AUTONOMOUS AND ASSISTIVE ROBOTS AND THEIR APPLICATIONS

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LEVEL OF AUTOMATION

Manual

Semi-automatic

Fully Automatic

1 http://www.lasparlaser.com/Automation.aspx
There are many tasks that have not been automated (e.g. in field and unstructured environments)

e.g. Surface Preparation in unstructured environments:

- Manufacturing: Steel work surface preparation
- Infrastructure: steel bridge maintenance,
- Ship and vessel maintenance
- Construction: surface cleaning
e.g. inspection of civil infrastructure

- Bridges;
- Power plants
- Power transmission tower
- Offshore structure
- ……
e.g. underwater structure cleaning, inspection and maintenance

Worker’s OH&S

- Hazardous working environment
- In-complete cleaning
- Labour intensive
- Other risks such dangerous or inquisitive marine animals
e.g. healthcare, aged care and disabled care

- Patient transfer
- Walking assistant
- Patient movement
- Rehabilitation
- Daily living assistant
- ……
Critical Issues

- Worker WH&S:
  - Hostile and hazardous environments
  - Extremely labour intensive
  - Lead
  - Difficult to access areas

- Very high cost
- Low productivity

Promising solution:
Supplement manual labour with that of robotic labour
ROBOTS: LEVEL OF AUTONOMY

Automation in well built environments

Robotic co-worker

Fully autonomous

UTS: CAS
FUNDAMENTAL RESEARCH

(1) Robots in unknown and complex environments
   • Sensing, mapping, motion planning, exploration and perception
   • Simultaneous localization and mapping (SLAM): “Finding your way in a city without GPS and maps”

(2) Human interactive robotics
   • “Human models” and control;
   • Robotic co-workers

(3) Robot Teams in Dynamic Environments
   • Coordination and Control
   • Simultaneously scheduling and planning
Autonomous robots:
- Bridge rehabilitation
- Underground mining
- Water mains condition assessment
- Logistics and transport

Assistive robots:
- Healthcare, aging in place
- Robotic co-worker for manufacturing
- Search and rescue
- Rehabilitation and strength augmentation;
- Mobility assistant: wheelchair and walking assistant
1. Autonomous robots for Steel structure maintenance

Robotic Systems for Steel Bridge Maintenance

- Worker safety and productivity
- Autonomous operation in complex and dusty 3D environments
- Deploy & blast without writing a program
- Two robots operating in the Sydney Harbour Bridge
- SABRE: An Australian start-up
Research challenges & Function Modules

- Environment awareness
- 3D map building
- Surface identification
- Planning
- Collision avoidance
- Control

Engineering challenges

Platform Design
- Ultra lightweight
- Quick and easy setup
- Minimal manual handling

Nozzle/Sensor Fittings
- Automated calibration
- Safety control system
- Intuitive User interface
- Heavy-duty Protection
2. Multiple autonomous robot collaboration

Two blasting robot collaboration and collision avoidance
Major challenges:

- Areas that are difficult to access
- Negotiation with rivets
- Inverted walking
- Positive and negative corners
  Openwork truss structures
- *Robot design*
Two prototype climbing robots have been designed and tested;
One robot is deployed to the SHB in June 2015
4. Robot teams for logistics automation

- Coordination of robot teams
- Applied in an automated container terminal;
- Potential applications: material handling in warehouse, airport; manufacturing plant, etc
5. Mining Automation

• Workers’ Safety and Efficiency
• Localisation of underground mining vehicles and personal
• Partners: Pempek (Australia) & Elgor-Hansen + Famur (Poland)
• **Tested on:** Developing Roadways & Rotary Head Miner
6. Automation of bridge Box Girder inspection

- Inspection of concrete box girders
- SLAM
- Condition assessment
ASSISTIVE ROBOTICS

Research Challenges:

• Building robots that cooperate with people is harder than building a fully autonomous robot
• Perception and Navigation in Dynamic Environments
• Human Intention Recognition
• Manipulation of Natural Objects
• Safe Physical Interaction

Application Domains:

• Robotics for Ageing in Place
• Robotics for patient care
• Manufacturing: robotic co-worker
ASSISTIVE ROBOTICS

Robotic co-worker for Industrial Applications

- Assistant-As-Needed paradigm
- Design of physical human-robot interaction
- Environmental and situation awareness
- Control through the integration of musculoskeletal, task and robot models
Robotic hoist for patient transfer; and Robotic walking aids

- Safe physical human-robot interaction
- Intuitive interaction;
- User intention recognition
- Situation awareness and collision avoidance
THANKS!