



Law Enforcement Ground Robots

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National Bomb Squad Commanders Advisory Board

Introduction

- General Trends
- Mission Specific Robots and Tools
- Standards Development
- Challenges
- Future Directions



General Trends

- Andros (F6, F6A, F6B) is the most common robot among public safety bomb squads
- Most bomb squads have multiple robots, large and small
- Cost is a factor for most squads



Multiple Robots on Each Squad



Las Vegas Fire Department Bomb Squad



Robots Working Together on a Single Task



Large and Small



Heavy duty robots are rare,
but some squads have them



Mission Specific Robots and Tools

- TSWG and DHS have worked on the development of mission specific robotic tools.
 - VBIED Tool Kit
 - Power Hawk
- Backpackable Robots
- Some may not look like conventional bomb squad robots.
 - SAPBER
 - MEDN
 - Raptor

VBIED Robots

- Recent development of a VBIED Working Group, which is working on ideas for how to coordinate RDT&E and manage training standards that relate to robot operations in VBIED situations

Changing Priorities on VBIED Render Safe Procedures



Away from large expulsion tools – Toward surgical and disassembly tools

VBIED Tool Kit



Robot Tool Kits



Power Hawk



Backpackable Robots for Southwest Border Remote Operations

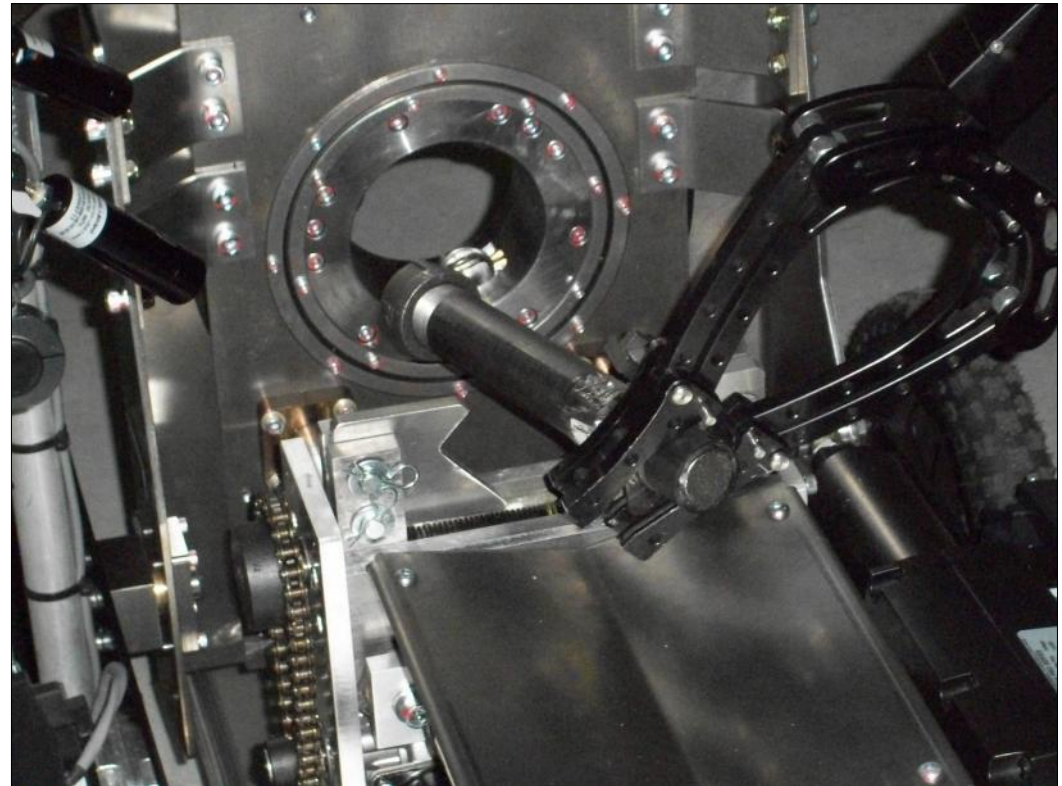
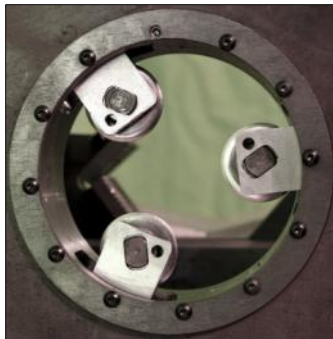




SAPBER

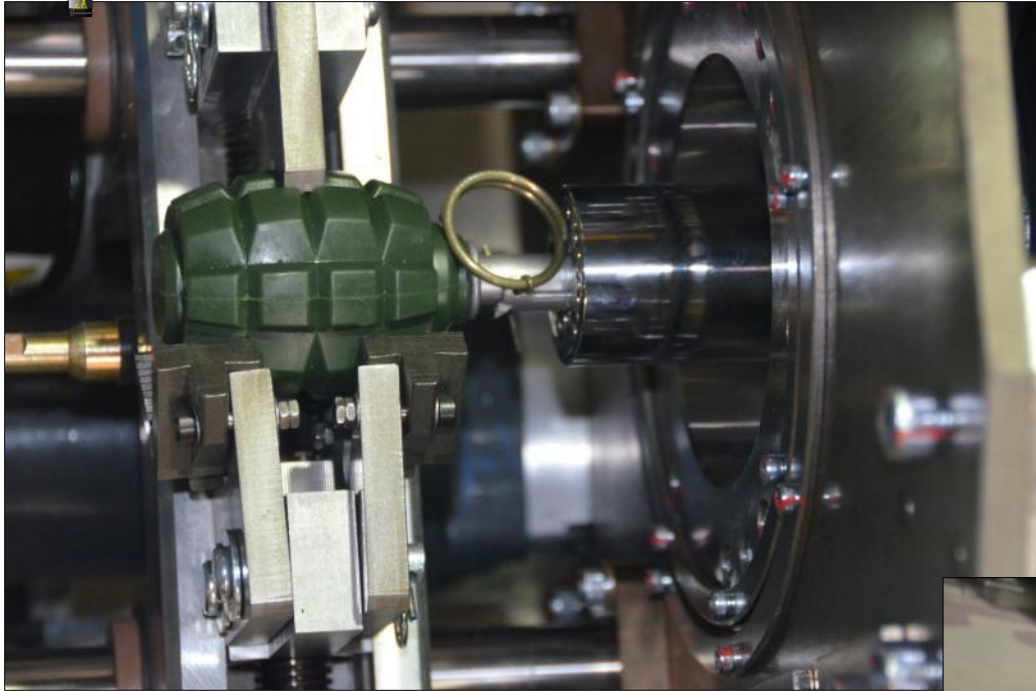


Semi-Autonomous Pipe Bomb End-Cap Removal



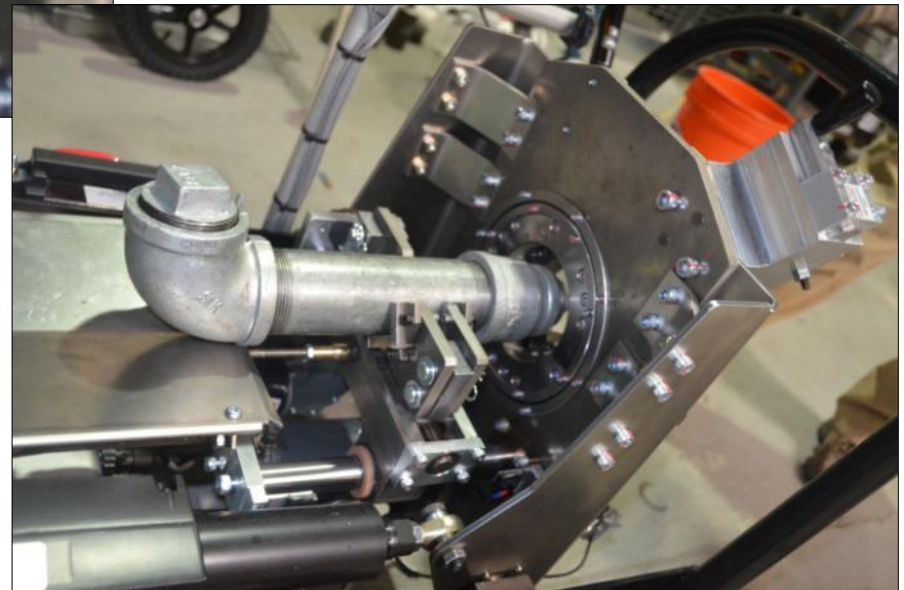


SAPBER



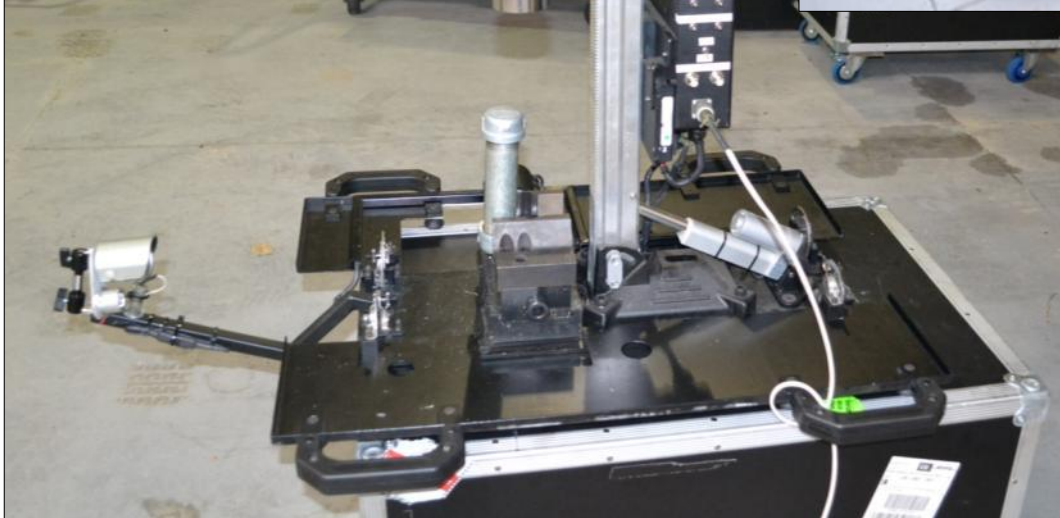
Gator-Grip held in rotating jaws,
used to unscrew grenade fuze

Unscrewing an endcap from a pipe
with an elbow joint





Mobile Explosive Device Neutralizer (MEDN)





Raptor

- Pan/Tilt/Zoom drop camera with disrupter



RP/Raptor

CarbonFire Final Parachute Test

With a more compact, lighter material weight, 42" canopy - contained within a reduced size Teflon lined container



Robot Standards

- Robot Definitions and Guidelines
- NIST Robot Standard Test Methods
- NIST Robot Standard Training Methods
- NBSCAB training and certification standards

Robot Definitions

- NBSCAB developed definitions for bomb squad robots and published them in the *National Guidelines for Bomb Technicians*.

Robot Definitions in the National Guidelines for Bomb Technicians

***Unmanned Ground Vehicle (UGV)**: A powered, mobile, ground conveyance that does not have a human aboard; can be operated in one or more modes of control (i.e., autonomous, semi-autonomous, teleoperation, remote control); can be expendable or recoverable; and can have lethal or non-lethal mission modules.

Teleoperation: A mode of continuous control wherein the human operator uses video feedback and/or other cues to directly control the actions of the UGV.

*As defined by the Joint Robotics Program Master Plan – 2004, published by OUSD (AT&L) Defense Systems/Land Mine Warfare and Munitions, 3090 Pentagon, Washington, D.C. 20301-3090.

Robot Definitions in the National Guidelines for Bomb Technicians

General Service Bomb Response Robot: A UGV capable of being operated in a teleoperation mode of control plus having a minimum:

- 300 feet range of operating distance from the human operator
- 2-hour mission duration without the need to replace/recharge the primary power source
- 6-inch obstacle clearance
- Outfitted with bomb disablement tools which includes, but not limited to:
 - Standard disrupter, with onboard aiming and firing capability
 - Mineral Water Bottle (MWB) or similar general type disruption tool with onboard firing capability
 - Manipulator Hand

Robot Definitions in the National Guidelines for Bomb Technicians

VBIED Capable Bomb Response Robot: A Bomb Response Robot that meets all of the requirements for a General Service Bomb Response Robot, plus capable of the following:

- Outfitted with a tool designed for breaking a side window in a passenger vehicle;
- Deploying, aiming and firing a PAN or similar gun type disrupter through the open window of a large sedan or Sport Utility Vehicle (SUV) and effectively engaging a package located at any position in the vehicle visible from the open window;
- Deploying and firing a MWB or similar general type disrupter through the open window of a large sedan or SUV and effectively engaging a suspicious package located at any position in the vehicle visible from the open window;
- Deploying and firing an overpressure disruption charge through the open window of a large sedan or SUV;

Robot Definitions in the National Guidelines for Bomb Technicians

VBIED Capable Bomb Response Robot: (continued)

- Operating it's manipulator through the open window of a large sedan or SUV at any position in the vehicle visible from the open window;
- Carrying, delivering, and firing a Bootbanger or similar ejection tool to a position underneath the trunk of a large sedan or SUV without the aid of a separate carrier;
- Deploying an ejection-type tool mounted on a separate cart alongside a target vehicle, such as the Modular Large Vehicle Disrupter (MLVD) or similar type disrupters;
- Being off-loaded from the bomb squad response vehicle, loaded with any one of the above weapon systems, and moved to a target 300 feet downrange within 20 minutes.

Robot Definitions in the National Guidelines for Bomb Technicians

VBIED Capable Bomb Response Robot:

• **Disassembly Capable Bomb Response Robot:** A Bomb Response Robot that meets all of the requirements for a General Service Bomb Response Robot, plus capable of the following:

- Outfitted with a multipurpose interchangeable Spreader & Cutter Tool that uses non-energetic disassembly methods for responding to various threats and operations including VBIED, PBIED, package bombs, pipe bombs, hostage rescue, etc.

- For VBIED response: Capability to gain access into vehicles, such as opening truck roll-up and trailer doors, opening vehicle side and rear doors, cutting vehicle posts and hinges, opening trunks and hoods, breaking window glass, etc.

- *(There are additional sections for PBIED and other purposes, but not shown here.)*

NIST VBIED Robot Test/Training Methods

- Based on these definitions, NBSCAB worked with NIST on the development of Standard Robot Test Methods.
- These Standard Test Methods are being considered for application as Standard Training Methods, and may be useful as NBSCAB develops training and certification for robot related skills.
 - The program is heavily supported by DHS Standards (Phil Mattson).
 - The test methods are supported by the Interagency Board. The IAB has for the last 2 years listed the Robot Test Methods in their top 10 standards requirements development needs along with the NBSCAB support.



NIST Robot Standard Test/Training Methods Apparatus

NIST Robot Test/Training Methods



Once the VBIED Robot Course is fully developed and robot competencies are established, thresholds could be adopted within each test set and applied as equipment standards, if desired.

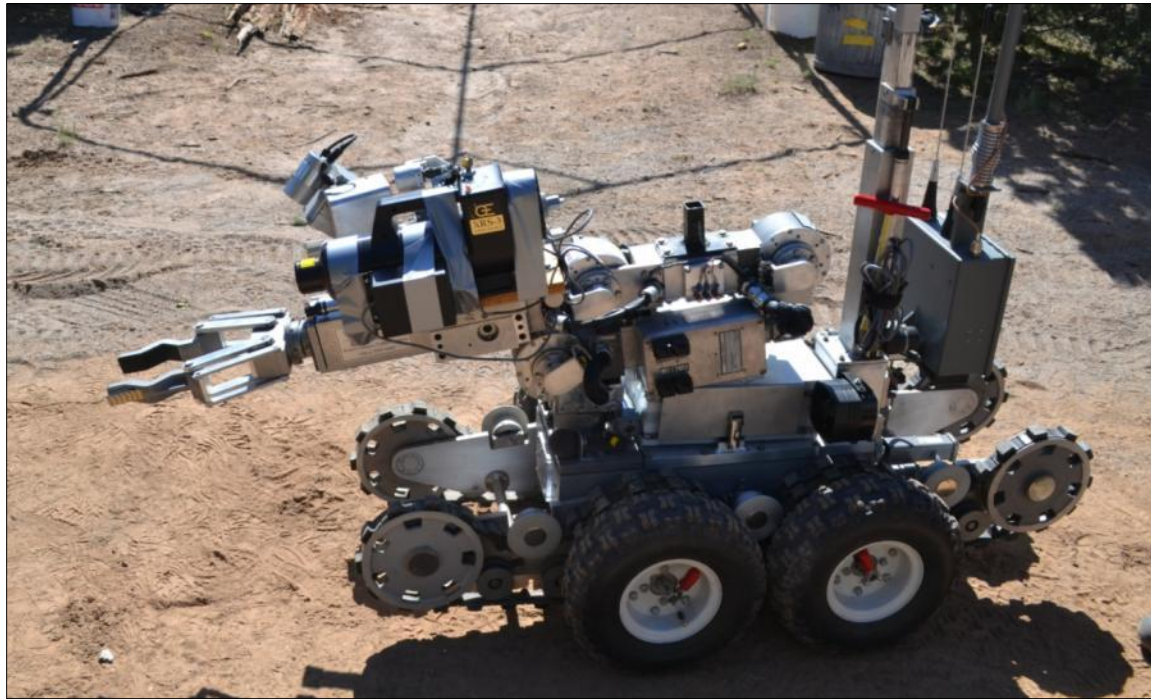
Challenges

- Human-Machine Interface
 - Visualization and situational awareness
 - 3D viewing
- Seeing inside vehicles
 - Camera probes
 - X-raying from robots
- Mobility Constraints
 - Climbing over obstacles in VBIEDs
- Interoperability and cross-platform interchangeability
 - Advancements are needed with end effectors, rather than platforms.
- Communications
 - Increased RF interference across all bands
 - Coordination between robots that have to work together

Human-Machine Interface



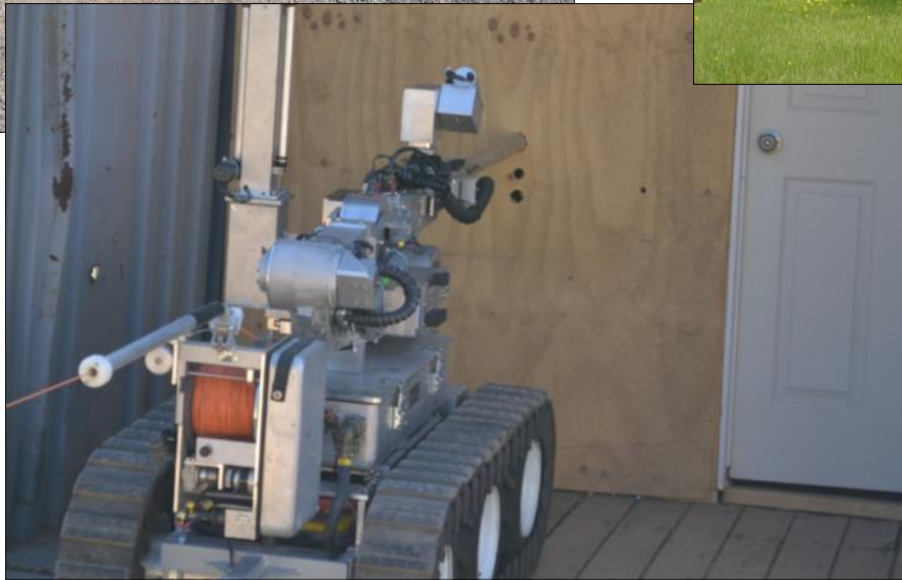
X-ray is still a challenge,
but becoming more common



Camera Probes



TVEDS Prototype



Mini-Gander camera/probe

Camera Probes



TVEDS (2011)

Future Directions



Force Feedback - Retrofit



Dual Arm Systems

- Taurus
- Lobster
- RE²



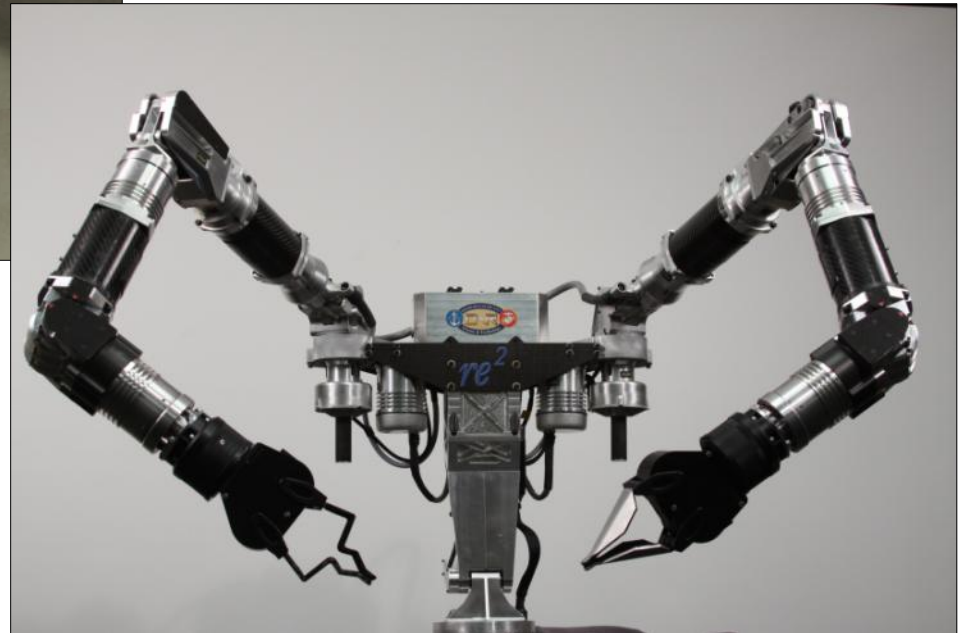
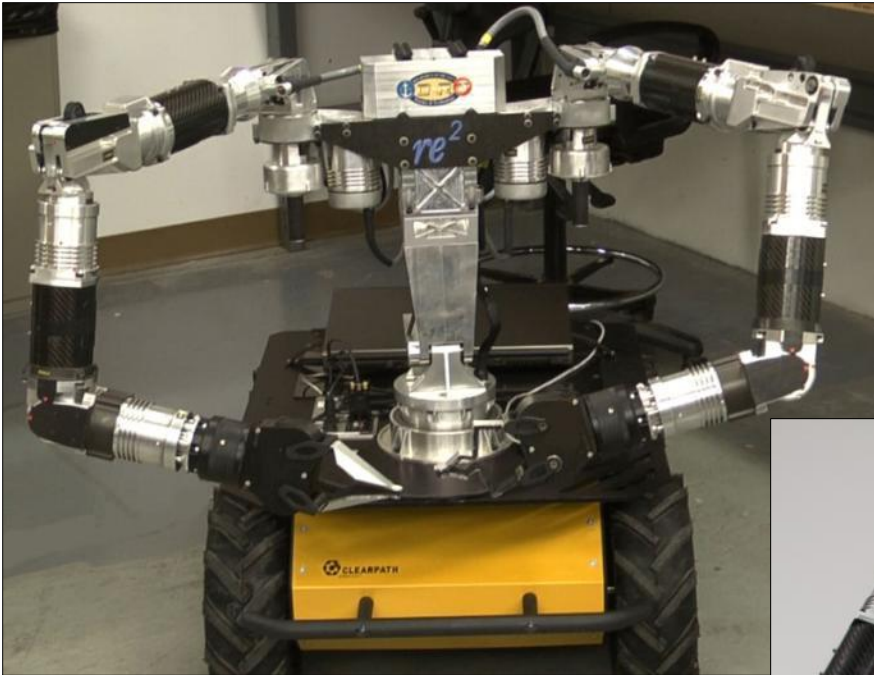
Remotec Lobster

Dual Arm Robots



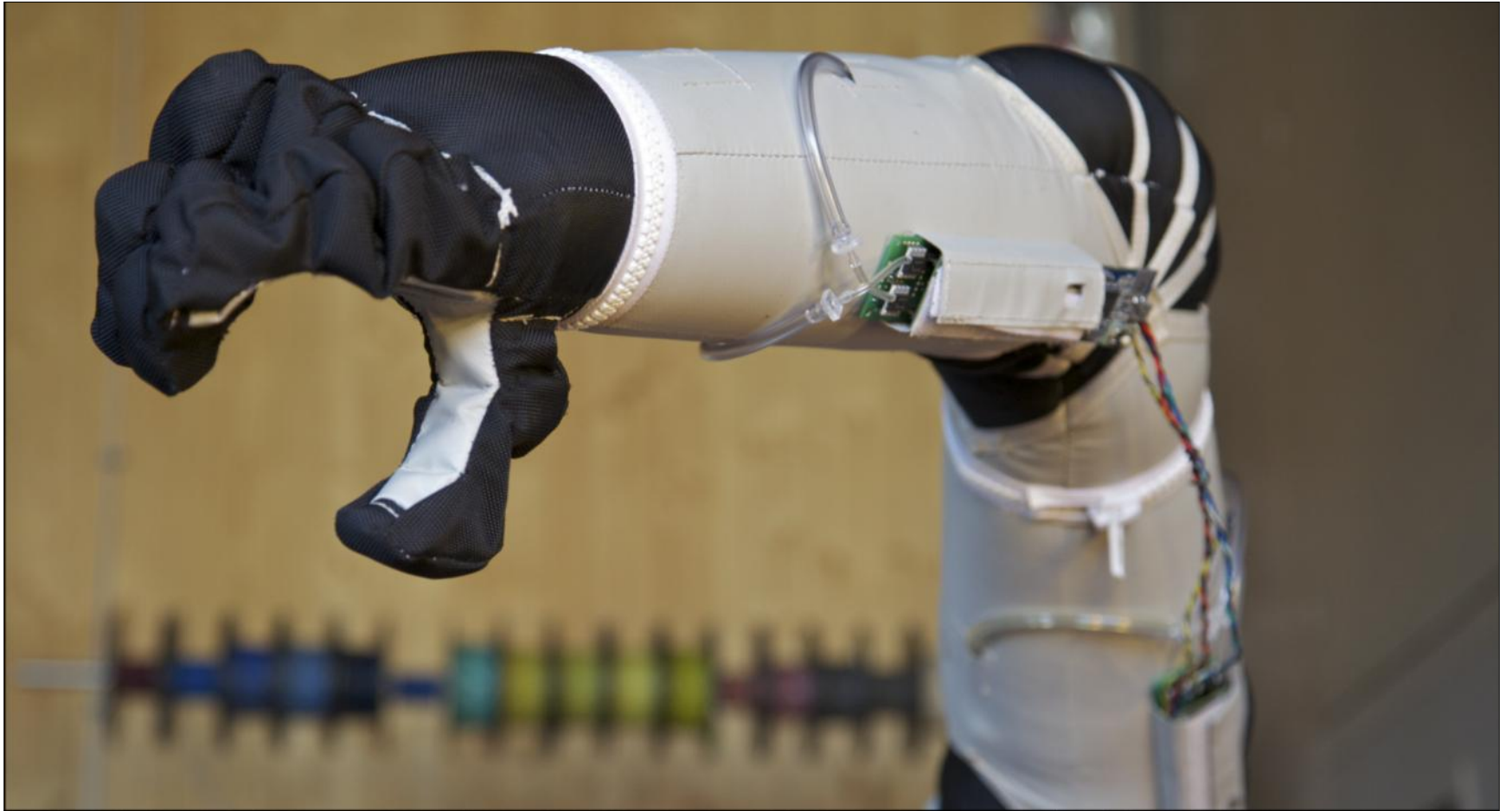
Taurus

Dual Arm Robots

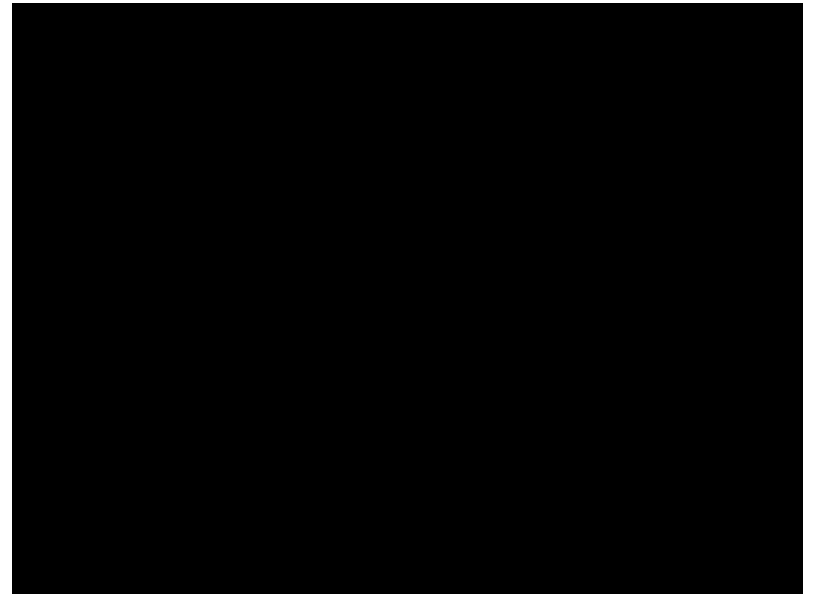


re²

Pneubotics



3D Printed Robots and Parts



Questions?

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