Sharing Spaces with Robots

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Postgraduate Tutor MERI

Background

• MSc in MATHS (both pure and applied)
• PhD in Geometry and Topology
• Extensive training and work experience in Computer Science and AI
• Knowledge of several engineering domains
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Research interests

• Surface Modelling of 3D objects:
  • Surface reconstruction
  • Shape modelling
  • Smoothing and simplification
  • Object comparison and recognition based on discrete curvature measures

• Representation of the environment by sensor fusion

Machine Vision

• Computational Geometry
  Path planning

• Team robotics
  Modelling behaviour patterns of a group of heterogeneous agents

• Topology and geometry of Sensor Networks

• Map Building
  • Tactile exploration of environment
  • Grasping by robot hands
  • Robot-Human Interaction
  • Cyber-Physical-Social Experience

SHEFFIELD ROBOTICS
Surface modelling (from discrete data)
Sheffield Robotics

• Sheffield Robotics is a joint venture between two Sheffield Universities, UK: University of Sheffield and Sheffield Hallam University (inaugurated in 2011)

• Areas of research interest
  - Robotics Technology
  - Biomimetic and brain-based robots
  - Human Robot Interaction
  - Robotics and humanities
  - Application of robotics in creative practice and research
  - Assistive robotics

• Associated areas: Virtual Reality
  - http://makinen.hallam.shu.ac.uk:9000/wifi/user/account/
  - Serious Games
  - http://steelminions.com

  http://www.sheffieldrobotics.ac.uk/
One of the main theme of our research is on the connection of artificial perception and physical action.
Starting Point: mobile robots

- A mobile robot is a robot which (its entire body) can move intelligently in the environment, e.g. navigate purposefully.
- Navigation is a fundamental feature of most animals and any intelligent mechanism.
- One of the most distinguished features of mobile robotics is the problem of large-scale spaces, often unstructured environments.
A Navigational Example
(inspired by R. Arkin and J. Penders)

1. Getting to the destination from the current location
2. Not bumping into anything
3. Not colliding with other people on the campus (negotiating the way around other people)
4. Observing cultural idiosyncrasies (habits), e.g. passing on the right (or left)
5. Coping with change in the environment (dynamic environment)

Moving from A to B may be harder than you think
A Navigational Example

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Not colliding with other people on the campus (negotiating the way around other people)
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Moving from A to B may be harder than you think
Where a mobile robot can be used?

• exploration of unknown environments, mapping of unknown or partially known environments,
• surveillance,
• search and rescue,
• navigation indoor and outdoor,
• transportation of large objects,
• agriculture (farming),
• Assistive robotics (robot as a companion)
Challenges of mobile robotics

- Sensing
  - Limited, noisy sensors, can fail in some environments such as vision
- Actuation (Locomotion)
  - Limited capabilities of robot effectors
- Thinking
  - Time consuming in large state spaces (polynomial, NP-problem)
- Environments
  - Highly dynamic, impose fast reaction times, low visibility
Autonomous robots that can work for and alongside human beings

- Combines sensor technologies (machine vision and others) and collective sensing for situational awareness
- Aims to understand and develop haptic human-robot interfaces (HRI)
- EU/EPSRC-funded projects on Search and Rescue
- HRI based on a physical connection; human 'feels' the robot when navigating visually-occluded environments
Search and Rescue

EU funded projects

• View-Finder
• GUARDIANS

EPSRC
(EPSRC, Engineering and Physical Sciences Research Council)

• REINS (Search and Rescue and Human-Robot Interaction)
Guardians (EU project)

• A swarm of autonomous robots applied to navigate and search an urban ground.
  – The project's central example is an industrial warehouse in smoke, as proposed by the Fire and Rescue Service (SyFire).
Guideline search procedure
Warehouse Search
Interaction

Robot Swarm ↔ Human

• Firefighters are under considerable mental and physical stress.
  – The robots should not complicate the navigation task of the human, not physical, not cognitive

• Signals from Human to Robots
• Signals from Robots to Human
Human to Robots

- Robots just assume the human is one of them.
Robots to Human

Visor design with Minimal Cognitive Load
Robot Swarm to Human
Other developments

• How robots recognise each other?
• QR codes

Potential applications

www.harper-adams.ac.uk

Agricultural Robotics: Alireza Janani


UAV: Patrick Saleh, Safat Khan

SHEFFIELD ROBOTICS
Movement Graph: building a map by a team of 3 robots (simulation)
Robot building the map
Reins Project (EPSRC)

• Application: a human-robot (search) team
  – for no-visibility conditions

• Aim:
  – Exploring the communicational landscape for (haptic) human-robot interaction
Following the robot, Final Aim
REINS
Guide dog Guidance

REINS: Focus on Locomotion Guidance

SHEFFIELD ROBOTICS
Robotics & Mechatronics and Social Implementations, 28.08-01.09.2018
Following the robot
Safe path

• Connection
  – Ball free mechanism

Unsafe
New Idea

- Use the robot as a walking assistant and possibly guide
Robot as a guide
Robot and Dementia  
(Pilot Study and in development)

• Use the robot as a walking assistant and possibly guide (people suffering from dementia)

• Points to look at and feedback from focus group
  – Design of the robot,
  – 'Design' of the robot behaviours (walking a robot), robot leads, human leads, walk together, distracted robot
All 3 versions of the robots displayed. All of the pictures have hyperlink to 3d model. Focus group of people diagnosed with dementia, unanimously chose design 2.

Version 01  Version 02  Version 03
Accompanying behaviour

a: Following the robot
b: Going together
c: The robot is distracted
d: Directing the robot
Internal state of the robot
DELPER ROBOT VERSION 01
Comparison of two scenarios of colour changing.
Calm happy robot changes colour of light very smoothly.
Autism, barriers to social engagement and interventions

- **2010 - 2014** Engineering for Life (interdisciplinary project, EPSRC), developing technological means

Remote shopping, visiting places
Connecting Virtual and Real Worlds

- **2012** Using Agents in Virtual Environments to Assist Controllers to Manage Multiple Assets, AAMAS 2012, CAVE 2012
  - Developing a GIS-based planning and simulation system for rapid response
  - Fusion of simulated (virtual) environment with aerial information from UAV’s – bird’s eye images
  - Challenge: localisation and positioning of real UAV’s and their counterparts in the simulated environment
Cognitive Assessment through Human-Robot Interaction (CATHI)

The research project aims to:

• Investigate the automatization of Psychological Cognitive Assessment and Screening
• Develop a prototype of a novel test performed by a Social Humanoid Robot.
• Test and scientifically validate the prototype in experiments with human participants.
• Create a friendly interface, tailored for clinicians, for retrieving and managing the data.

@Alessandro di Nuovo
Cognitive Assessment through Human-Robot Interaction (CATHI)

- Cognitive Level Assessment can detect early signs of dementia for prompt intervention, including non-pharmacological treatment.
- Recent research (Hammer et al., 2017) points out that the older population prefer to be evaluated by a social robot rather than with a human or a computer.
- Furthermore, the interaction with robots is a novel and motivating experience that encourages people to take the test.

Robots as Cognitive Assessors

• Advantages of using a robotic assessor would be multiple:
  – widely available tools,
  – standardization of the scoring
  – the avoidance of assessor bias, scoring objectivity
  – quick and easy updates,
  – having a recording of the administration
Controlled Autonomous Robot for Early diagnosis and Rehabilitation of Autism and Intellectual Disability (CARER-AID)

- This project envisions a humanoid robot as a supervised autonomous assistant that will support caregivers in early diagnosis and to improve the treatment of individuals with Autism Spectrum Disorder (ASD) associated with Intellectual Disability (ID).
- The robot can be part of the diagnostic team during the administration of the psycho-diagnostic tests in order to enrich the data that the psychologist can use to refine the diagnosis.


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Clinical experiments

• Robot has been embedded in the therapy (TEACCH approach) for four weeks

• 6 hospitalised children with ASD and ID.
Long-Term Trial

We introduce a long-term study of robots in a social shared-space and Sheffield Robotics’ investigation into the dynamics of the public’s interest and habituation towards the robots.

The study has two key aims:

1) Explore factors affecting habituation towards robots in long-term interactions, particularly people’s use of the shared-space around the robot

2) Develop effective and reliable non-invasive measures of public interest towards robots.
Long-term trial

Robots used: Pioneer LX, Fetch, Pepper
Long-term trial: analysing human interests and acceptance

STEM atrium. Sheffield Hallam University
Festival Being Human
17th-25th November 2016

In a future where intelligent androids are fully integrated with everyday life, how do we distinguish ourselves as human?

Organisers:
Overall Lead: Dr Lyuba Alboul
Interactive Display:
Dr Martin Beer, Dr Alessandro di Nuovo, Dr Louis Nisiotis, Alexandr Lucas, Enohor Igbeyi, Matthew Haire, Muhammad Sayed, Alireza Janani
Scriptwriting: Sue Bodnar
Filming: Oliver Newman, Roagan Hall
Overall Support: Ekaterina Nikolova and Ekaterina Netchitailova
Contributors:
Professor Jacques Penders, Professor Marcos Rodrigues, Alessandra Moschetti, Inna Popa, Rinella Cere, Ayan Ghosh, Robot Pepper, Robot Betty, Robot Green/Kermit
With special thanks to Professor Wayne Cranton


https://youtu.be/NKrk258iHTU
New applications, Robotics in Cultural Heritage

Martin Beer, Louis Nisiotis, Enohor Egbeyi
Example: Virtual Museum

Special exhibition to museum visitors through the exploration of both the physical and a virtual world. This will allow visitors to be:

• Guided by a virtual curator who can respond to their particular interests, knowledge and needs.

• Explore parts of exhibits that are normally inaccessible, for example the backs of paintings, x-ray and other images, close up detail, interiors of sculptures and other artefacts etc.

• Similar works that are displayed elsewhere, or have been removed for conservation or on loan, or indeed have been lost through fire, conflict etc.

• Interact with other visitors either through real time communication, or by leaving messages on a virtual “wall”

• Improve accessibility for those unable either to travel or gain access in the conventional way

• Provide a more comfortable means of studying extremely popular exhibits without being crowded out by large numbers of visitors, tour parties etc. as can happen in a conventional museum etc.
Virtual Reality Robotics Museum

http://makenen.hallam.shu.ac.uk:9000/wifi/user/account/

Instructions how to create a login can be given by request
Cyber-Physical-Social System

• This research project proposal focusses at creating a new type of conceptually led environment that fuses real (physical) and virtual worlds interactively with cyber social spaces providing a unique experience of exploring both worlds simultaneously.

• We want to go beyond current augmented reality environment experience, and provides new modalities, for example, by merging two physical realities via a virtual link and integrating social input such as discussions between visitors in the various domains with mutual interests.
Projects on Collaborative robots and human working alongside

Both Sheffield Universities and several companies are involved
Benefits

- Faster realisation of safe and ergonomic production cell design
- Increased worker job satisfaction
- More efficient production through reduced stoppage time
- Increased H&S compliance
- Greater acceptance of a cobot in the workplace
- The implementation of co-bots in the workplace will secure manufacturing in the UK
- Transferable skills and knowledge for all UK companies
- A new area of study.
- The participants reputations as world leaders on collaborative robots will be further enhanced
- Backed by experienced staff from 2 Universities and Industry
Further reading

1. Swarm Robotics

2. Robot Swarms in Search and Rescue

3. Human Robot Interaction (no-visibility)
Further References


References, Assistive Robotics


