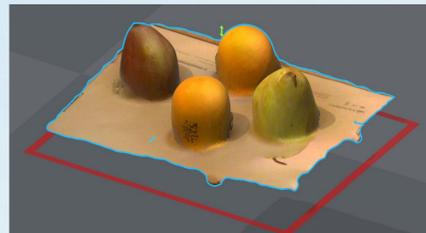
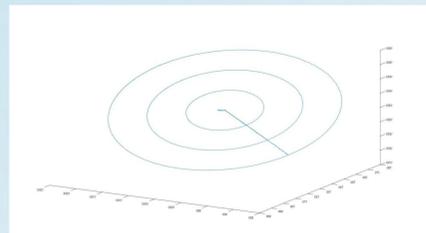
- High resolution RGB-image (1920 x 1080 pixels)
- Depth-map output (640 x 480 pixels) at 30 fps (frames per second)
- The capture ranges between 0' 4" - 3' 0" <sup>4</sup>

## References

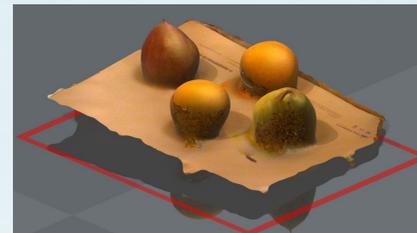
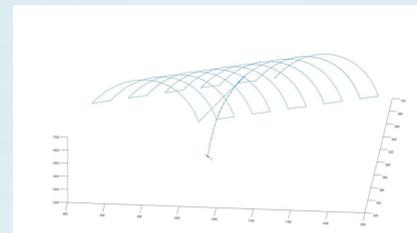
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## Results

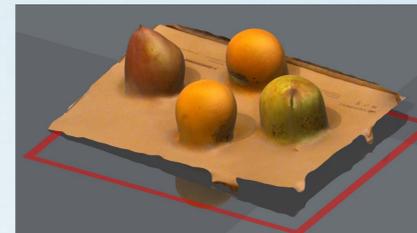
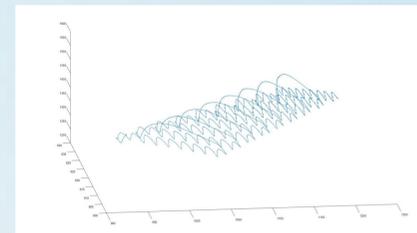
*Circular Motion*



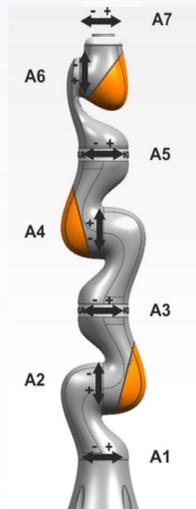
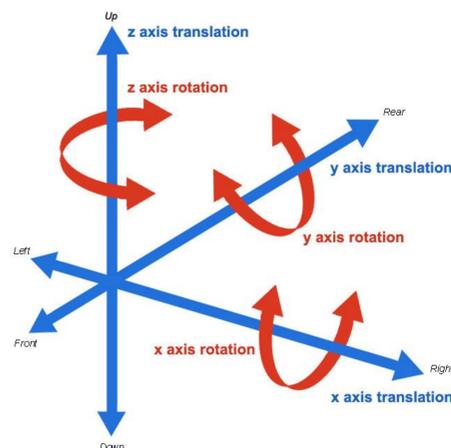
*Half-Cylindrical Motion*



*Square Mesh Motion*



**Six axes of translation and rotation**



## Methods

- German manufactured KUKA robot, which is a new, lightweight robotic technology is easy to handle and designed for industrial projects with human interaction.
- KUKA IIWA LBR consists of seven joints, which move in a world coordinate system, or in other words, X-Y-Z translation coordinate system and alpha-delta-gamma rotation on the axis.
- It has built-in sensors that detect joint torques and soft edges that make it safe for human collaboration. The sensors prevent the robot from reaching unfeasible joint configurations.
- The robot relies on a set of Java libraries and a dedicated programming environment to implement applications.
- This researcher attaches a 3D camera to the KUKA IIWA arm robot that provides detection of human body and estimation of joint locations, which can be used to extract a kinematic skeleton of the patient. The Intel RealSense 3D Camera is a depth-sensing camera manufactured by Intel that establishes natural interaction capabilities. <sup>4</sup>
- RealSense is composed of a video (RGB) camera, an infrared-based depth camera, and a set of four microphones for directional sound capture. The data (RGB video + depth) obtained from the cameras can be used to reconstruct and visualize 3D views of the observed scene in real-time.

## Discussion & Conclusion

As the 3D reconstructions show, there are many factors that affect the precision and quality of the scans, such as light, the initial and final points defined by the user, the velocity of the robot, the distance of the camera to the object, and the shape and color of the object.

This research continues improving telemedicine by implementing robot-controlling systems with VR and AR. The KUKA IIWA arm robot, with its light and human friendly technology, can help many patients to get real-time medical consultation during disasters or when saving their life is time-dependent. The next step is to remotely control the robot and generate 3D mesh pictures of a human body; we hypothesize that this technology will enhance healthcare provision in telemedicine. <sup>1</sup>

## Acknowledgment

Thanks to NSF, UC Berkeley, E3S, TTE REU, COD, Lea Marlor, Kimberley Fountain, David Anton PhD, Gregorij Kurillo PhD, Professor Ruzena Bajcsy PhD, and Pariya Samandi.



**Support Information**  
This work was funded by National Science Foundation Award ECCS-0939514 & ECCS-1461157