Robotic Vehicles

Robotic vehicles study group:
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I. What are Robotic Vehicles?

Machines that move “autonomously” on the ground, in the air, under the sea or in space

Robotic vehicles are “Unmanned”, either remotely operated or fully autonomous.
**Why are Robotic Vehicles Important?**

Go where people can’t go -
- space, oceans, …

Hazardous environments
- contaminants, military, …

Do tasks over large spaces -
- agriculture, environment, …
- urban and built environments

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**How? What technology is needed?**

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WTEC Robotics Study: Robotic Vehicles
### How? What technology is needed?

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Example: NASA Mars Rover

- Remote Hostile Environment
- Large Scale Exploration
- Sensors and Navigation
- Autonomous Power

Example: Deep Ocean Exploration

- Remote and Hazardous Environment
- Sensors and Visual Linkage
- Tethered or Untethered Operation

- Titanic Exploration –
  
  Alvin and Jason Undersea Robotic Vehicles
Example: Deep Ocean Exploration

- Remote and Hazardous Environment
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- Tethered or Untethered Operation

II. Research Challenges

- Mechanisms and Mobility
- Power and Propulsion
- Computation and Control
- Sensors and Navigation
Mechanisms and Mobility

Principles of Motion
- wheels vs legs
Analysis of Movement
- walking gaits
Materials
- weight, compliance
Power and Propulsion

Source of Power
- duration
- efficiency
e.g. batteries, fuel cells

Harvesting Energy
e.g. solar cells

Efficiency and Energy Management

Computation and Control

Embedded computer systems create “intelligent” computer architectures, organizing sensor-based feedback and control actions.
Sensors and Navigation

- Where am I?
- Do I have a map?
- How do I move to accomplish a task?

Example: Military Navigation

- Multiple Vehicles: Land, Sea, Air
- Dynamic Coordination
- Large Scale Operations
- Sensor Feedback and Assessment
- Human Interaction
III. International Survey

U.S. – Robotic Vehicles

- Military and Defense Systems
- Space Robotics
- Agriculture and Field Robotics
- Undersea Vehicles – Science and Security
- Search and Rescue Robotics
U.S. – Robotic Vehicles

U.S. – Military and Defense Robotics
U.S. – Field Robotics

- Mining
- Agriculture
- Hazardous Environments

U.S. – Undersea Robotics

- AUV – Environment and Coastal Security
- Deep Sea Missions – Science
U.S. – Search and Rescue Robotics

- Hazardous Missions
- Rapid Response
- Human Interaction

Japan/Korea – Robotic Vehicles

- Personal and Service Robotics
- Biomimetic Mobility
- Undersea Vehicles and Systems
Japan/Korea – Personal and Service

- Household
- Eldercare
- Security and Surveillance
  - Search and Rescue Robotics
- Entertainment

Japan/Korea – Biomimetic Mobility

- Locomotion
- Humanoid Walking
Japan/Korea – Biomimetic Mobility

• Locomotion
• Humanoid Walking

Japan/Korea – Biomimetic Mobility

• Insect Motion
• Swimming
• Energy Sources
Japan/Korea – Biomimetic Mobility

- Insect Motion
- Swimming
- Energy Sources

Japan/Korea – Undersea Robotics

- Deep Ocean Science
- AUV Technologies
Europe – Robotic Vehicles

- Navigation and Architectures
- Transportation Systems
- Personal and Service Robotics
- Undersea Vehicles

Europe – Navigation and Architecture

- Sensor-Based Navigation
- Vehicle Control Systems
- Infrastructure Applications
Europe – Navigation and Architecture

- Sensor-Based Navigation
- Vehicle Control Systems
- Infrastructure Applications

Europe – Transportation Systems

- Vision-Based Vehicle Control
- Urban Transport Systems
- Navigation and Mapping in Structured Environments
Europe – Personal and Service Robotics

- Household Robotics
- Rehabilitation and Eldercare
- Search and Rescue Robotics

Europe – Undersea Robotics

- AUV Systems
- Deep Ocean Science
- Oil and Gas Industry Applications
Europe – Undersea Robotics

RESEARCH PRIORITIES in ROBOTIC VEHICLES

US
Outdoor Vehicular Mobility: Ground, Air, Undersea
Navigation and Mapping in Complex Outdoor Environments
  Key Applications: Defense, Space

Japan/Korea
Indoor Mobility using humanoid locomotion
Novel mechanisms of locomotion
  Key Applications: Service, Entertainment, Commercial Applications

Europe
Mobility in urban and built environments
Sensor-based Navigation with maps
  Key Applications: Infrastructure support and transportation

IV. Comparative Review
## Comparative Analysis: Robotic Vehicles

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Robotic Vehicles: Summary

- US leadership in robotic vehicles has been strongly dependent on federal mission-oriented programs (DOD, NASA,…), and continuity of investment in basic research will be critical.
- US lags in the identification of strategic priorities that could translate vehicle capabilities to innovative commercial, industrial, and civil infrastructure applications.
- Japan and Korea have aggressive national plans and investment to develop mobile robots supporting personal and service applications, including healthcare and eldercare.
- The European community has developed strategic plans that coordinate vehicle programs and emphasize civilian and urban infrastructure, as well as some space applications.

Robotic Vehicles: Future Challenges

- Multivehicle Systems
  - Distributed Sensor Networks and Observatories
- Long-Term Reliable Deployment
- Micro and Nanoscale Mobility
- Efficient and Independent Power
- Human-Robot Vehicle Interactions
  - Service and Entertainment