Advancing Autonomy on Man Portable Robots

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**Advancing Autonomy on Man Portable Robots**

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Introduction

• Autonomous Robotic Mapping System (ARMS)
  – Hardware
  – Software: Refactored Robotic Intelligence Kernel (RRIK)
  – Capabilities (SLAM, Exploration, AEKF, Target Following)

• ONR’s Center for Commercialization of Advanced Technologies (CCAT) Payloads

• Future Work

• Automatically Deployed Communications Relays
• **Goals:**
  – Provide Reconnaissance of Targets of Interest Using Man-Portable System
  – Keep Operator Out of Harm’s Way
  – Reduce Operator Workload
  – Increase Operator Situational Awareness

• **Initial Capabilities:**
  – Autonomously Map Selected Building/Area
  – Geo-Reference Map and Sensor Data

• **Future Capabilities:**
  – Report Anomalies (Moving Objects, Weapons, etc.)
  – Enhance Mission Capabilities (Manipulation, Explosives and Radiation Detection, etc.)
ARMS Hardware

• Packbot Scout Chassis
• Navigator Payload
  – SICK LD-OEM
  – Ublox GPS
  – 3DM-GX1
  – KVH Gyro
  – Serial Radio
• SEER Payload
  – TYZX Stereo Vision
ARMS Software: Refactored RI K

Sequence of behaviors to achieve high level capabilities.

Produce actuator command to achieve given goal based on perceptual and device data.

Produce “more useful” data by analyzing and fusing data from devices and other perceptions.

Source data and sink commands. Connection to real world.

Tasks
- Explore
- Find Rad. Source
- Warfighter’s Associate

Behaviors
- ODOA
- Follow
- Retro Traverse
- Waypoint
- Visual Targeting
- Etc.

Perceptions
- SLAM
- Obstacle Map
- Explore Goals
- Doorway
- Path Planning
- Skin Detection
- AEKF
- Etc.

Devices (Aware2, Player, etc.)
- Position
- LADAR
- Stereo Vision
- IMU
- GPS
- Video
- Rad. Sensor
- PTZ
- Weapon
- Soldier Data
- Botdrop
- Etc.
ARMS Capabilities:
SLAM (SRI)
ARMS Capabilities: Exploration

Current Map

Waypoints to Current Goal

Map “Frontiers”
ARMS Capabilities:
Exploration + Room Detection

The Map:

Rooms Perception:

25 Rooms Found
ARMS Capabilities:
Adaptive Extended Kalman Filter

- Adapts to Platform and Sensor Noise
- Fuses GPS, SLAM, IMU, Odometry, Visual Odometry, etc.
- Automatically Chooses Best Sensors.
- Allows for Seamless Indoor-Outdoor Navigation and Geo-Referencing Data

Kalman Filter initial testing on Navigator Payload Packbot.
Date: 12/6/2007
Performed by: Brandon Sights (sights@spawar.navy.mil)
Distance = 118.79 meters.
Error = 0.26 meters.
Error % = 0.22%
ARMS Capabilities: Multi-robot Operator Control Unit (MOCU)

- Map and Sensor Data Georeferenced
- Geodetic Waypoint Navigation
- Video Feedback
- Easily Choose Task, Influence Behavior, or Teleoperate
ARMS Capabilities: Stereo Vision

- Obstacle Avoidance
- 3D Models
- Visual Odometry
ARMS Capabilities:
Target Detection + Following

- Robot Follows Target Using Combination of LADAR, Vision, and/or GPS
- Easier Deployment
- Cooperative Behaviors
- Security
FY07 Solicitation (Smart Robotics Initiative) focused on technologies applicable to man-portable systems

6 Awards:
- iRobot – Navigator and SEER payloads
- SpaceMicro – radiological sensor providing detection and vector to source
- SAIC – robot behaviors inferred from operator actions in proximal operations (Warfighter’s Associate)
- CornerTurn – leave-behind sensors
- Digivision – miniature video-contrast enhancement module
- AETC – miniature acoustic sensor
Future Work

- ARMS Testing
- UrbEE Project
- Tentative CCAT Projects 2008:
  - iRobot Navigator Payload 2
  - SD Technologies Autonomous Gamma Tracking System (AGTS)
  - Think-A-Move Speech Recognition
  - Taser
  - Honeybee Door Breaching Manipulator
- Enhanced Human Robot Interaction
Automatically Deployed Communication Relays (ADCR)

- Non-line-of-sight communications and increased range
- Ad hoc mesh network based on 802.11 protocol
- Relays automatically deployed when needed
- Self-righting mechanism ensures proper antenna extension
- Only requires an Ethernet interface from the UGV
Conclusion

• SPAWAR Developing ARMS Based on iRobot Packbot with Navigator and SEER Payloads
• SPAWAR Working With CCAT to Transition Technologies to Man-Portable Robots
• Proven Ability to Rapidly Transition Technologies to Fielded Platforms
• Questions?
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