Fingers See Things Differently (FIST-D): A Robotic Explosive Ordnance Disposal (EOD) based on Augmented Tactile Imaging

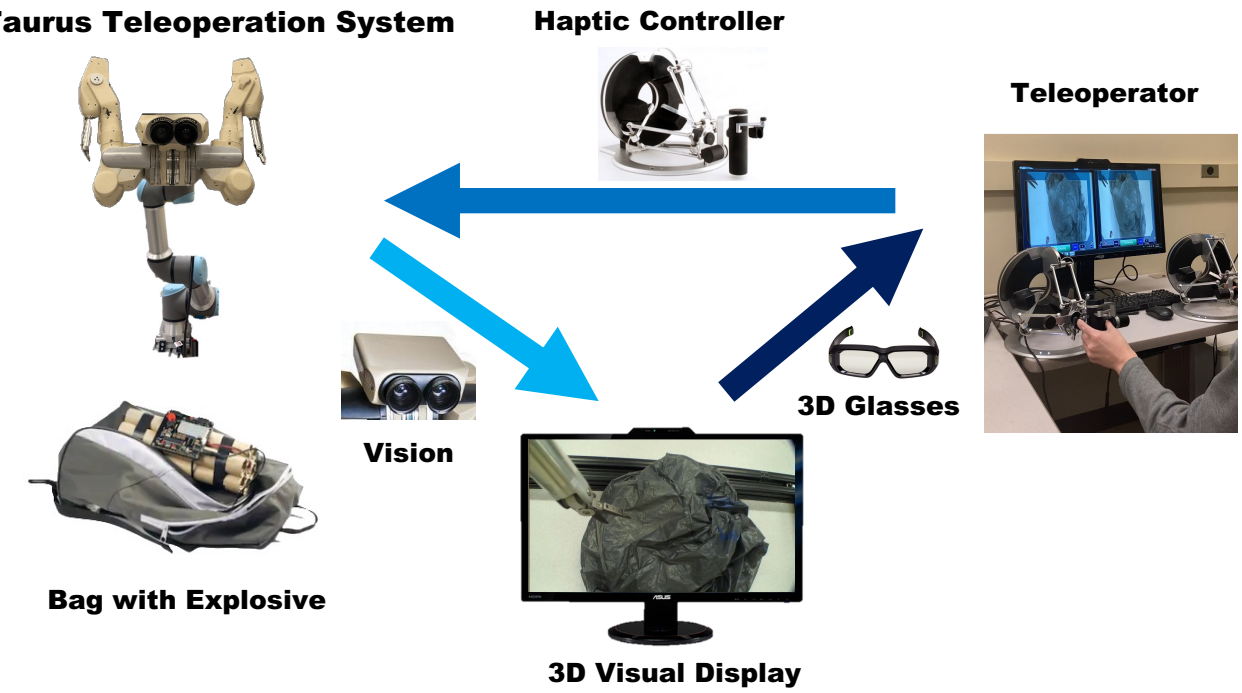Wenzhuo Wu[1], Stephen Beaudoin[1], Hong Z. Tan[1], Bryan Boudouris[1], Thomas Low[2], Juan Wachs[1]   [1]Purdue University, West Lafayette, IN   [2]SRI International

Research Task

Explosive ordnance disposal is among the most hazardous occupations. We mitigate the risk of explosive ordnance disposal by developing a robot that can detect and display concealed improvised explosive devices based on augmented tactile information.

Key Challenges

- ❖ Visualize the concealed objects and plan manipulation policies.
- ❖ Develop tactile device with high resolution and contact sensitivity.
- ❖ Develop selective polymers to detect explosive residues with high sensitivity.
- ❖ Develop a haptic display system to convey the multi-modal information.

Taurus Teleoperation System

Haptic Controller

Teleoperator

3D Glasses

Vision

Bag with Explosive

3D Visual Display

Scientific Impact

- ❖ Technology for detecting trace energetics in surface residues could be also applied to detection tasks of other hazardous chemicals.
- ❖ The intelligence based on tactile expands the application of robotics to scenarios where optical vision is not applicable.
- ❖ The enhanced tactile feedback in teleoperation contributes to the task performance of telesurgery.
- ❖ The developed haptic display system could also assist communication for hearing/visually impaired people.

Broader Impact

- ❖ Reduce the risk of EOD teleoperators using enriched perception.
- ❖ Incorporating the research outcomes into the coursework of Purdue University.
- ❖ The research activities have increased the participation of minorities。

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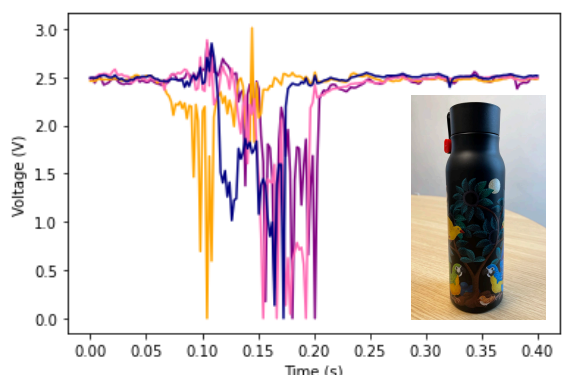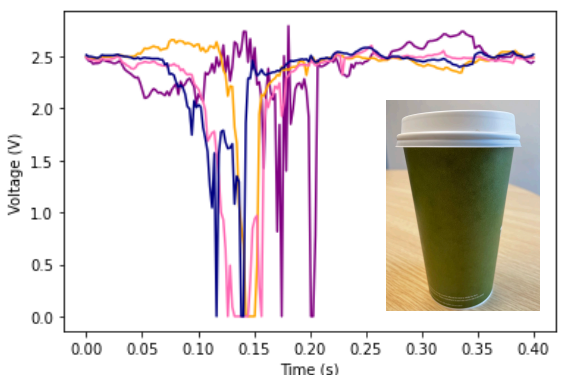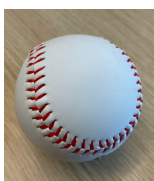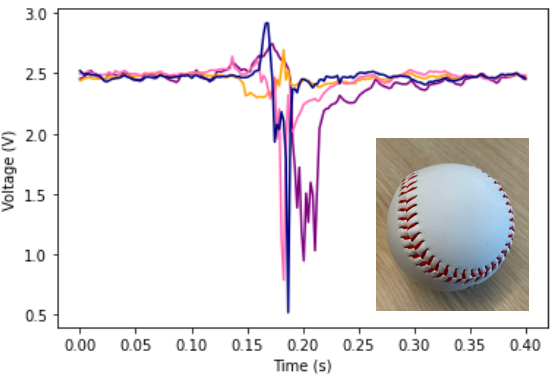Wenzhuo Wu[1], Stephen Beaudoin[1], Hong Z. Tan[1], Bryan Boudouris[1], Thomas Low[2], Juan Wachs[1]

[1]Purdue University, West Lafayette, IN   [2]SRI International
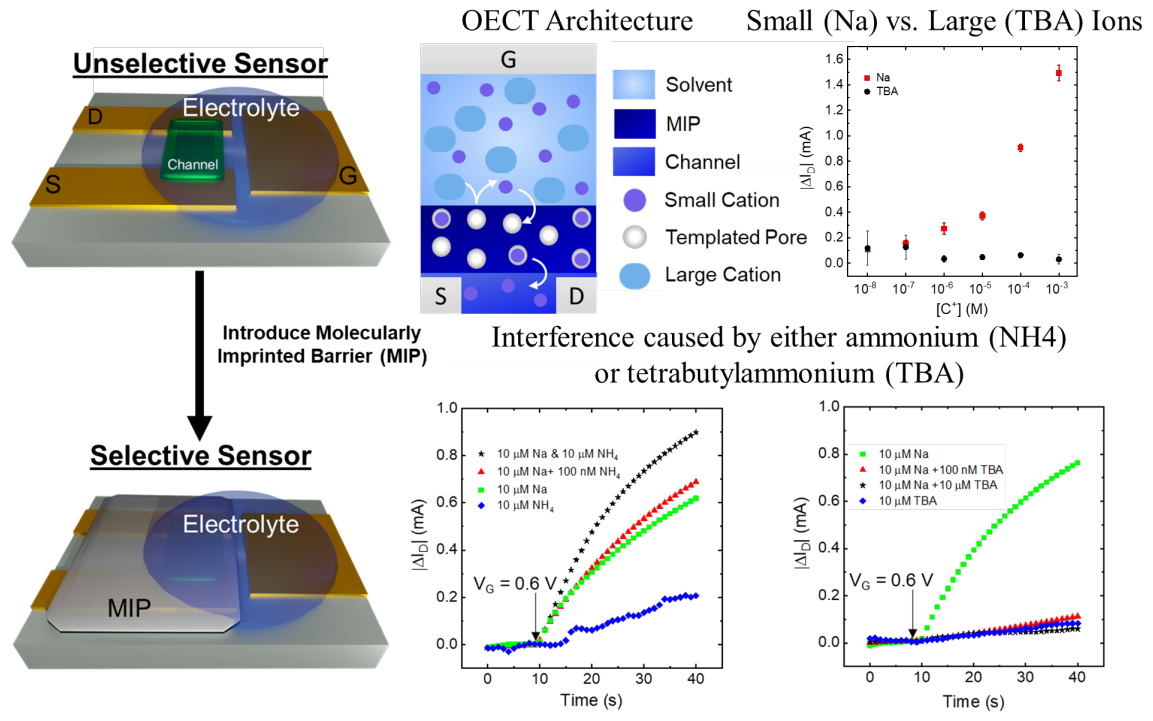
Technical Solution for Sensing Devices

1: Develop Tactile Device for Object Recognition

Triboelectric tactile glove

2: Develop Sensor for Explosive Recognition

Unselective Sensor

OECT Architecture   Small (Na) vs. Large (TBA) Ions

Introduce Molecularly Imprinted Barrier (MIP)

Selective Sensor

Interference caused by either ammonium (NH4) or tetrabutylammonium (TBA)

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Wenzhuo Wu[1], Stephen Beaudoin[1], Hong Z. Tan[1], Bryan Boudouris[1], Thomas Low[2], Juan Wachs[1]   [1]Purdue University, West Lafayette, IN   [2]SRI International

3: Haptic Display for Virtual Reality based Manipulation

300 Hz

300 Hz mod 60 Hz

60 Hz

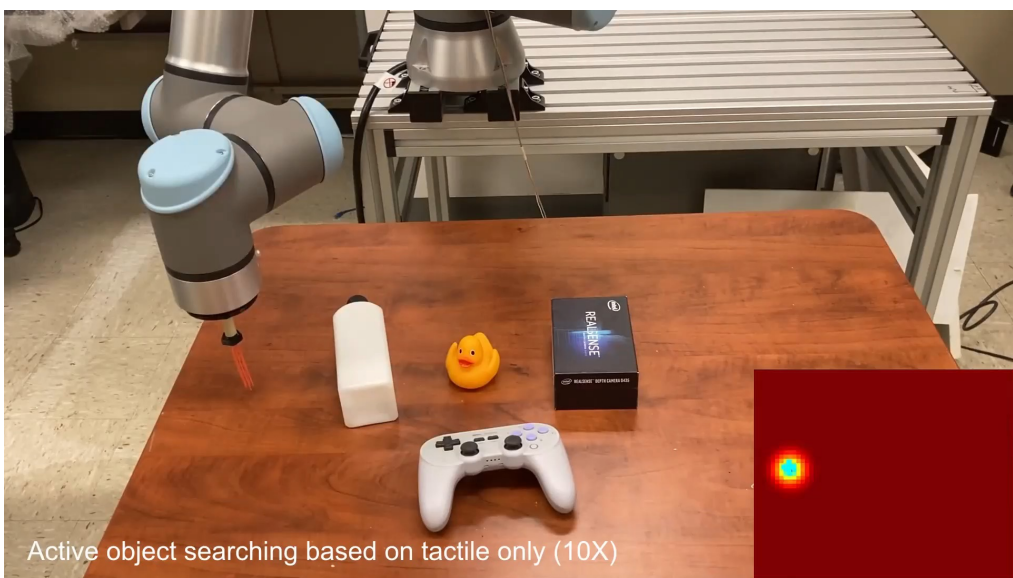Haptic sleeves worn on the forearm and opposite upper arm
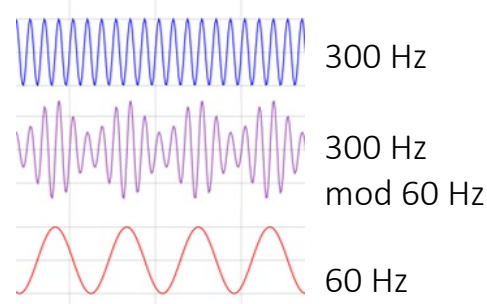
Frequency components of vibrotactile stimuli

Virtual Reality simulation for manipulating a bag

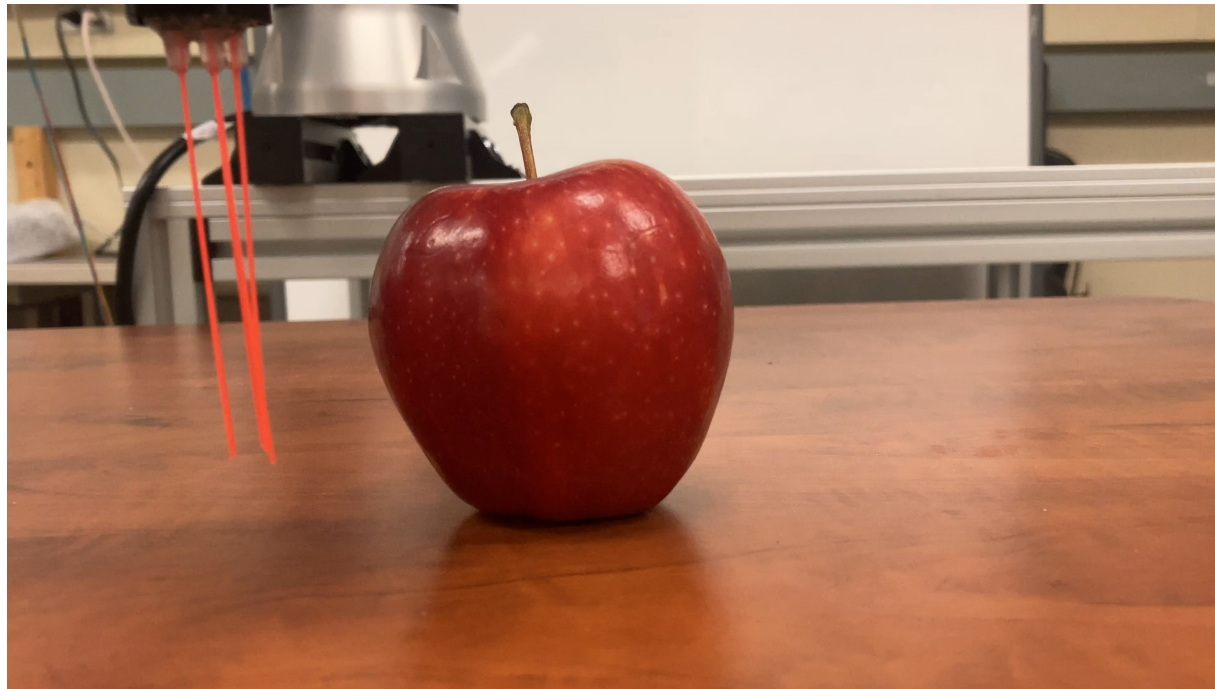## 4. Autonomous tactile exploration & recognition

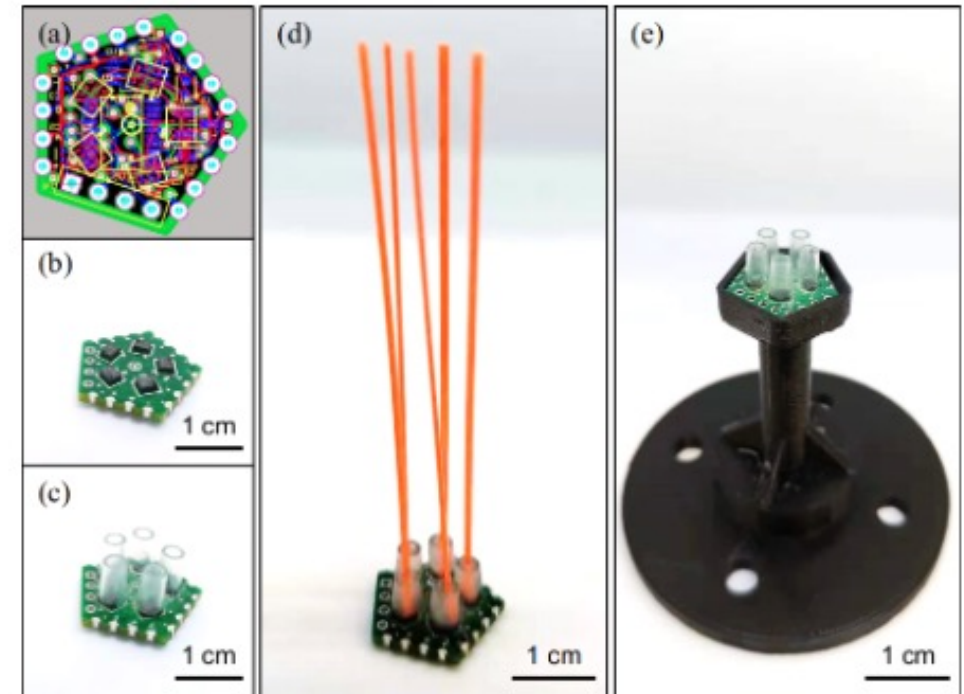Active object searching based on tactile only (10X)

The procedure of autonomous tactile exploration

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Locomotion algorithm for contour tracing

Whiskers based tactile sensor for safe object exploration

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Thank you!