**COMRADES (Cooperative Multi-Robot Autonomous Detection System) for Humanitarian Demining**

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**Objective:** Develop novel coordination techniques between multiple low-cost, autonomous, mobile robots which enable them to collaboratively detect landmines with high accuracy in post-conflict regions

### Existing Robot Technologies for Humanitarian Demining

Robots can navigate in a variety of terrain - more focused on mechanical construction of robots

- High cost
- Heavy weight, limited maneuverability
- Logistical/maintenance care
- Limited testing
- Mine detection is very sensitive to moisture, ground cover, solar loading, burial depth, etc.
- Sensor data is very prone to false-positives
- High cost
- Heavy weight, limited maneuverability
- Logistical/maintenance care
- Limited testing

### Proposed Solution

A multi-robot system consisting of relatively inexpensive, off-the-shelf robots, where each robot is equipped with a different type of sensor, can be used to perform automated landmine detection in an efficient manner while reducing the number of false positives.

### COMRADES Project Robots

- **Corobot:** $5,500  
  - Sensors:  
    - IR range sensor  
    - Camera  
    - Indoor localization

- **Explorer:** $13,000+

### Robot Operational Features

- Explore an initially unknown region while searching for landmines
- Recognize landmine-like objects on its sensors (metal detectors, ground penetrating radar, IR sensors)
- Coordinate actions with other robots so that multiple robots with different types sensors can converge on the object to analyze it
- Confirm object as landmine using sensor data fusion techniques

### Expanded Applications of COMRADES Technology

- **Agricultural:** Automated crop harvesting, virtual fences for cattle herding
- **Engineering:** Checking turbines, bridges for cracks and fissures
- **Space and Extra-terrestrial exploration**
- **Homeland security:** Perimeter protection and surveillance of high security areas

### Basic Research Focus Areas

#### Terrain Coverage with multiple robots

Current/Proposed Solutions: Complete coverage algorithms with very limited comm. overhead, game theory for dynamically forming robot teams and flocks for efficient coverage

#### Multi-robot Task Allocation

Current/Proposed Solution: Swarming-based and market-based algorithms for efficient task allocation that guarantees rapid yet accurate task completion within the system