Robotics Capabilities and Tech Transfer

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Robotics: Value Added

- Provide missing capability
- Increase productivity
- Improve quality
- Reduce operational costs
- Improve safety
Commercial Applications

- Mining
- Excavation
- Agriculture
- Maintenance
- Service
- Material Handling
- Consumer
- Entertainment
Anatomy of a Mobile Robot

Laser sensors
Force sensors
Computing box and positioning sensors

Sense → Act → Plan
Robot Sensors

CCD Cameras

Ladar

Sonar

Radar
Sensor Data Processing

- Excavation Site
- Truck
- Excavator
- Rails
- Wire coils
Scene Classification

- Trees
- Grass
- Sky
- Unknown
Planning and Optimization

Suboptimal trajectory

Optimal trajectory
Physical Mechanisms

Pipe Inspection and Repair

Tank Clean-up
Component Technologies

Sense:
- Enhanced awareness
- Monitoring
- Inspecting

Act:
- Special purpose machines
- Add-on automation kits

Plan:
- Warning
- Advising
- Process optimization
Autonomous Ship Cleaning

- Objectives: improve productivity for grit blasting, reduce environmental impact, minimize human hazard, allow adjacent operations

- Technologies: mechanical platform, computer vision tracking

- Status: multiple ships cleaned using prototypes

Current Cleaning Method
Autonomous Ship Cleaning

Ship Cleaning Robot

Water Jets for Cleaning

Robot Deployed

Cleaning Pattern
Plant Nursery Automation

- Objectives: 2 billion plants in U.S. nurseries, shortage of labor to handle the pots
- Technologies: mechanisms for grasping and hauling pots, sensors for measuring growth
- Status: several prototypes built and tested
Plant Nursery Automation

Semi-Autonomous Machines for Transporting Pots

Tree Measurement Sensor
Underground Coal Mining

- Objectives: increase productivity and improve safety for underground mining

- Technologies: vision based motion and heading estimation, sensors for equipment monitoring

- Status: beta prototypes produced—underground tests in progress

Room and Pillar Coal Mining

Seam in Conveyor Belt for Hauling Coal

Mining Machine Cutting Coal
Underground Coal Mining

Continuous Mining Machine

Camera Sensing for Position Estimation

Conveyer Belt for Coal Transport

Conveyer Belt Images
Buried Landmines

- Objectives: detect and safely eliminate buried landmines
- Technologies: mine detection, position sensing, autonomous navigation
- Status: prototypes built for training and deployment

Detection Method

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<th>Sweep Pattern</th>
<th>GPR Detector</th>
<th>Metal Detector</th>
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Buried Mine Detection

Sweep Pattern using Position Sensing

Sensor Deployment on Autonomous Platform
Tech Transfer Process

1. Reach Consensus on Problem and Solution
2. Develop and Test Prototype
3. License and Manufacture
Reaching Consensus

Problems Customer Has

Problems Robotics Can Solve

Problems the Customer Believes Robotics Can Solve

Problems CMU Believes the Customer Has

Consensus