BIOINSPIRATION

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Bioinspiration:

Bioinspiration is the development of novel **materials**, **devices**, and **structures** inspired by solutions found in **biological systems** and **biological evolution** which has occurred over millions of years.

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Strengths:

Bioinspiration is the development of novel **materials**, **devices**, and **structures** inspired by solutions found in **biological systems** and **biological evolution** which has occurred over millions of years.

- Human problems are often shared with other natural species (e.g., moving across the land, sea, or sky).
- Humans have been developing technologies to solve these problems for a few millennia (in most of the problems that interest us, a few decades).
- Nature has been developing solutions to these problems for millions of years, mainly through biological evolution.
- Some natural solutions can be reproduced, adapted, and improved with human technology (e.g., legs, fins and wings).

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Weaknesses:

Bioinspiration is the development of novel **materials**, **devices**, and **structures** inspired by solutions found in **biological systems** and **biological evolution** which has occurred over millions of years.

- Biological evolution allows natural species to adapt to their environments.
- This process takes place over millions of years through random genetic changes in the individuals and the survival of the best adapted.
- However, biological evolution has some limitations: it cannot solve all the problems and its solutions are not optimal.
- For instance, nature solves locomotion on the ground by means of legs, whereas technology does it mainly through wheels.

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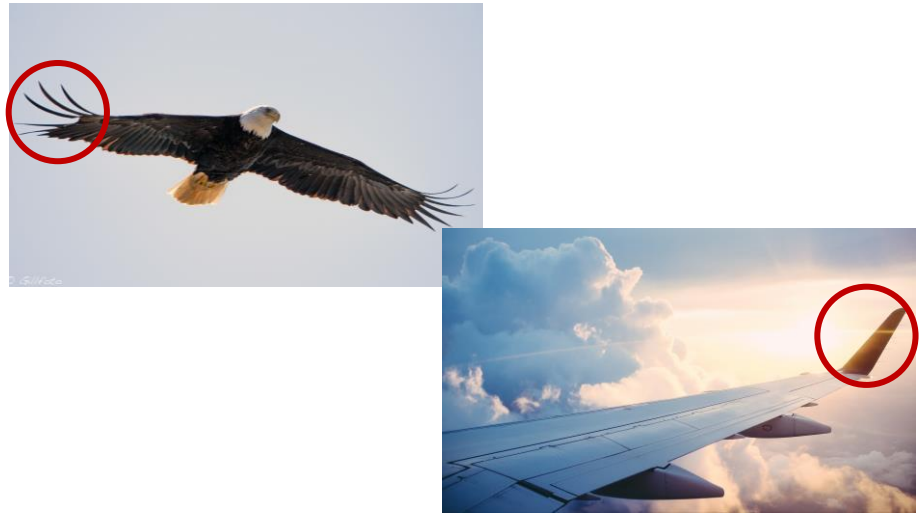
Bioinspiration vs biomimetics:

Bioinspiration is the development of novel **materials**, **devices**, and **structures** inspired by solutions found in **biological systems** and **biological evolution** which has occurred over millions of years.

Biomimetics is the **emulation** of the **models**, **systems**, and **elements** of **nature** for the purpose of solving complex **human problems**.

Example:

- **Airplanes** are inspired by **birds** (**bioinspiration**) because they share some elements (lift), although others are different (function, scale, propulsion…)
- **Wingtips** in **airplanes** mimic **birds** (**biomimetics**) because they have the same morphology and function without relevant changes or improvements.



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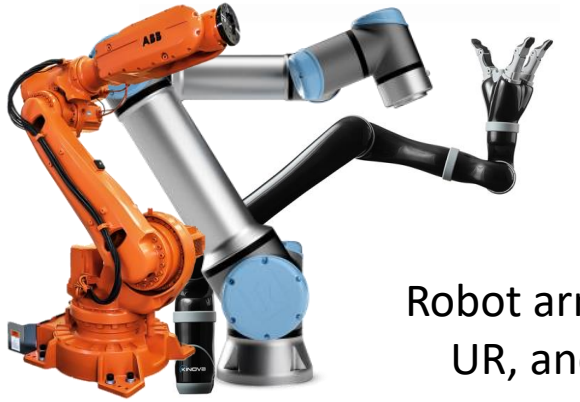
Hardware:



Robot arms by ABB, UR, and Kinova

Spot by Boston Dynamics

Octobot by Harvard University

Erle Spider by Erle Robotics

Snakebot by Carnegie Mellon University

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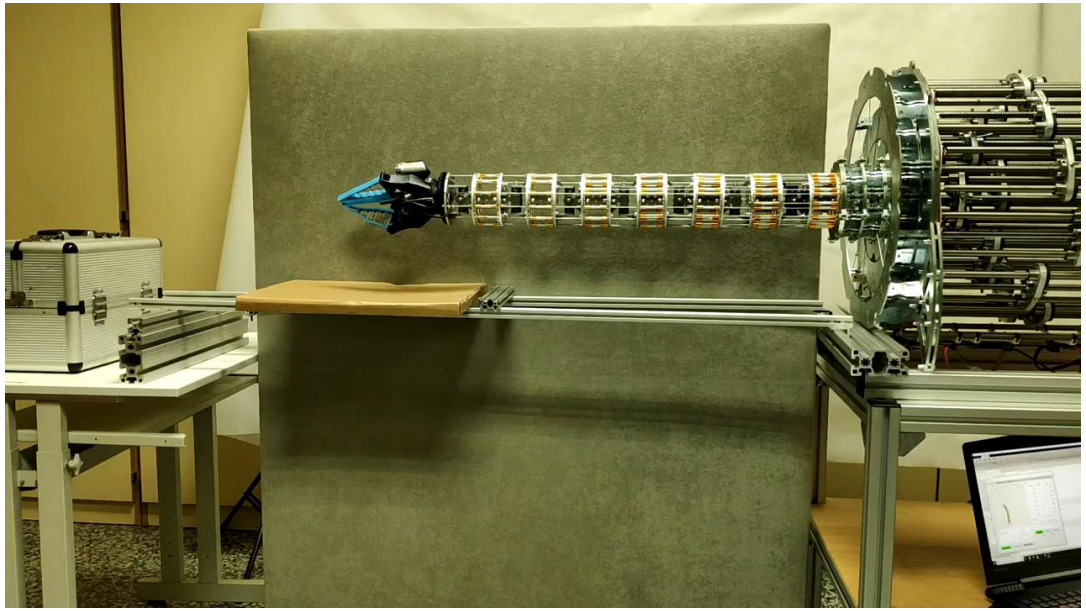
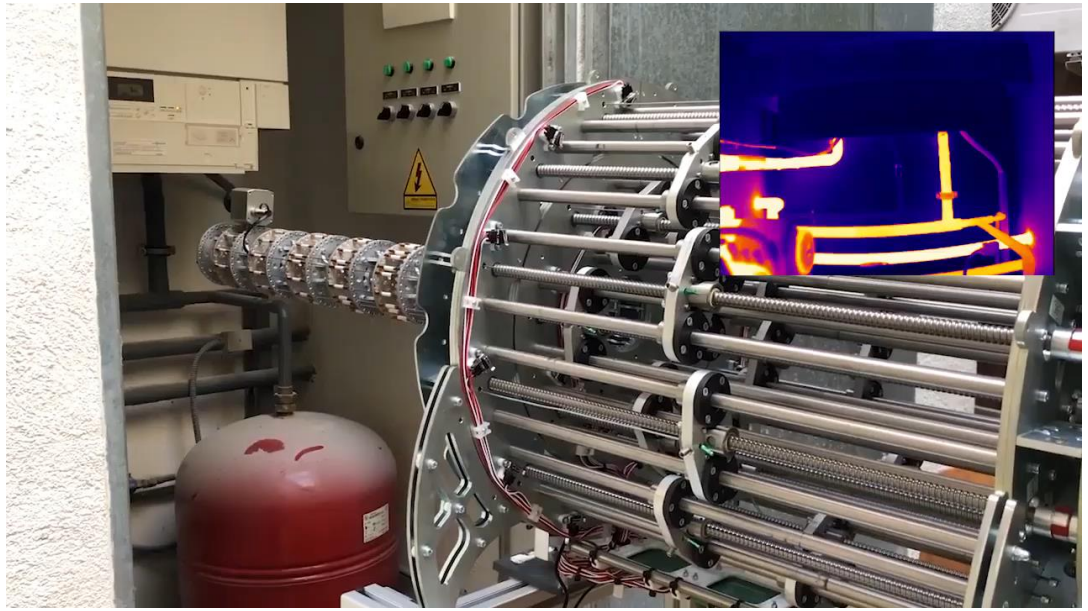
Rigid robot:

A. Martín-Barrio et al., ***Design of a Hyper-Redundant Robot and Teleoperation Using Mixed Reality for Inspection Tasks****, Sensors, 2020.* Link





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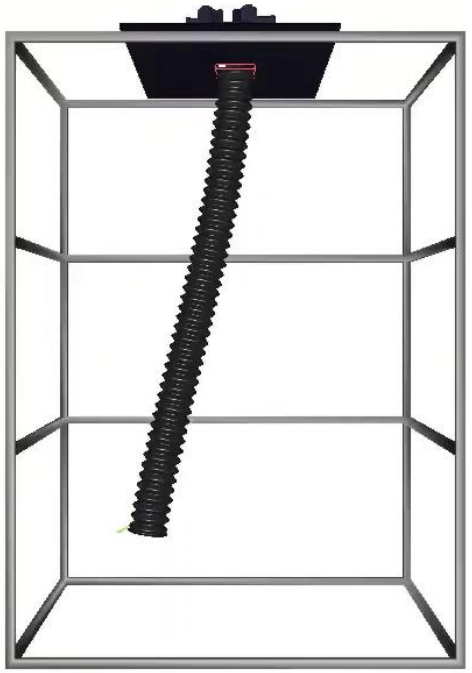
Soft robot:

A. Martín-Barrio et al., ***Modelling the Soft Robot Kyma Based on Real-Time Finite Element Method****, Computer Graphics Forum, 2020.* Link



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Software:

Evolutionary Algorithms
(Biological evolution)

- Genetic Algorithm (GA)
- Differential Evolution (DE)

Swarm Intelligence
(ants, termites, bees, wasps, birds, fishes…)

- Particle Swarm Optimization (PSO)
- Ant Colony Optimization (ACO)

Artificial Neural Networks
(brain and nervous system)

Reinforcement Learning
(human and animal cognition)

Fuzzy Logic
(human cognition)

…

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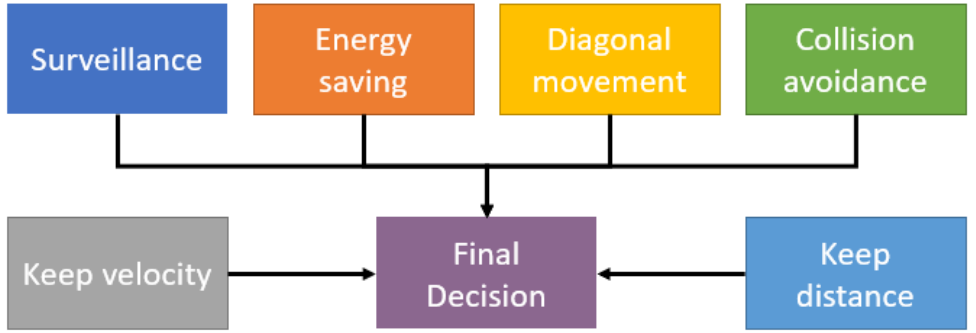
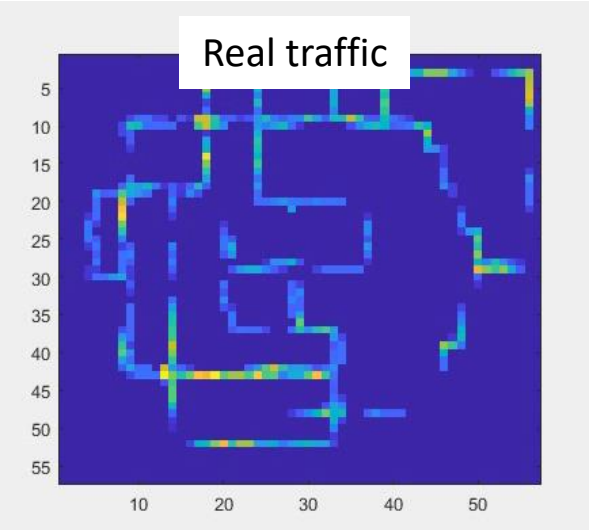
Swarm City:

City simulator

Behavior-based architecture





P. García-Auñón et al., ***Monitoring traffic in future cities with aerial swarms: Developing and optimizing a behavior-based surveillance algorithm****, Cognitive Systems Research, 2019.* Link