SWARM ROBOTICS SPECIAL TRACK

INTRODUCTION

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Supported by:

TII Technology Innovation Institute

Autonomous Robotics Research Centre

GIULIA DE MASI

I am a PhD in Physics, very committed to multidisciplinary collaborations, in particular applications of statistical physics models to engineering and economics. My PhD thesis and postdoc were in complex networks' field between statistical physics, applied mathematics, computer science and advanced statistics.

Then I started my journey in the industry sector, getting a position in the R&D sector in marine and offshore Industry. Currently I am Principal Scientist in the Autonomous Robotics Research Center (Technology Innovation Institute) in Abu Dhabi, UAE. I am also adjunct Associate Professor in Rochester Institute of Technology in Dubai.

My research activities consist in statistical physics, stochastic processes, collective decision making, machine learning, artificial intelligence applied to swarms of robots. My main applications are in bio-inspired marine robotics.

ELISEO FERRANTE

Dr. Eliseo Ferrante holds a Faculty position at the Vrije Universiteit Amsterdam, in the Computational Intelligence groups within the Department of Computer Science. He also holds a Principal Scientist position at the Technology Innovation Institute in Abu Dhabi. He owns a Ph.D. in Applied Sciences delivered by the Université Libre de Bruxelles (ULB) in 2013, a master and a bachelor degree in Computer Science Engineering from Politecnico di Milano (Italy), and a Master of Science in Computer Science from the University of Illinois at Chicago (USA). Dr. Ferrante's research focuses on swarm robotics studies from an interdisciplinary perspective comprising computational, statistical physics, and evolutionary models of collective behaviors. Some of the phenomena he studies include collective motion, task specialization, and collective decision-making in animals, artificial agents and robots.

GROUP OR SWARM OF ROBOTS?

A robot swarm is a self-organizing multi-robot system.

Robots' sensing and communication capabilities are local and robots do not have access to global information.

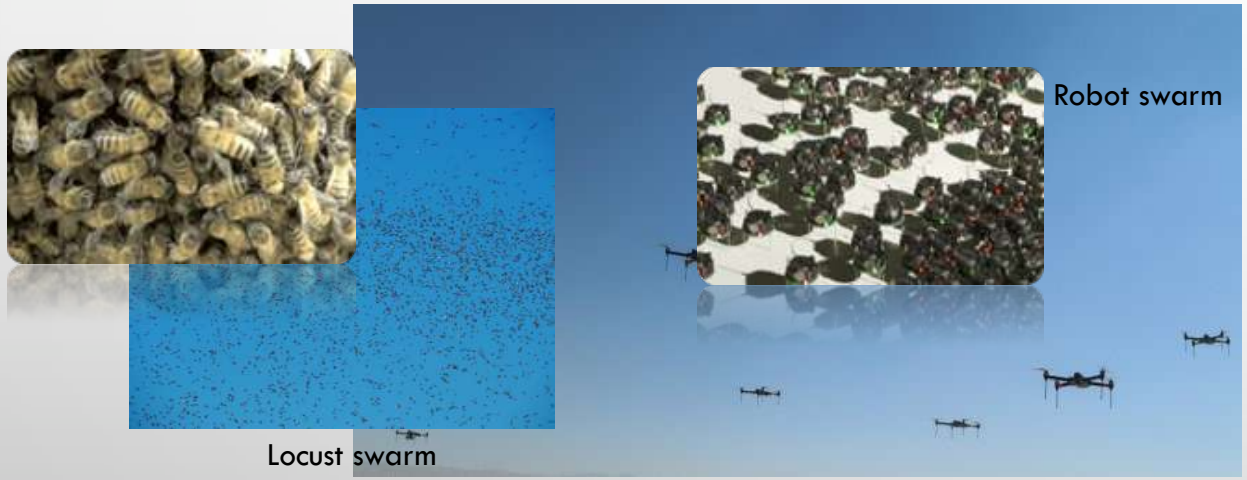
The collective behavior of the robot swarm emerges from the interactions of each individual robot with its peers and with the environment.

WHY A SWARM IS BETTER THAN ONE DRONE

- ✓ Monitoring of large areas
- ✓ cheaper
- ✓ more resilient
- ✓ more flexible
- ✓ more scalable
- ✓ Using local interactions, It is working also in GPS-denied regions

FROM NATURAL TO ARTIFICIAL SWARMS

In nature many animals' societies are based on collective decision making, where the single individuals coordinate to make a common decision.



- **Social insects** such as honeybees and ants are able to collectively choose and commit to a single suitable nest site using collective and distributed information processing
- **Social animals**, like schools of fish, flocks of birds, and wild baboons are able to move coherently in a common direction using only local interactions with their neighbors

Engineering: Can we design artificial swarms of drones to achieve a specific task?

OUTLINE OF THE TRACK

- ✓ Introduction
- ✓ Giulia De Masi: Collective decision making for environmental monitoring
- ✓ Judhi Prasetyo: The effect of differential quality and differential zealotry in the best of N problem
- ✓ Dario Albani: Area Inspection by Robot Swarms through Exploitation of Information Gain
- ✓ Open Discussion and Closing session

FUTURE CHALLENGES OF SWARM ROBOTICS

- Robustness, scalability, flexibility→ Flexibility is under-achieved (but widely observed in biology)
- Fast information transfer within swarms as in fish schools or bird flocks → Collective response and awareness
- Field swarm robotics → Achieving swarms outside of laboratory conditions
- Swarms of UAVs → Currently hard to control groups of UAVs without precise positioning (tracking or GNSS)
- Security and safety of swarms → As swarms are inherently "open to adaptation" and new individuals, how to identify attacks?

- Verifiability → Noise and stochasticity is inherent in swarms, so how to guarantee certain performance (e.g. for certifications)
- Nano swarms → How to coordinate swarms of individuals at nano scales, need to reduce further and further individual capabilities
- Swarms of underwater vehicles → How to face the challenges of open and wild environments
- Increased autonomy for self-deployment (e.g. recharge etc)