UTS:CAS

CENTRE FOR AUTONOMOUS SYSTEMS

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UNIVERSITY OF TECHNOLOGY SYDNEY

Dr Alen Alempijevic

www.cas.uts.edu.au

UTS:CAS

- One of the three nodes of the ARC Centre of Excellence for Autonomous Systems – Funded from 2003 – 2010.
- **Team**: 53 robotics researchers (starting from 1 in 2002)
  - 9 Academic staff; 9 Postdocs; 4 Research Engineers
  - 28 HDRs (10 or 35% are UTS graduates)
- $14M in external research funding since 2003 ($1.7M in 2014)
- **Teaching**: Mechatronics Undergraduate Program: 300+ students in total
- One of the leading robotics research teams in Australia

UTS:CAS

- Reputation: (1) World leader in SLAM: most cited robotics paper since 1996; (2) International leader in infrastructure maintenance robotics; (3) Australian leader in assistive robotics
- **Research strengths**: sensing, mapping, motion planning, human-robot interaction →Robots in complex, unstructured environments and working with people
- **Application** of robotics in infrastructure, mining, stevedoring, agriculture and manufacturing
- Track record for delivering industry outcomes
- Entrepreneurial culture

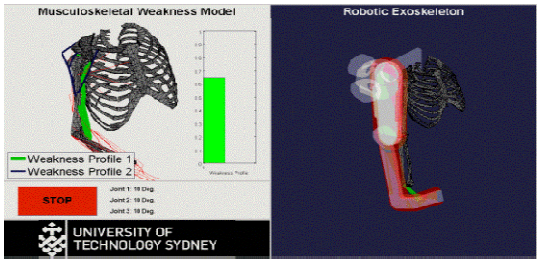
CAS: FUNDAMENTAL RESEARCH

(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”

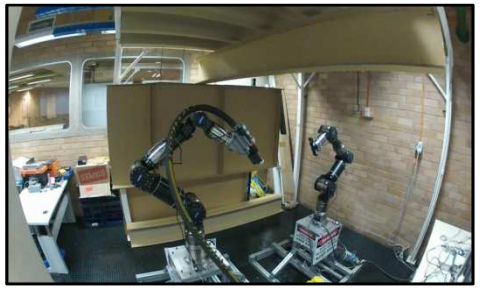
(2) Human interactive robotics

- “Human models” and control;
- Robotic co-workers



(3) Robot Teams in Dynamic Environments

- Coordination and Control
- Simultaneously scheduling and planning



CAS: ENGAGEMENT

Autonomous robots for industry automation:

- Bridge rehabilitation
- Underground mining
- Water mains condition assessment
- Logistics and transport

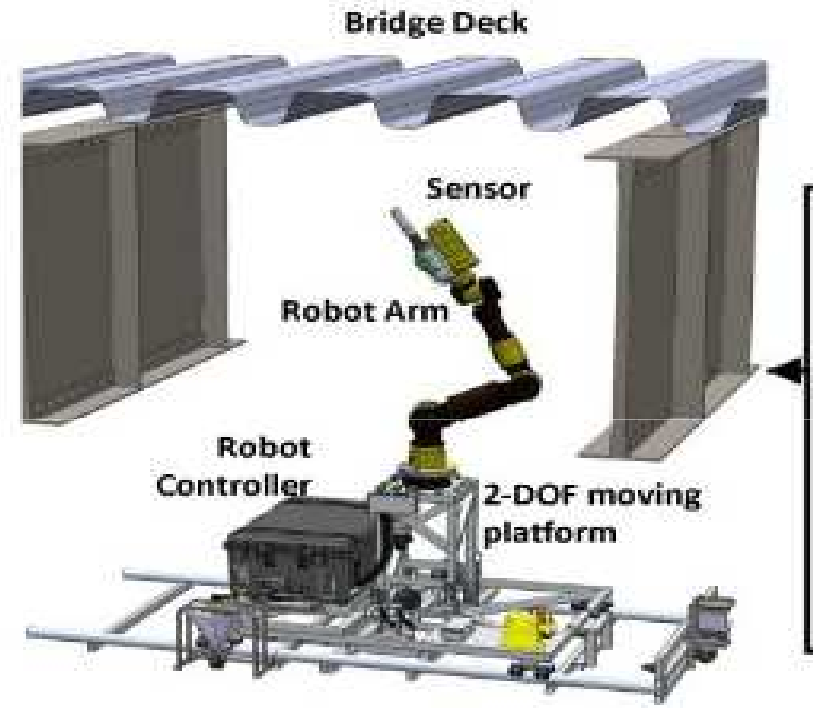
Assistive robots:

- Robotic co-worker for manufacturing
- Healthcare and aged care
- Meat and livestock industry
- International competitions: RoboCup search and rescue, Robot@home, Amazon picking challenge, DARPA)

AUTONOMOUS INDUSTRIAL ROBOTS

Robotic Systems for Steel Bridge Maintenance

- Worker safety and productivity
- Autonomous robots operating in complex and dusty 3D environments
- Two robots operating in the SHB
- SABRE: An Australian start-up



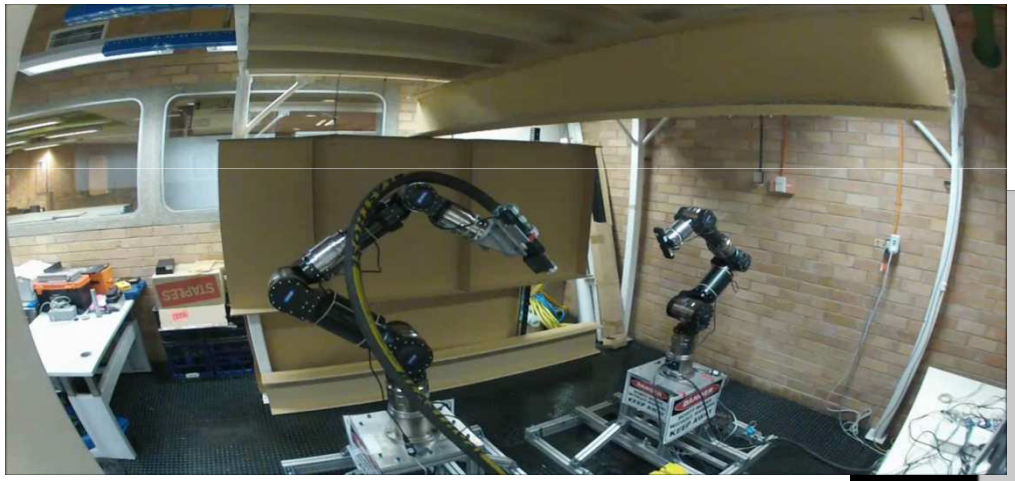
Platform Design

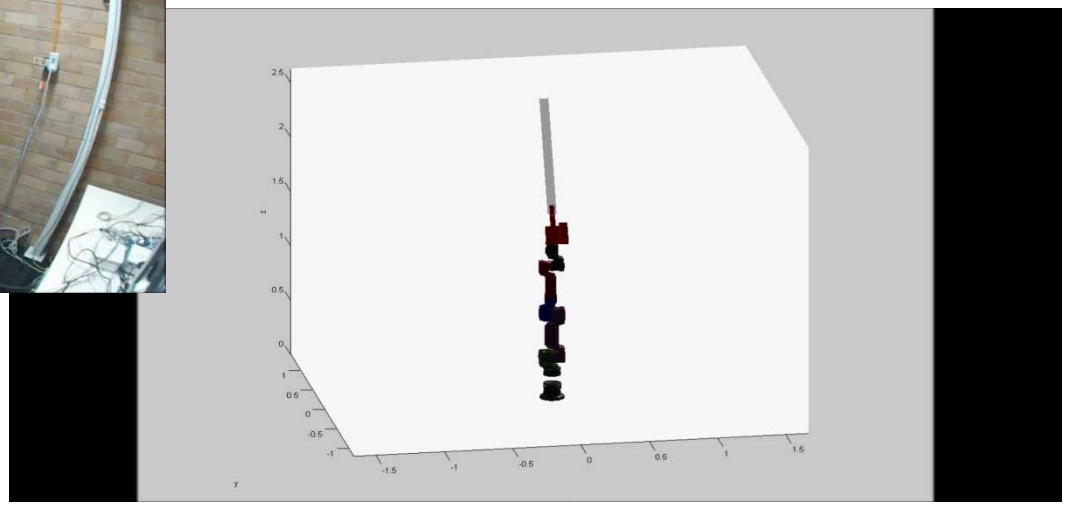
- Ultra lightweight
- Quick and easy setup
- Minimal manual handling

- Nozzle/Sensor Fittings
- Automated calibration
- Safety control system
- Intuitive User interface
- Heavy-duty Protection

MULTI ROBOT COOPERATION

Two blasting robot collaboration and collision avoidance



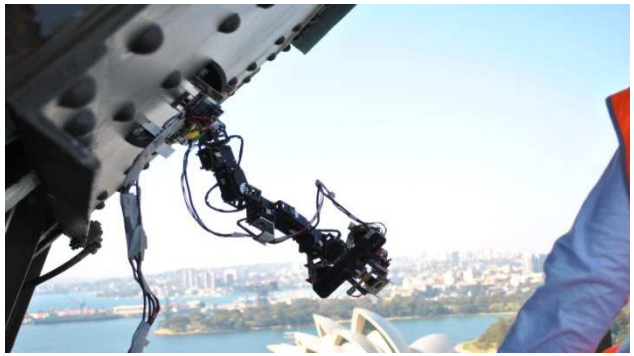


BIOLOGICALLY INSPIRED AUTONOMOUS CLIMBING ROBOTS

Major challenges:

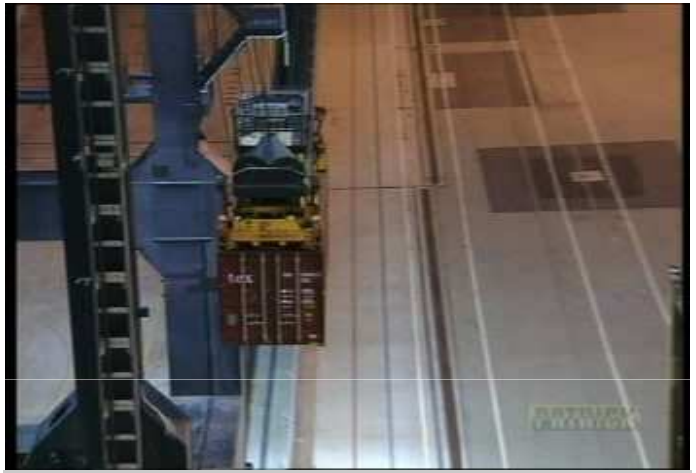
- Areas that are difficult to access
- Negotiation with rivets
- Inverted walking
- Positive and negative corners openwork truss structures
- *Robot design*

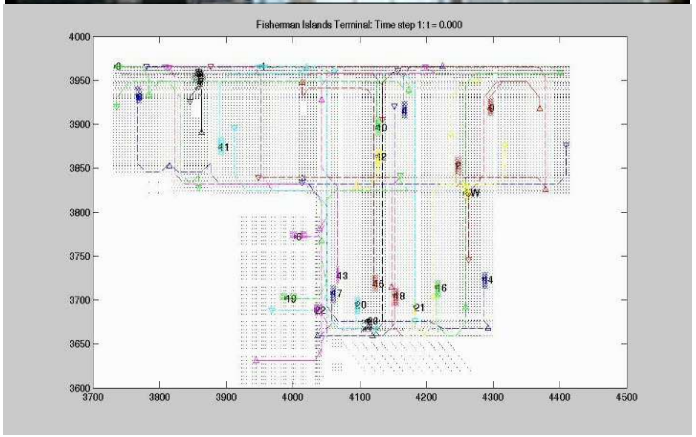
- Two prototype climbing robots have been designed and tested in the Sydney Harbour Bridge (SHB);
- A robot is going to be delivered to the SHB by April 2015



ROBOT TEAMS - LOGISTICS

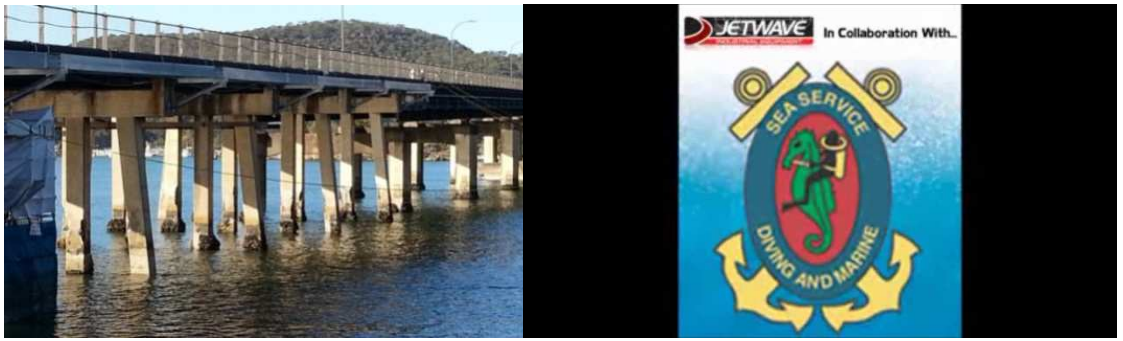
- Coordination of robot teams
- Applied in the world's first fully automated container terminal;
- Potential applications: material handling in warehouse, airport; manufacturing plant, etc
- Significantly improve the productivity

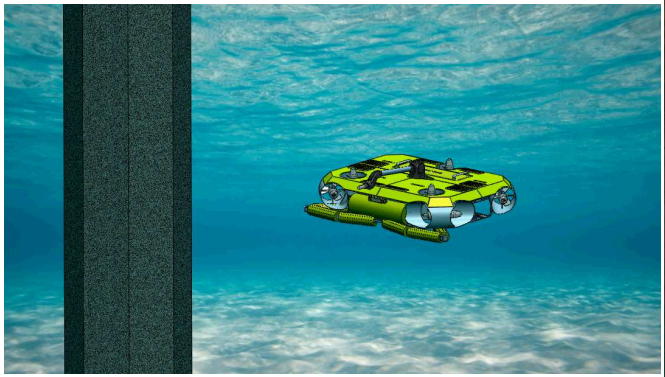




UNDERWATER MAINTENANCE

- Develop a underwater robot for cleaning and inspection
- Address the research issues and develop enabling methods





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:

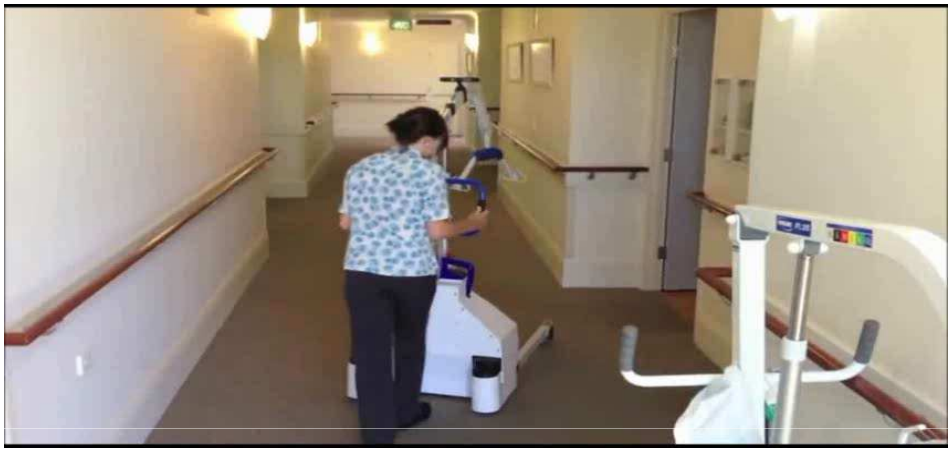
- Robotics for Ageing in Place
- Robotics for patient care
- Manufacturing: robotic co-worker

ASSISTIVE ROBOTICS: CO-WORKER

- Assistant-As-Needed paradigm
- Reduce forces while performing manual tasks
- Safety framework
- Intelligent control through the integration of musculoskeletal, task and robot models
- Robot development

ASSISTIVE ROBOTICS: CO-WORKER

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



EDTAS – TRENDS, BARRIERS, DRIVERS

Technical/Social Trends:

- Collaboration (Multi-Robot; Human-Robot)
- Assistance As Needed (Intent)
- Deep Learning (Demonstration / Interaction)

Barriers:

- Technology: Perception (Sensing)
- Complex Reasoning in Dynamic Environments
- Trust / Legislative

Drivers:

- Aging Population, Labour / Skills Shortage
- Private Venture Capital: SpaceX, Google, Uber

AUTONOMY - EVOLUTION

< 5 years:

Complete Logistics Automation

< 20 years:

Driverless Vehicles in Non-Urban Point->Point (under constraints)

Automation of tasks without complex reasoning (Human on Loop)

THANKS !