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

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

[1]Purdue University, West Lafayette, IN [2]SRI International

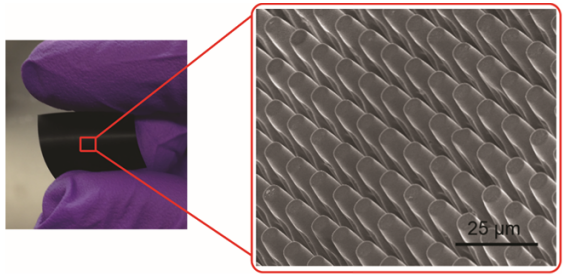
Research Task

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

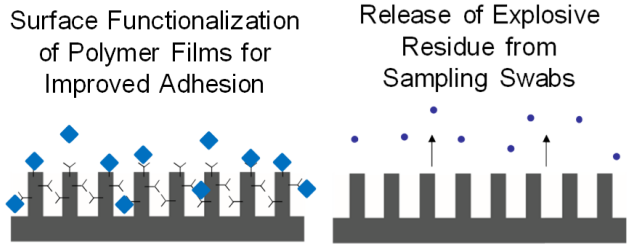
Key Challenges

- How to develop sensors that can recognize explosives efficiently
- Develop algorithms that can give assistance to dispose explosives effectively
- Develop a haptic display system to convey tactile information to a teleoperator
- Recommend feasible strategies to approach and explore hazardous objects

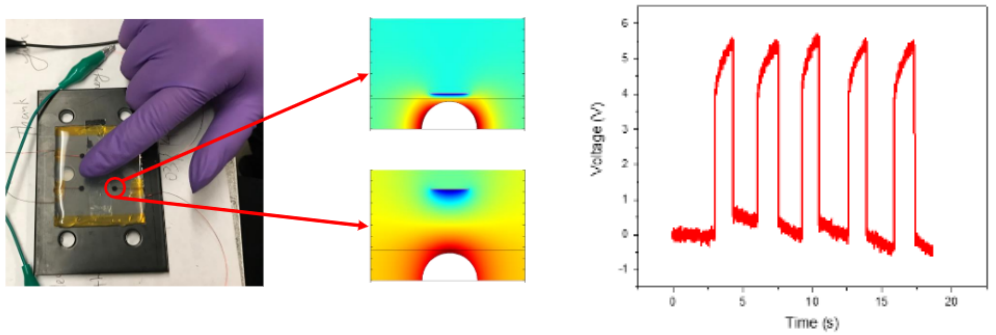
Technical Solution 1: Develop Tactile Sensors for Explosive Recognition



Scanning Electron Microscope Image of a Micro-structure. Small Bristles Can Improve Adhesion of Explosive Residues



Schematic Diagram of Particle Adhesion of Functionalized Microstructure, Which alters the adhesion of molecules of interest to the polymer.



Response Signal of Repetitive Contacts. The Signal Magnitude is Correlated to the Texture and Contact Location

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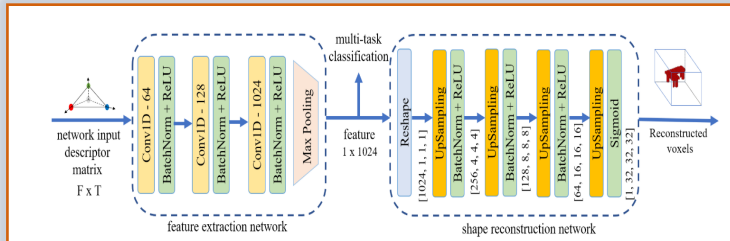
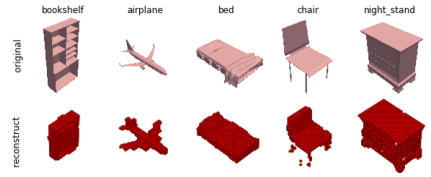
Technical Solution 2: Multi-modality Display for Tactile Information

Shape Information



We Designed a Neural Network That Can Accomplish Object Classification and Reconstruction from sparse point clouds.



The Object Reconstruction Result Using Only 16 Points Randomly Sampled From Each Object

Vision Channel

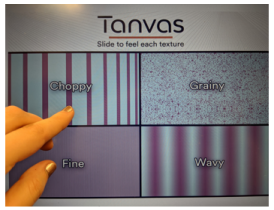
Object Recognition Based on Limited Observations from Tactile Sensing

Teleoperator

Bag with Explosives

Texture/Explosive Detection Information

Stretch-pro Wearable Skin-stretch Device



Mimo Vue Monitor Convery Texture information Using friction

TAPs Tactile Communication System That Can Convery Contact Information From Multiple Tactile Sensors Mounted On Taurus Arms

Sensory Channel

Tactile Display System for Conveying Multi-modal Information to EOD Teleoperator

Scientific Impact

- Dexterity and tactile feedback is the key technology in telesurgery.
- Technology for detecting trace energetics in surface residues could be also applied to detection tasks of other hazardous chemicals.
- Develop new approach for object recognition and tactile visualization.

Broader Impact

- Decrease the risk of EOD teleoperators using enriched perception.
- Incorporating the research outcomes into coursework of Purdue University.
- The project will exhibit at a children museum at West Lafayette, Indiana.
- The research activities will broaden the participation of minorities.

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