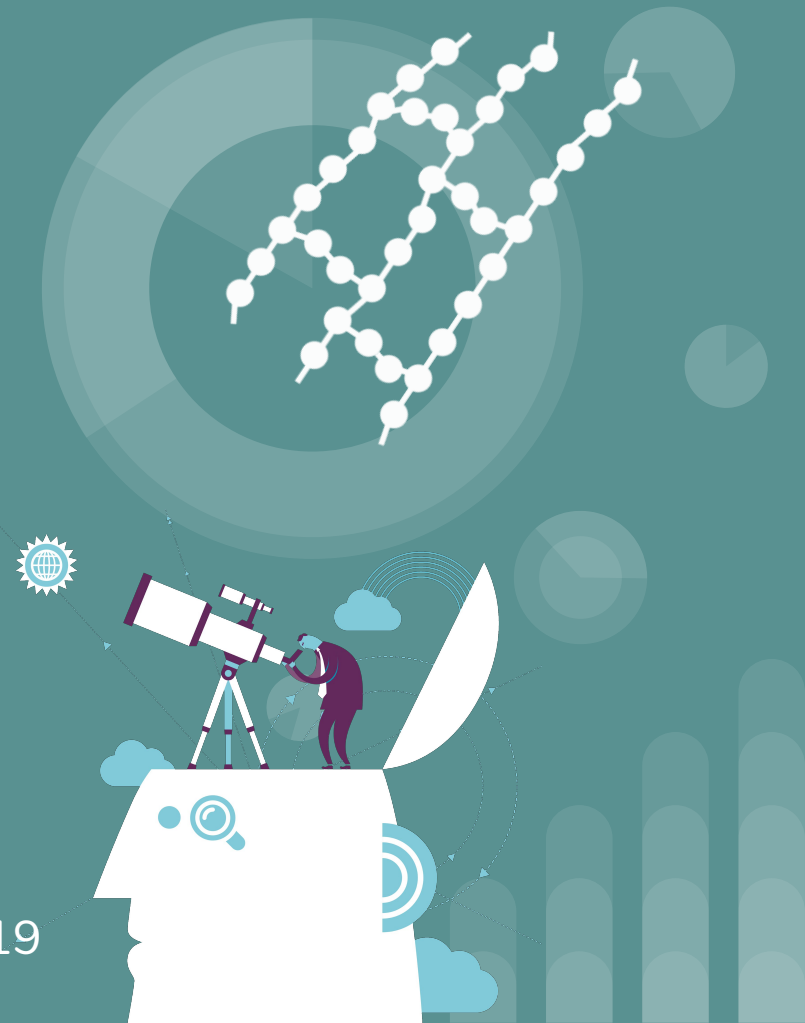


# Monocular SLAM for Drone Swarms

Marina Sofia Garcia Perez

20th Nov 2019



# Content:

1. Introduction
  - a. SLAM
  - b. Drone swarm
2. Motivation
3. Related work
  - a. CCM-SLAM
4. Approach
5. Research questions
6. Progress

# SLAM

- Simultaneous Localization and Mapping
- Monocular?



# Drone swarms



Drone/UAV/Quadcopter

Swarm

# Drone swarms



Drone/UAV/Quadcopter

Swarm

# WHY?

- SLAM is important
  - Autonomous navigation
- Monocular is cheaper
- Why in swarms?
  - Cooperation
  - Faster? Better?

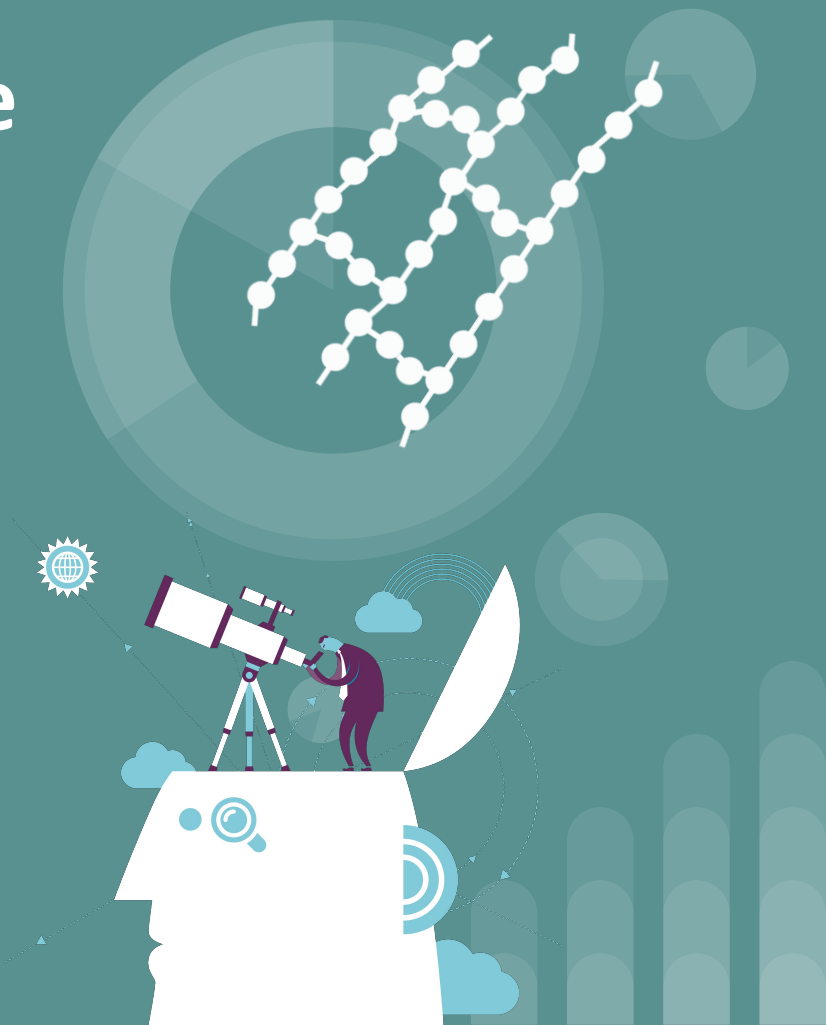
# HOW?

- Research into literature
- Starting point
- Change and/or add
- **CCM-SLAM**
  - **Centralized Collaborative Monocular**

# Multi-UAV Collaborative Monocular SLAM

Patrik Schmuck and Margarita Chli  
Vision for Robotics Lab, ETH Zurich

2017 IEEE International Conference on  
Robotics and Automation (ICRA)





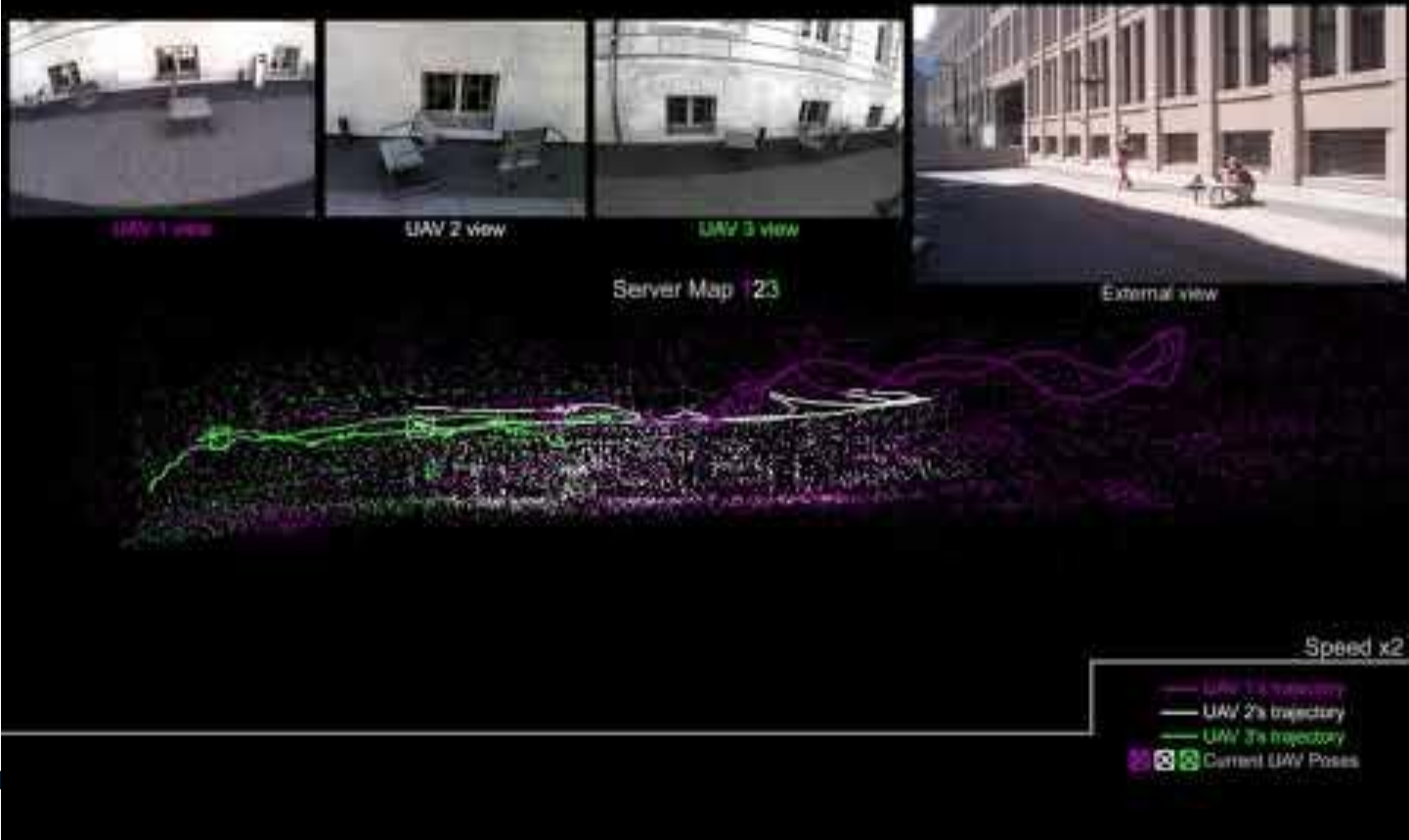
# Context & motivation

- Collaborative monocular visual SLAM
  - Really collaborative
- Centralized architecture
  - Efficiently used

# Key attributes

- Fully visual
- Expensive tasks run by server
- Information sharing
- ROS

# Video experiments



The diagram illustrates the system architecture, showing the interaction between multiple agents and a central server.

**Agents:**

- Agent 1:** Includes a camera input, a VO (Visual Odometry) module, a Local Map, and a Communication module. It exchanges KF (Keyframe) and MP (Map Point) data with the server's Agent Handler 1.
- Agent 2,...,x:** Similar structure to Agent 1, with a camera input, VO module, Local Map, and Communication module, interacting with the server's Agent Handler 2,...,x.

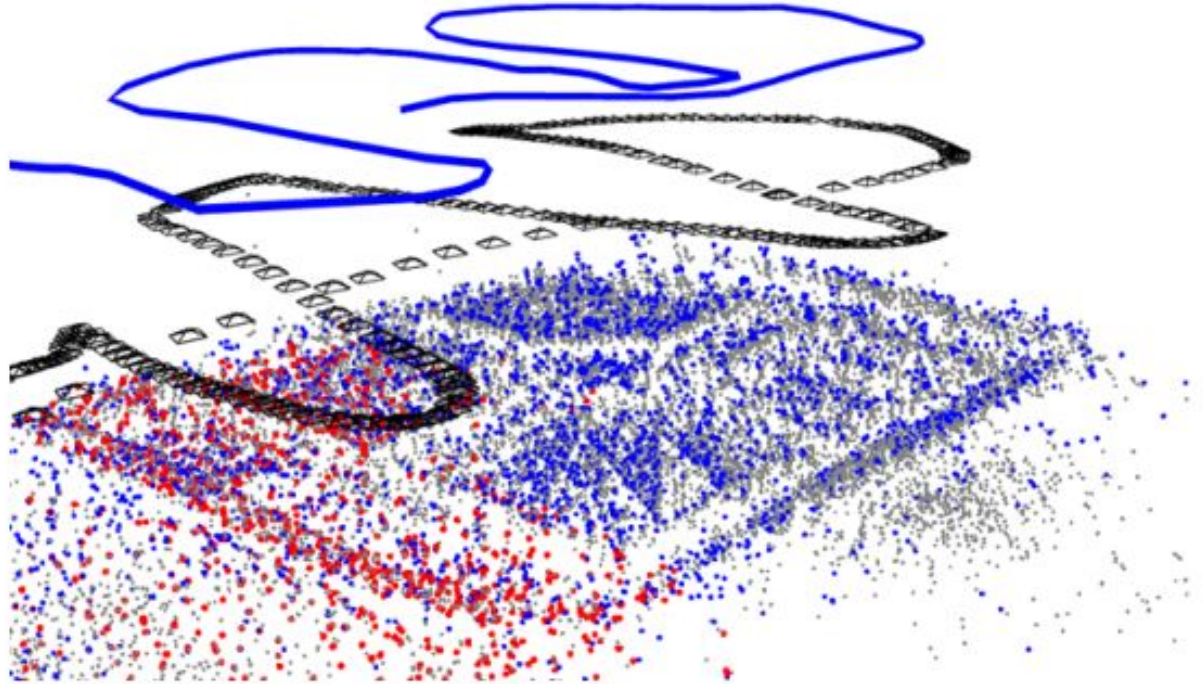
**Server:**

- Agent Handler 1:** Contains a Communication module and an Intra-Map Place Rec. module. It receives KF and MP data from Agent 1 and sends KF data to the Inter-Map Place Rec. module.
- Agent Handler 2,...,x:** Receives data from Agent 2,...,x and sends data to the Inter-Map Place Rec. module.
- Data Structures:** Includes a Global Map Stack and a Place Recognition Database. The Global Map Stack receives KF and MP data from the Agent Handlers and sends KF data to the Inter-Map Place Rec. module.
- Inter-Map Place Rec.:** Receives KF data from the Agent Handlers and the Global Map Stack, and sends data to the Map Fusion module.
- Map Fusion:** Receives data from the Inter-Map Place Rec. module and sends data to the Global BA module.
- Global BA (Bundle Adjustment):** Receives data from the Map Fusion module and sends data to the Place Recognition Database.
- Optimization:** The Global BA module optimizes the map(s).

# EXPERIMENT: 4 UAVs, outdoors



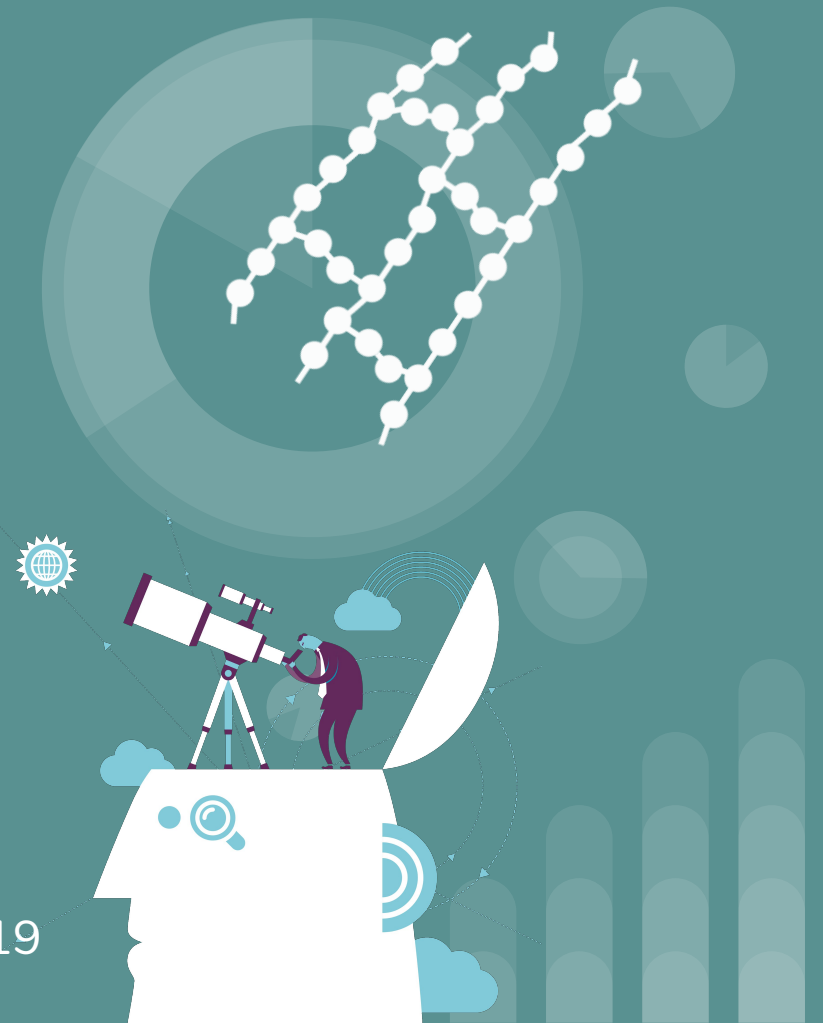
(a) Small park



# Monocular SLAM for Drone Swarms

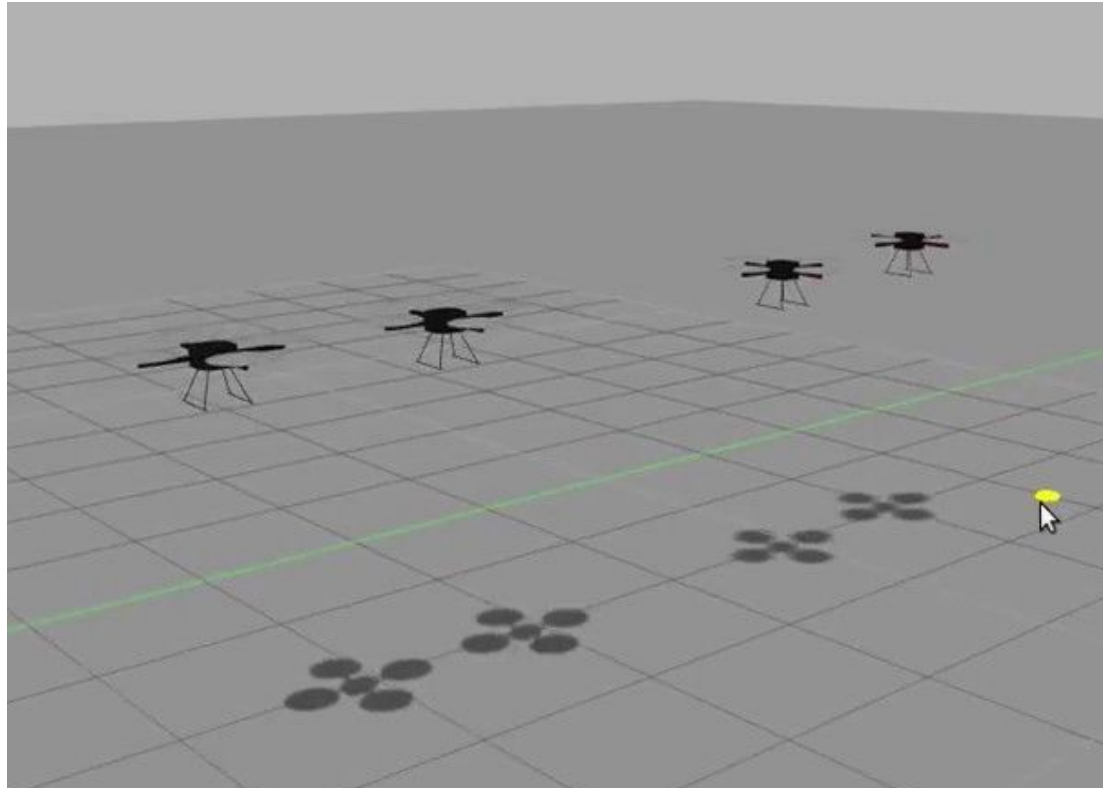
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# SIMULATION

- (and maybe later HW)
- ROS + Gazebo
- More experiments
- More flexibility

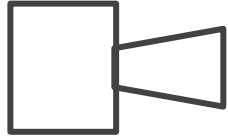
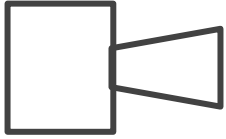


# How to improve on SoA?

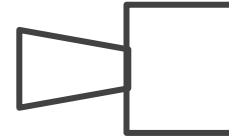
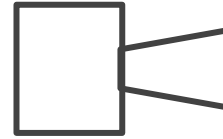
- Map fusion when:
  - **CCN**: location recognized (visual features)
- **Thesis**: add *drones seeing each other*
  - Improve location of seen drone?
  - Fuse map when drone seen?



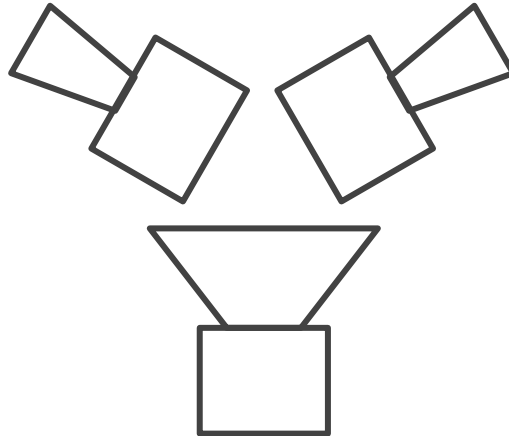
# Formations?



a



b



c

# Research questions:

- SLAM having agents see each other? Improve?
- Better add information on location or map fusion?
- Which formations give better results?
- Transferable to HW?

# Progress

- Many to learn and research:
  - ROS
  - Gazebo
- Now:
  - setting the environment
  - connecting CCM to Gazebo
- Next → Test CCM & my additions

# THANK YOU FOR YOUR ATTENTION!!!

Marina Sofia Garcia Perez

20th Nov 2019

