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.

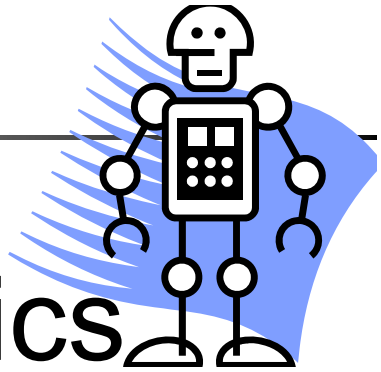
- Research overlaps with a-life, cognitive science, cybernetics & robotics, hybrid intelligent systems design and study.

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 **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=35º, 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 $x_i(i=1, 2, \ldots, n)$ 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

  $w_{ij}x_i(j=1, 2, \ldots, m)$
- Parameters of the nonlinear functions are chosen based on practical considerations.

Neural Networks (NNs)

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

AI Areas

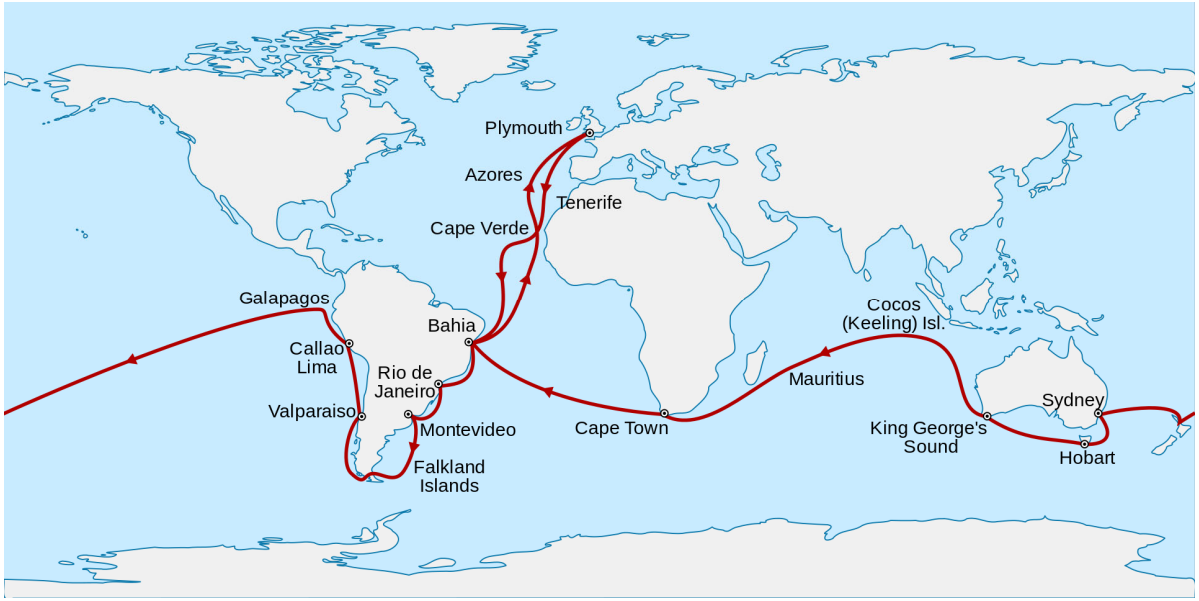
- **Machine Vision**:
  - Interpreting visual data, Classification, Face recognition…
- **Speech Recognition**:
  - Text to Speech (ACROBAT Reader), OCR
- **Advanced Logics**: Advanced logic systems.
- **Reinforcement Learning**
- **Robotics**: Software and hardware. Projects.

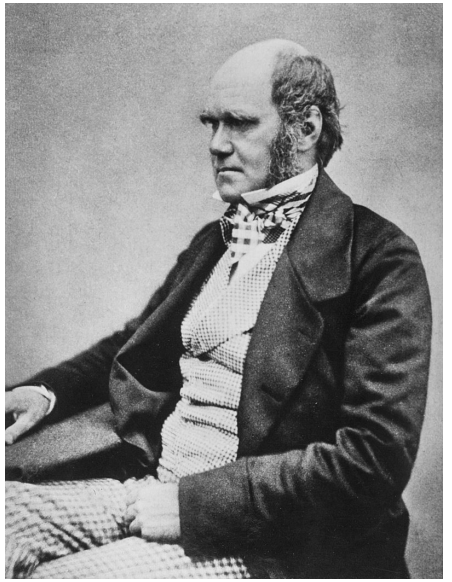
Classification of Species

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

https://en.wikipedia.org/wiki/Charles_Darwin

Algorithms and Circuits

- Boolean Intelligence
  - Everything can be express using binary Alphabet
    B={0,1} => 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 that 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

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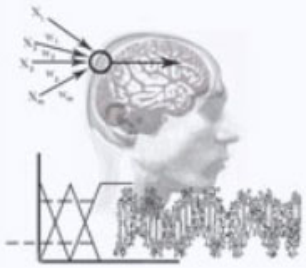

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The **KES Journal** provides a medium for publishing the results of recent research into the applications, tools and techniques of Intelligent Systems, including a wide range of Topics.

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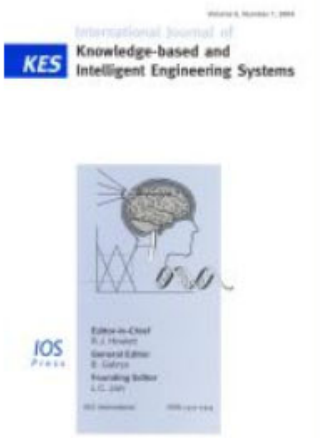

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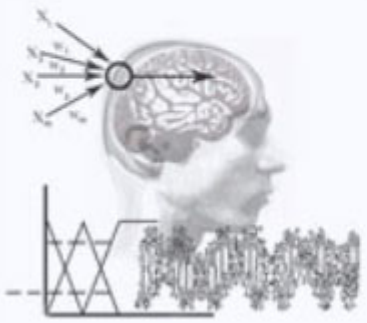

Journal Topics

The aim of research into Knowledge-Based Intelligent Engineering is to develop systems that replicate the analytical, problem solving and learning capabilities of the brain. These systems bring the benefits of knowledge and intelligence to the solution of complex problems. Authors are invited to submit original unpublished work that is not currently under consideration for publication elsewhere. The topics covered by the Journal include the following:-

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Applications using Intelligent Techniques

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Emerging Intelligent Technologies:

Artificial Intelligence and the Internet, Information Agents on the Internet, E-commerce/E-business and E-learning, Intelligent Information Retrieval, Intelligent Web Mining & Applications, Intelligent User Interfaces, Bioinformatics using Intelligent & Machine Learning Techniques, Intelligent Tutoring Systems, Virtual Reality & Multi-Media Intelligent Information Systems, Artificial Life, Ant and Swarm Algorithms.

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