

Mechatronics Design

AI and Future Trends in Mechatronics Systems

Future Trends

- Microsensors and Microactuators
- Micro-Electro-Mechanical Systems (MEMS)
- Applications of MEMS
- Industrial Trends
 - MEMS, Robotics, Sensor networks, RFID...
- On-line Quality Monitoring
 - Communications, LAN (Ethernet), WLAN, Internet, Security, IPV6...
- Hardware-in-the-loop Simulation
- Artificial Intelligence (AI)

Microsensors and Microactuators

- Microelectronic starts in 1948.
- Manufacturing of micro-electro-mechanical systems using Micro System Technology (MST) starts in 1980s.
- MEMS consist of;
 - Microsensors, sense the input signals,
 - Microprocessors, process and analysis signals,
 - Microactuators that produce the output, mechanical action.

Microsensors and Microactuators

- Microsensors have dimensions in the sub-mm level.
- They are used to convert non-electrical input quantities into electrical signals.
- Microactuators are devices that convert the energy from one form to another (usually to mechanical).

What is Artificial Intelligence - AI

???

What is Artificial Intelligence - AI

- Study of human intelligence so that it could be artificially simulated, or generated,
- The search for a way to map intelligence into machine, hardware and software, and enable such system to formalize thinking,
- A branch of computer science, dealing with machine intelligent behaviour,
- The implementation and study of systems that show an autonomous, intelligent, behaviour...

Conventional AI

- This approach is distinguished by formalism, statistical analysis, definitions and proof.
- Machine learning is primarily associated with conventional AI.
- It includes
 - expert systems,
 - case based reasoning,
 - Semantics.

Computational Intelligence - CI

- CI is known for its informal, non-statistical and trial-and-error approach.
- Learning is generally an iterative process of improvement based on empirical data.

CI categories:

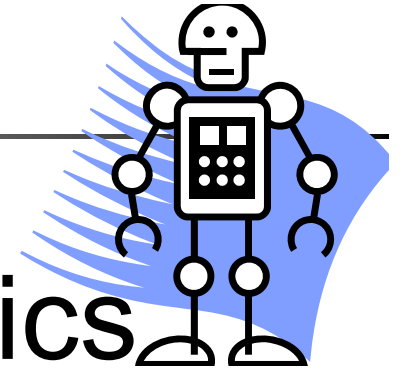
- Neural networks,
- Fuzzy systems,
- Evolutionary computation.
- Research overlaps with a-life, cognitive science, cybernetics & robotics, hybrid intelligent systems design and study.

What is Intelligence

- A property of mind that include many related abilities:
 - Reasoning, Planning,
 - Problems solving, Abstract thinking,
 - Comprehend ideas, Language, Learning...
- Intelligence also include qualities as:
 - Creativity, Personality, Character, Knowledge...
- How could we recognise whether something inhuman have intelligence

Intellegere

- Latin verb "intellegere", means "to understand"
- Deeper understanding of the relationships of the world around us
- Capability for metaphysical manipulation of abstract objects and relationships once their understanding is achieved.



Artificial Intelligence Topics

- Planning, Decision making and Problem Solving
- Uncertainty, Probability, Games,
- Deduction in Logic, Fuzzy Logic
- Machine Learning,
- Knowledge Engineering: Databases, Expert Systems, Diagnostic Systems
 - Web, Google, Learning Hub, Online Exam?,
- Natural Language : Markov models...
- Artificial Life
- Neural Networks

Binary vs. Fuzzy Logic

- Binary Logic is based on 2 states alphabet $\mathbf{B}=\{0, 1\}$
- Fuzzy Logic uses continuously varying degrees of states (**membership functions**)
 - Temperature (very hot, hot, warm, lukewarm, cool, cold, very cold)
- The controller assigns **membership grades** to variables
 - If $T=35^{\circ}$, it may be interpreted as 80% warm and 20% hot

Neural Networks (NNs)

- Artificial NN consist of layers of
 - Linear and
 - Nonlinear

Algebraic functions that transform a given input $x_i(i=1, 2, \dots, n)$ to an output.

- During the neuron learning stage, the parameters of the linear functions, called weights, w , are defined by processing input sets and producing output sets

$$w_{ij}x_i(j=1, 2, \dots, m)$$

- Parameters of the nonlinear functions are chosen based on practical considerations.

Neural Networks (NNs)

- Non-recurrent NNs
 - No feedback
- Recurrent NNs
 - Feedback

AI Areas

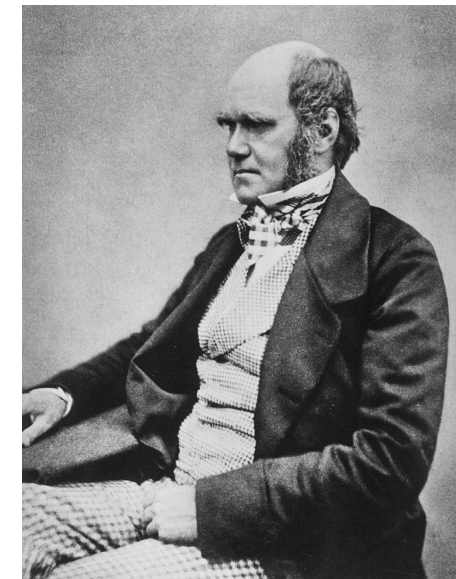
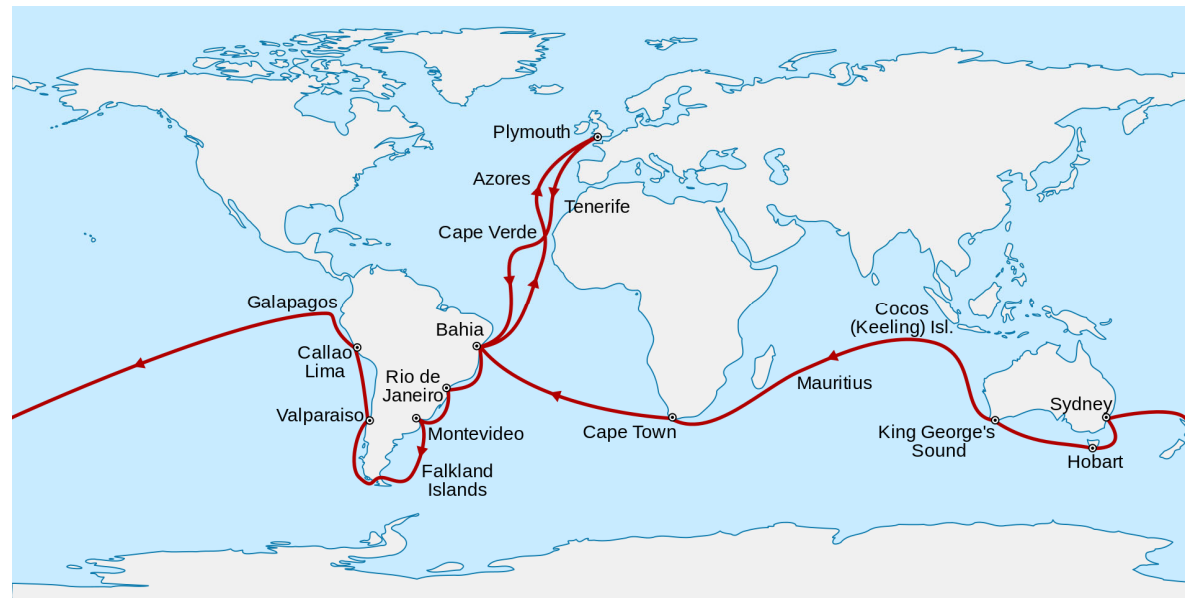
- **Machine Vision:**
 - Interpreting visual data, Classification, Face recognition...
- **Speech Recognition:**
 - Text to Speech (ACROBAT Reader), OCR
- **Advanced Logics:** Advanced logic systems.
- **Reinforcement Learning**
- **Robotics:** Software and hardware. Projects.

Classification of Species

How did we do it before AI

Charles Darwin (1809-1882)

“On the Origin of Species”



Charles Darwin. 1854, preparing *On the Origin of Species*

Algorithms and Circuits

- Boolean Intelligence
 - Everything can be express using binary Alphabet
 $B = \{0,1\} \Rightarrow$ Binary brain can be built
- 1-Bit Learner
- N-Bit Learning Circuit
- Circuits encoded in Java (Neuron), could be other Object Oriented languages

Artificial Intelligence

- What type of mater and organization is necessary?
- Is it possible for a machine made of metal to have intelligence comparable to our?
- Could non-organic machine had problem-solving capabilities like a human's
- Could a machine have consciousness and emotions?

Intelligent Robots

- If we could create robots with intelligence comparable to ours, should we do that?
- Many ethical questions may arouse
- Machine that can learn
- Machine that can reproduce itself
- Can such a machine be more intelligent than us???

Garry Kasparov World Champion vs. Deep Blue, IBM

- Garry Kasparov playing chess against computer Deep Blue.
- **Deep Blue was the first machine to win a chess match against a world champion.**
 - Photo courtesy of IBM.
- 1996: Garry Deep Blue 4:2
- 1997: Garry Deep Blue 2.5:3.5



http://www.thetech.org/robotics/universal/breakout_p11_ibm.html

Few References

- [1] C. Sun et al., "Software Development for Autonomous and Social Robotics Systems," in *Intelligent Interactive Multimedia Systems and Services*, Cham, 2019, pp. 151-160: Springer International Publishing.
- [2] J. Young, M. Elbanhawai, and M. Simic, "Developing a Navigation System for Mobile Robots," in *Smart Innovation, Systems and Technologies*: Springer, 2015.



Thank you,
Questions

