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Medical Robotics & Imaging



Kawal Rhode
Professor of Biomedical Engineering
School of Biomedical Engineering & Imaging Sciences
King's College London

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Healthcare Systems

- Increasing **burden of disease** – ageing population
- **Limited resources** for healthcare




Financial Staffing

- Need to make healthcare systems **more efficient**

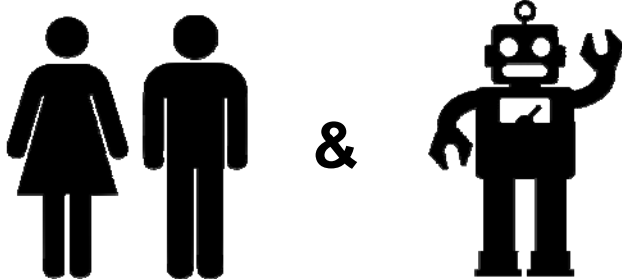
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Impact of Technology

- Should provide one or more of
 - **Patient** benefit, e.g. better outcomes
 - **Staff** benefit, e.g. better working
 - **Economic** benefit, e.g. cost savings
- **Robotics** and **Imaging** are two great examples of healthcare technologies

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Humans vs. Robots



Humans Are Amazing!!!

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- Millions of years of EVOLUTION = HUMAN BEINGS



Amazing Hands

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- Opposable thumbs allow the complex use of tools



Evolution of the human hand



Thumb Movements



Amazing Legs

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- Bipedalism – walking on 2 limbs



Scott 1912



Hillary & Norgay 1953




Usain Bolt 2012

Amazing Intelligence

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- Ability to learn & deal with complex problems





Social Interaction

- Working together

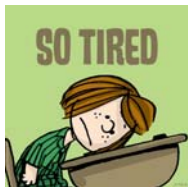


Empathy

- Caring about each other's feelings



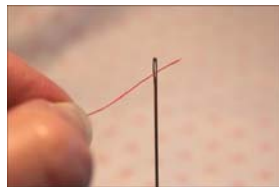
However.....



Fatigue



Emotions



Limited Fine Movements



Argument / Disagreement



Limited Computational Power

Rise of Machines

- Robots are about to revolutionise healthcare



Robots are Amazing!!!

- Don't get tired – can perform repetitive tasks
- Not affected by emotions
- Can make ultrafine and complex movements
- Can work in hazardous environments, e.g. radiation
- Can make billions of calculations per second
- Can increase efficiency & lower costs
- Don't make mistakes

Medical Robots

- Many commercial medical robots already available
 - Rehabilitation and assisted living robots
 - Pharmacy robots & hospital transport robots
 - Telepresence robots
 - Surgical Robots
 -
- Many are in development

Rehabilitation Robots

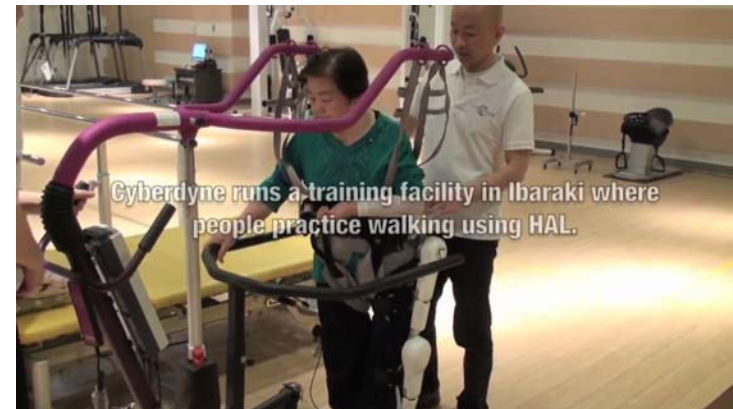


ReWalk



HAL

HAL




Pharmacy Robots 




Willach | Pharmacy Solutions


Faster and safer:
Batch and individual dispensing
with CONSYS robotic systems.


Suitable for hospital, mail-order
and community pharmacies.

Telepresence Robots 




From Left: AnyBots QB, RoboDynamics TiLR, Gostai Jazz Connect, Mantaro's Mantaro Bot, and VGO


Surgical Robots 




Da Vinci



ROBODOC



Sensei X



ARTAS

Da Vinci 



ROBODOC KING'S College LONDON


ROBODOC®
Curexo Technology Corporation



Sensei X KING'S College LONDON


hansen®
MEDICAL
The Global Leader in Intravascular Robotics

Artas KING'S College LONDON



Successful Medical Robots KING'S College LONDON


- Don't be a Solution looking for a Problem
- Most surgical robots have shown no direct patient outcome benefit




Hansen Medical share price over time

■ Closing Price: 3.99
■ Vol: 0.0147M

Successful Medical Robots




- da Vinci robot – most successful commercial medical robot
- Why ?.....Not clear.....Advertising?

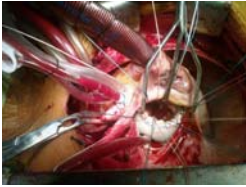


Intuitive Surgical share price over time

Medical Imaging

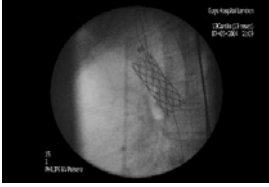


- Medical imaging has transformed the practice of medicine over the last 120 years
- We can look into the body without cutting it open
- We can image anatomy & function




Invasive, high infection risk

➔




Minimally-invasive, low infection risk, go home same day

Foundations for Ultrasound Imaging

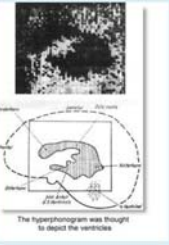


- Langevin invents the hydrophone for locating icebergs 1915
 - Pulse-echo principle
 - Followed Titanic disaster in 1912
 - Later used for submarine detection in WWI & II
- Patent for metal defect detection 1940
 - Firestone
- First transmission ultrasound image of a human 1942
 - Dussik




Paul Langevin
1872 – 1946

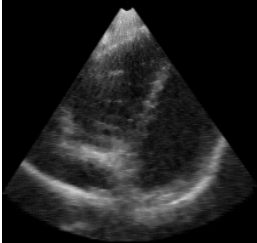
Invented hydrophone
1915



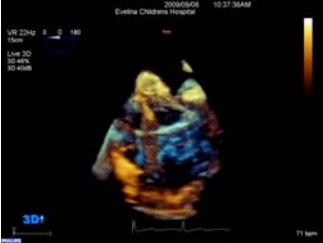
The hydrophonogram was thought to depict the wreck.

Ultrasound Imaging





2D (or B-mode) imaging



3D imaging

- Low cost
- Portable
- Safe

Modern Ultrasound Systems

- ❑ More compact
- ❑ On-board image analysis
- ❑ Faster







Intra-body
(TOE/TEE)



Extra-body (TTE)


Demand for Imaging+++

3 Operators



2010
600 TOEs


10 Operators



2017
1000 TOEs


Figures for St. Thomas' Hospital

Why Robotic Ultrasound?

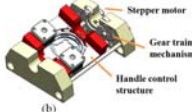


- ↑ Standardisation of imaging
- ↑ Resource management
- ↑ Efficiency
- ↑ Cost-saving
- ↑ Patient / operator safety

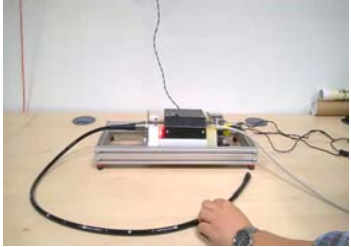
Robotic TOE @ KCL




(a)



(b)





(c)

Intelligent Robots

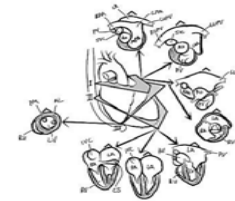
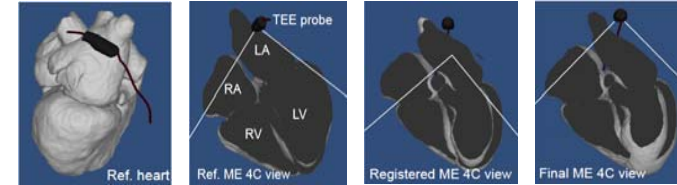


- Surgical robots are currently all master-slave, i.e. operated by humans
- Rehabilitation robots & pharmacy robots already pack a lot of intelligence
- Machine learning allows robots to learn just like humans
- Vast experience can be built into robotic systems

Automatic Robotic TOE



- Examples of standard view slices at different stages:



- There are approximately 20 standard views

Challenges & Next Steps



- Ensuring patient safety
- Regulatory approval
- Patient testing
- Multi-site clinical testing
- Commercialisation



Thank You



"Once you start to make machines that are rivalling and surpassing humans with intelligence, it's going to be very difficult for us to survive. It's just an inevitability."

Thank you to all my colleagues at KCL and outside, especially James Housden, Shuangyi Wang & Davi Singh