

# Robot Telemanipulation with surgical precision

Bill Rusitzky

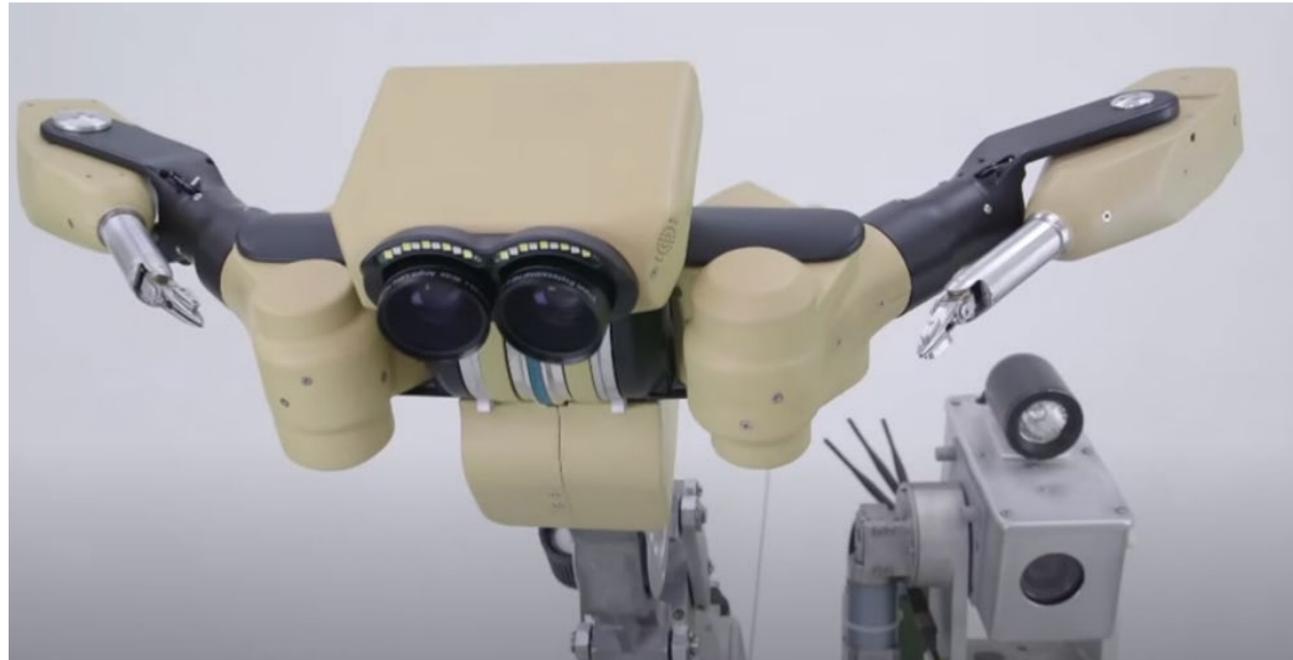
[bill.rusitzky@sri.com](mailto:bill.rusitzky@sri.com)

+1 415.706.1543

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# Robots for Telemanipulation



## Automation

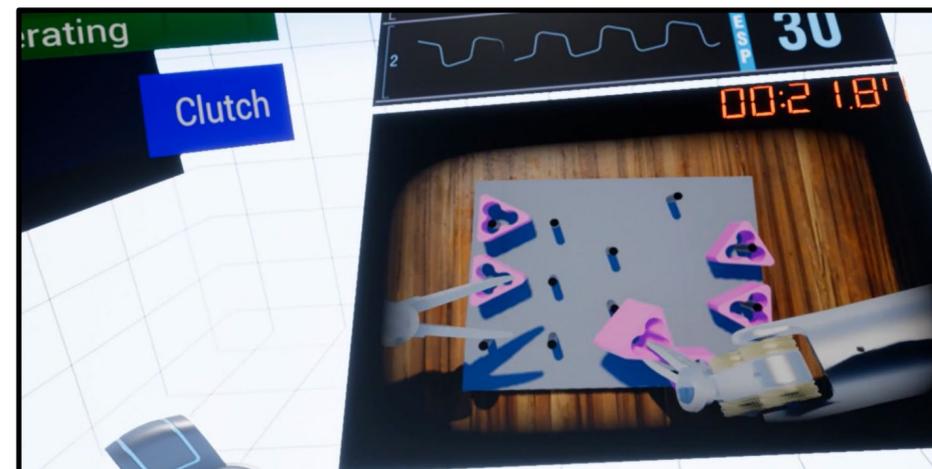
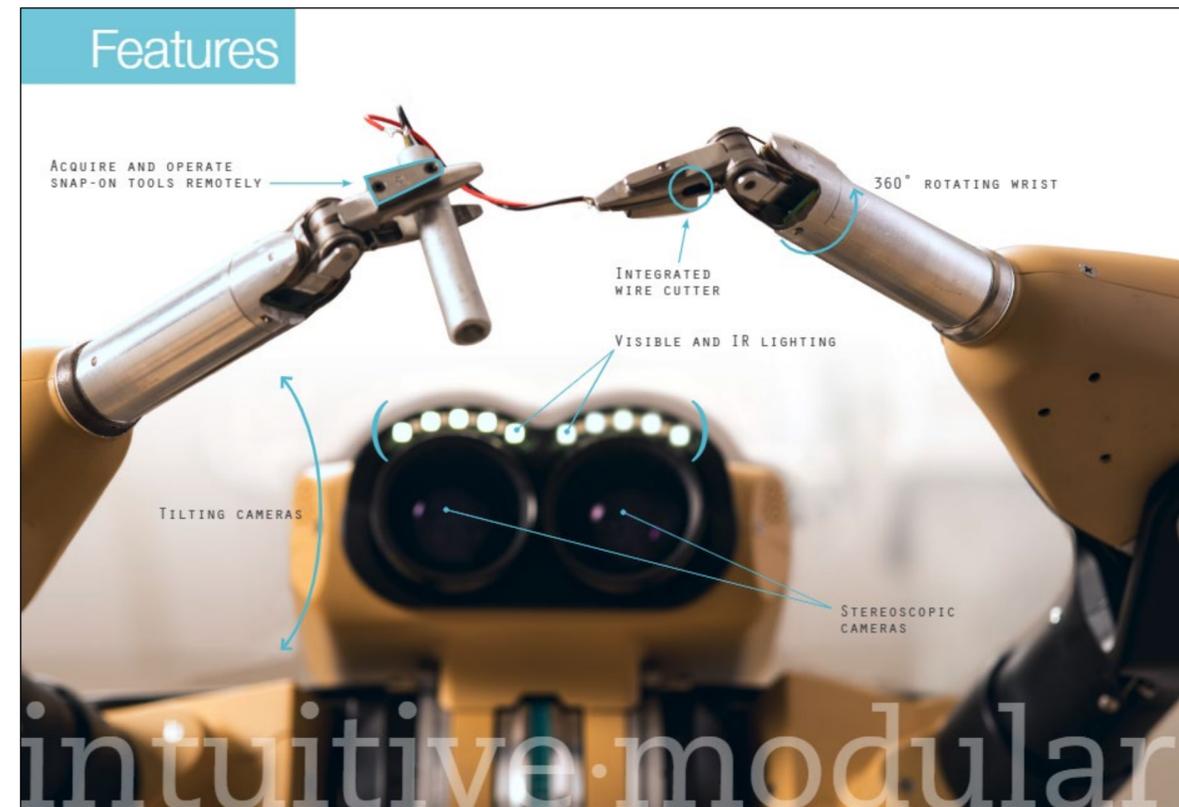


## Human Enhancement



# Taurus Robot Manipulator Arm

- High Dexterity Hardware
  - Designed and used for
    - Remote machine repair
    - Surgery
    - Bomb Disposal
  - Lightweight / Portable
  - Swappable tools
- Immersive User Experience
  - Stereo Augmented Reality Viewing
- Software
  - System simulation embedded
  - Taurus software can be used with a variety of hardware



# Hardware Design Options

## Field Surgery

- In Development with US government

## Mining

- Developed in conjunction with Enaex (subsidiary of the Sigdo Koppers Group)
- Mine safety and exploration
- Capture the mining environment in real time with 3D vision
- Monitor gasses, temperature
- Measure topography

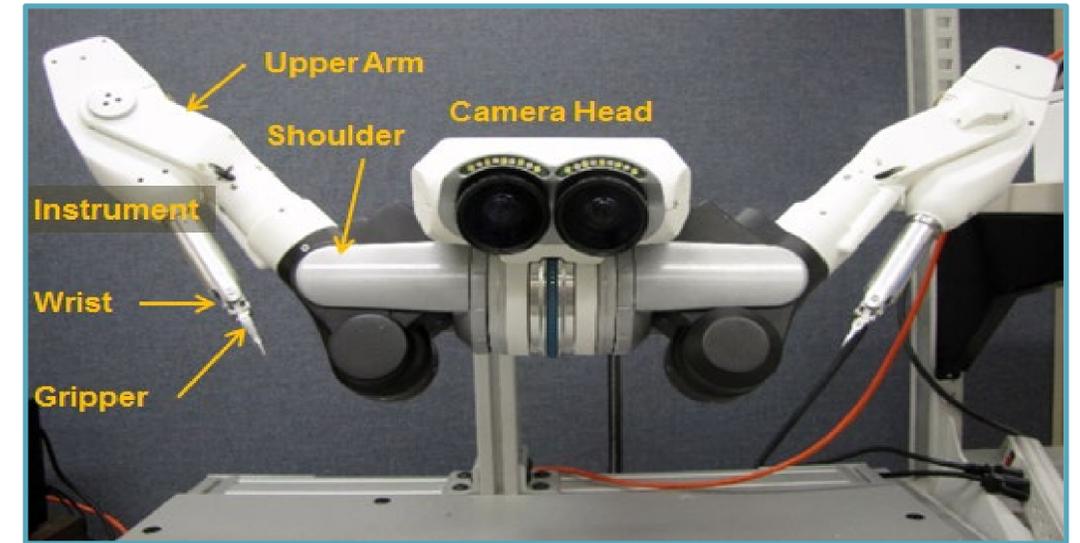
## Oil and Gas

- Remote repair
- Take the hands of a skilled technician and transport them
- Allows skilled team members to operate quickly in environments that take time to get to or are too hazardous for humans



# Hardware designed to provide optimum teleop performance

- Flexible – In operation interchangeable tools
  - Can use power and communication from ‘host’ robot
  - “Tool Belt” Universal dovetail adapter
    - Non-Powered – Suction Cups, Scalpels, wire cutters
    - Powered – Screwdriver, drill, hot knife, voltage and current probe
  - Multiple controllers available
- Lightweight and Portable -18 lbs
  - Can be transported in a backpack
  - Battery or external AC/DC powered
  - Entire robot can be self-contained with up to six hours of operation



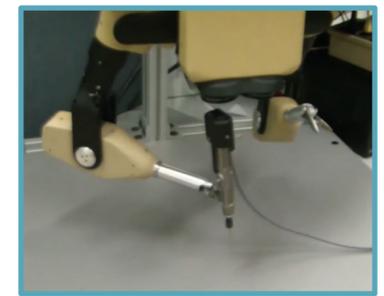
Omega.7 Controllers



Scalpel



Pliers / Grabber



Drill

# Hardware designed to provide optimum teleop performance

- Video - Integrated stereoscopic camera system
  - Optical zoom, IR and visible lighting, and 180-degree tilt range
  - Intuitive, natural 3D scene understanding
  - Proprioceptive operation.
  - Stereo sound
  - Patented grasper actuation
- Robust operating parameters
  - 7 DOF arms provide large overlapping dexterous workspace
  - Haptic feedback - Force feedback and vibro-tactile sense of texture and hardness (with compatible HIDs)
  - Patented “Manipulator/Camera” as a tool for hard to reach places



Manipulator Camera



3D Camera and Glasses

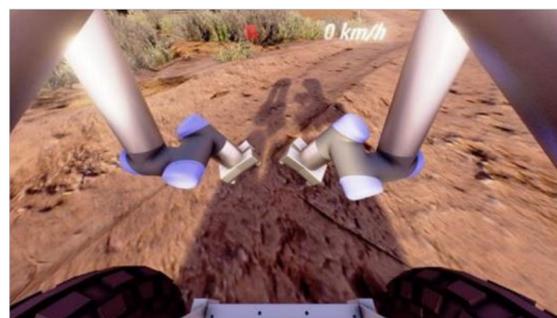
# Software designed to provide optimum teleop performance

- Intuitive man-machine interface
  - Enabling complex remote manipulation tasks to be performed with ease
- Custom C++ software application
  - Supports a variety of displays, user input devices
  - Flexible and rapidly reconfigurable to support COT's manipulators.
  - VR based interface & system simulation for operator training
  - Tolerant to network interruption
- Video recording integrated
- Can be used with existing SGI Taurus Manipulator Arm or used with customized robot arms or devices. Has been ported to construction equipment

Same software applied to other systems



Example UI Implementations



SRI Hardware Simulation



Desktop OCU

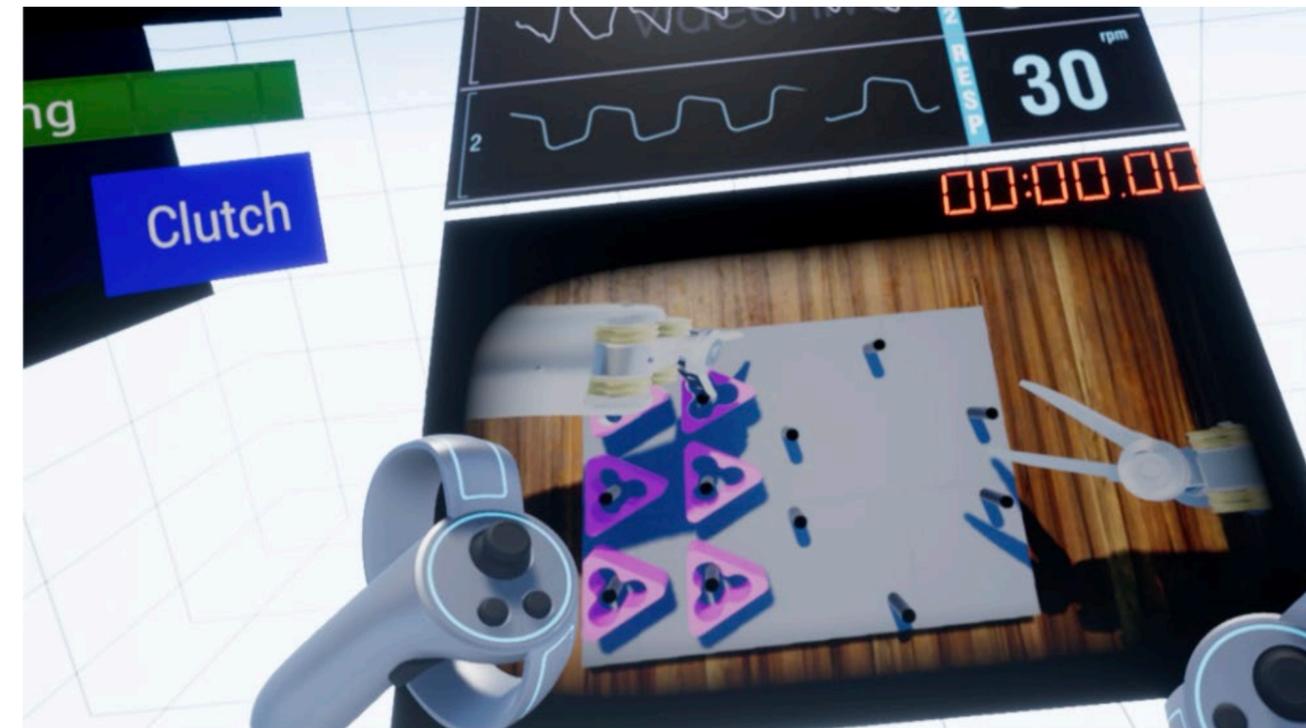


Operator

UIDs

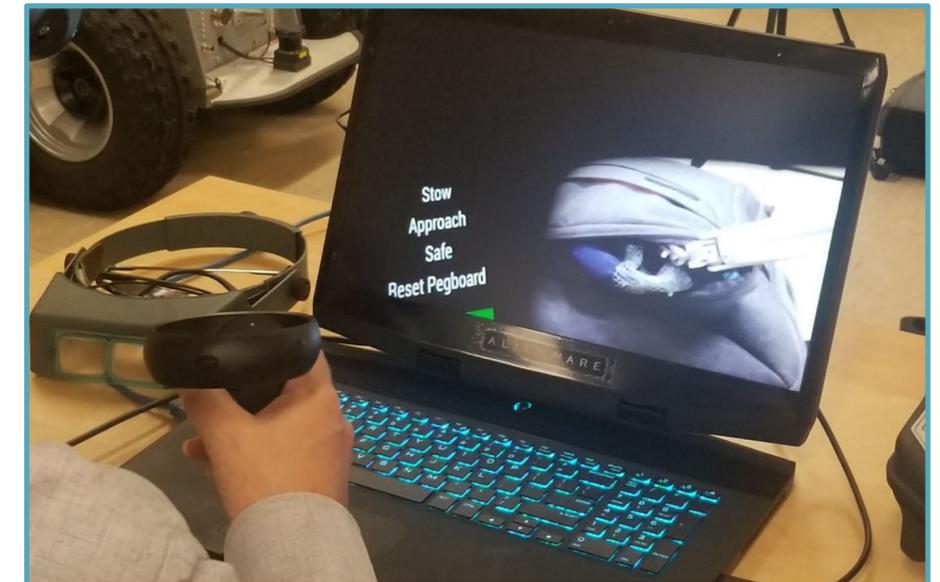
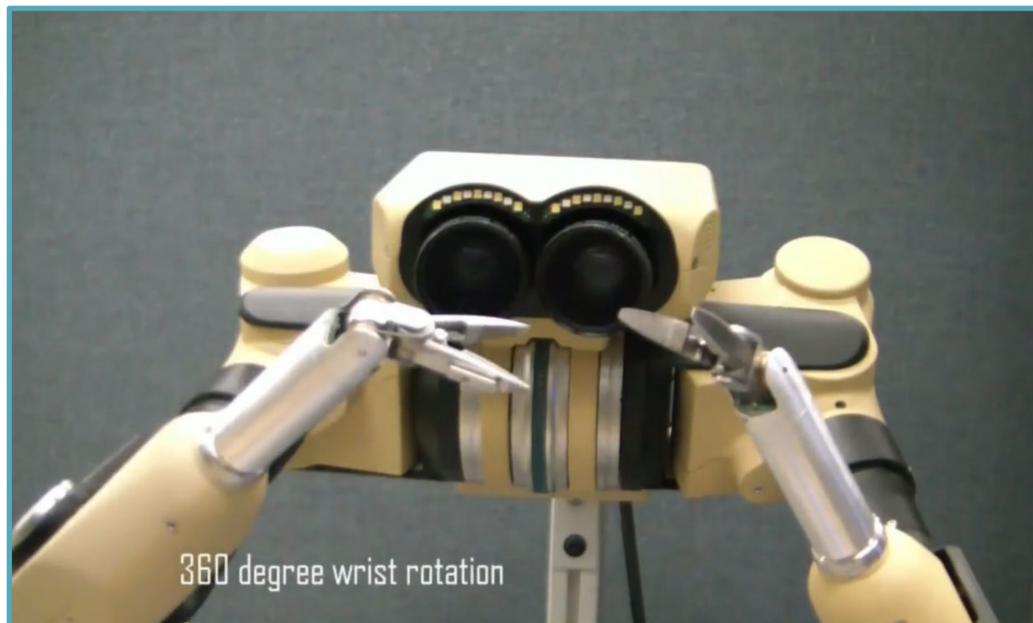
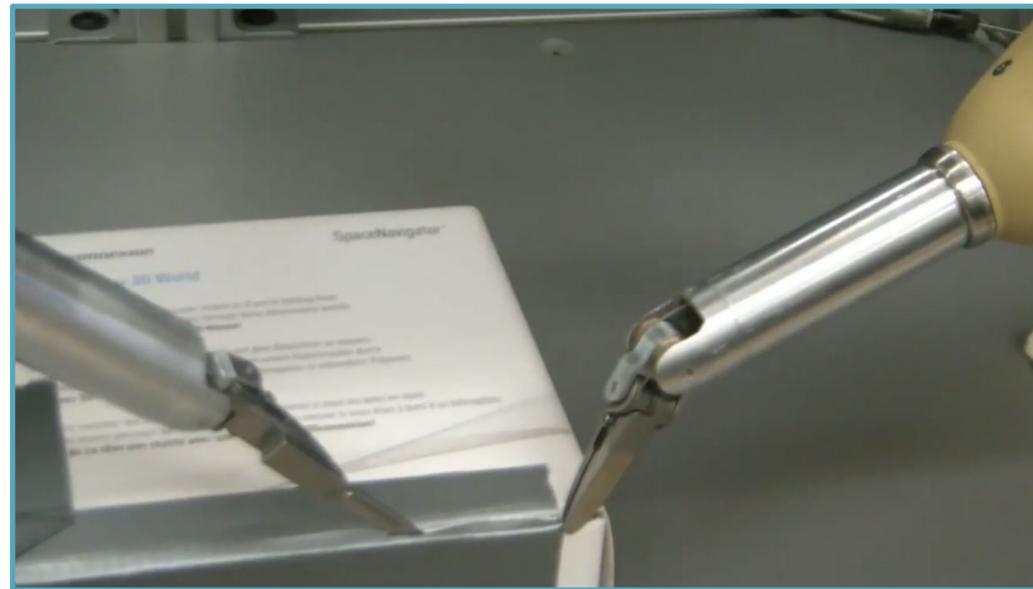
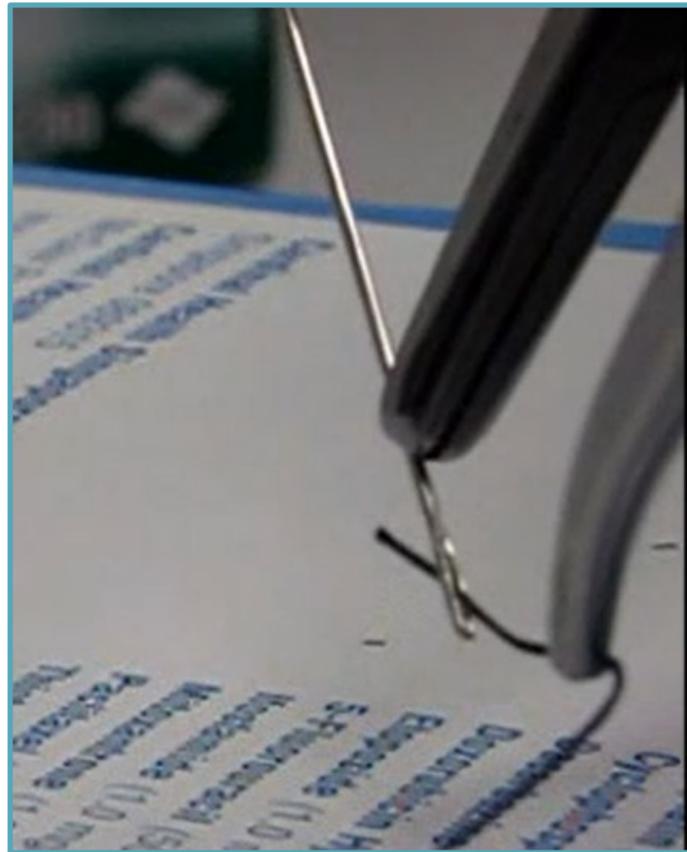
Pedals

VR Interface and Simulator



# High Dexterity Telemanipulation Robot in action

## Video Demos



**Simple User Interface**

# Taurus Technical Description and Specifications

- Two high dexterity, 7-DoF, force-feedback manipulators

Specs	
Robot Weight	18 lbs
Payload Weight	4 lb (full extension)
Min. Porthole Entry	14 in x 5.2 in
Operating Workspace	42 in x 33 in x 33in
Robot Width, Compact	15 in
Cutting Force	24 AWG
Avg. Power	60W (36VDC nominal input)
Battery Life	6 hrs
Communication Link	Copper, fiber optic, RF, IP



Controllers



Mobile Power Control Unit (PCU)

Taurus Mobile Manipulator



Scalpel

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