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Unmanned Aerial Vehicles Technologies State-of-the-art

Where are we?

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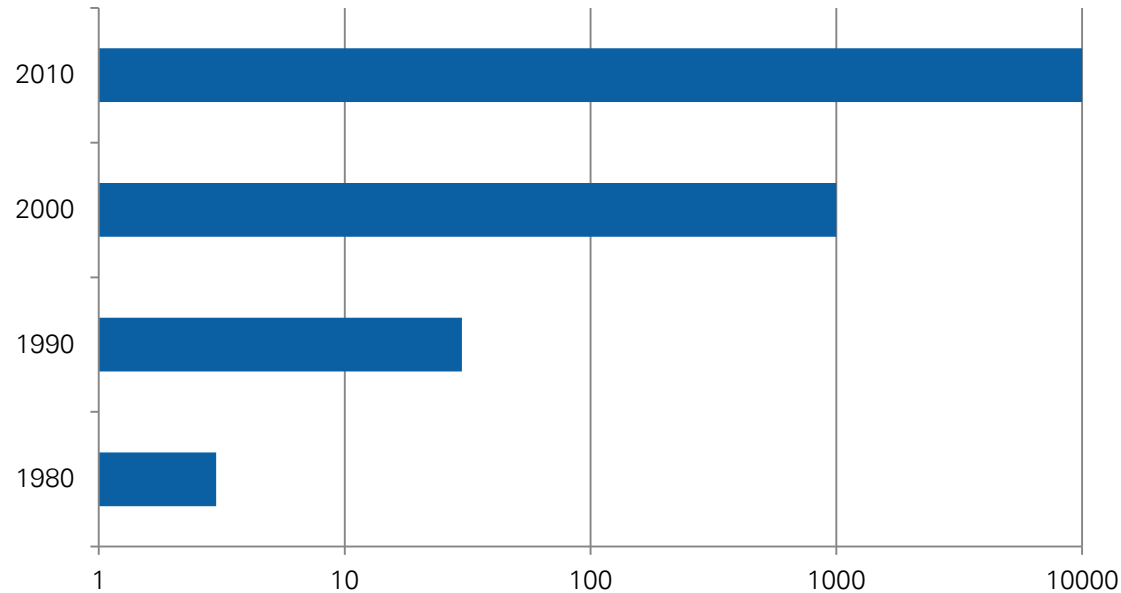
Agenda

- Facts and Figures
- Technologies
 - Intro: Size does Matter and First Response
 - Dynamics, Control and Planning
 - State Estimation (Autonomy)
 - Swarm technology

Facts and Figures

Unmanned Aerial Vehicles

- Number of UAVs worldwide



- > \$10B industry
 - Military: Surveillance, force protection, warfare (> 75 countries)
 - Civilian commercial: Transport, environment
 - Civilian private: DIY Drones

More and more articles



droneassociation.ch

How Drones Are Changing the Way We Do Business



BY NINA ZIPKIN | March 3, 2014 | 3 Comments | Clip it



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image credit: senseFly

BUSINESS UNUSUAL

Creativity has rebooted business. Discover how through this ongoing series featuring unique products, services and technologies, as well as the personalities who have turned their dreams into our realities.

These days, if you're looking for drones, you don't have to look far. Also called unmanned aerial vehicles, these devices are being adapted from government to private use as tour guides and high-tech couriers. They're even finding their way onto film sets and archaeological digs. If Amazon has anything to do with it, we'll soon see them on our doorsteps.

It's a growing industry that expects sweet to explode. In a report released this summer, the FAA

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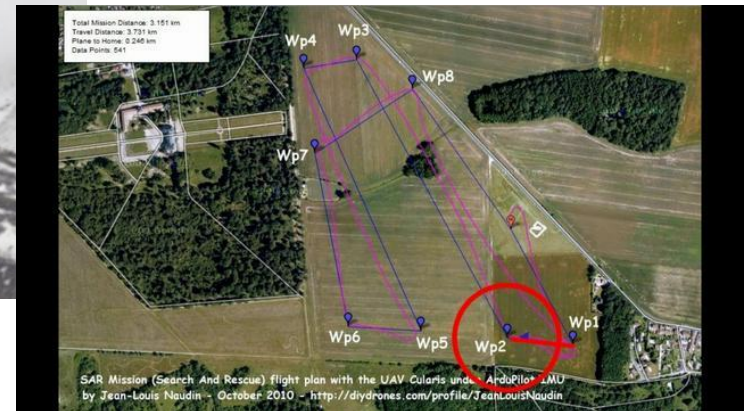
More and more startups growing here in Switzerland

DRONE
WITH ME


senseFly

Pix4D

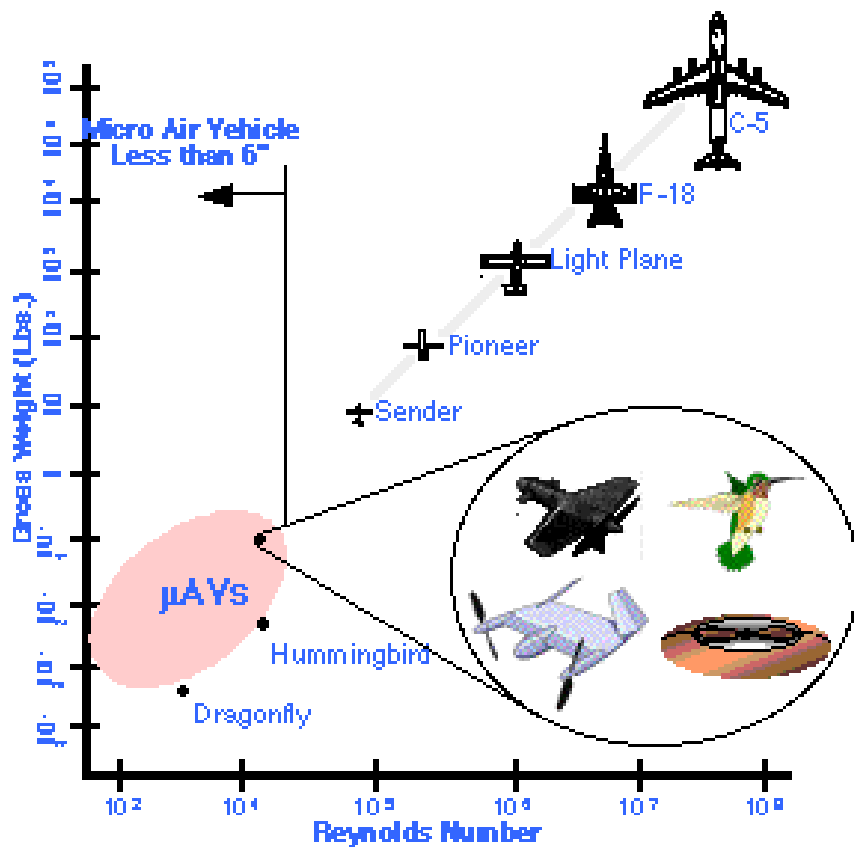
Search and Rescue



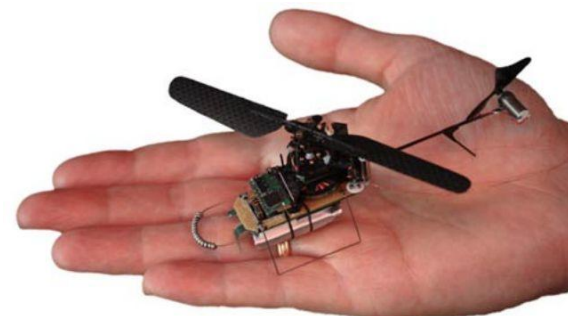
Security



Comparison



Micro drone



Black Hornet nano drone

Technologies

Technologies

Intro

Size does Matter



Linear Acceleration

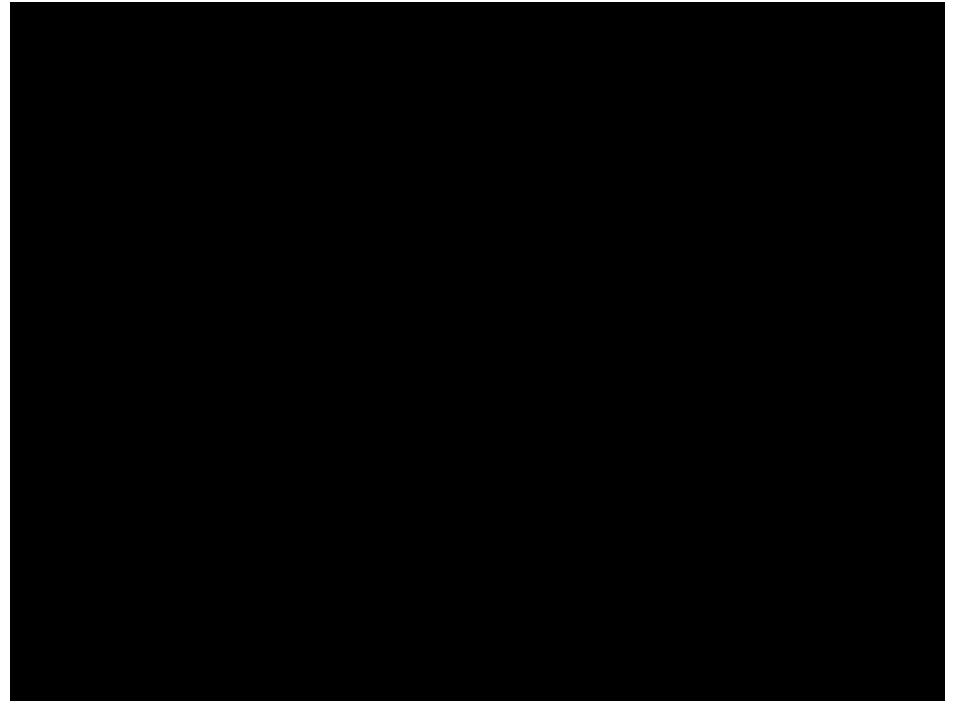
$$\sim 1/R$$

Angular Acceleration

$$\sim 1/R^2$$

First response

- Operate indoors and outdoors
- No GPS
- Small, maneuverable
- Agile, fast
- Operate in teams

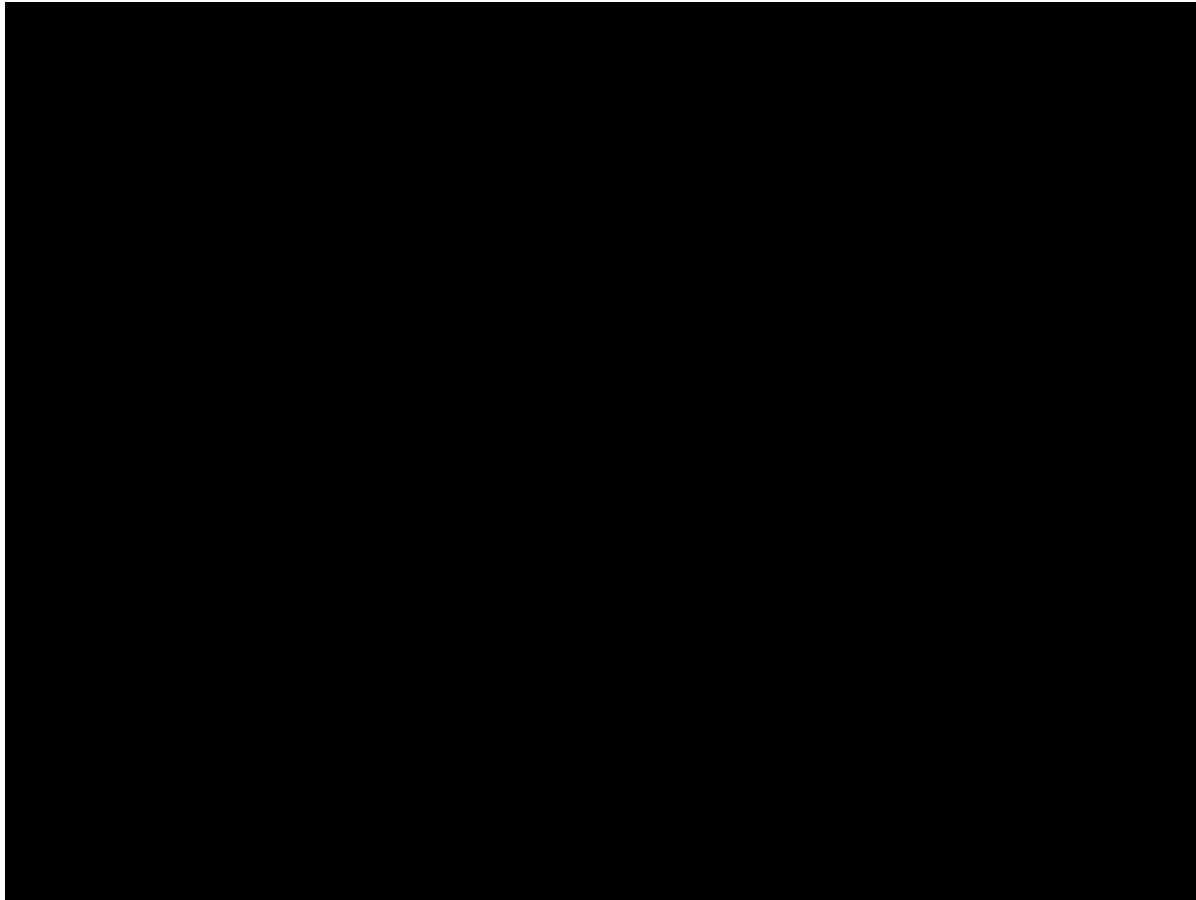


Technologies

Technologies

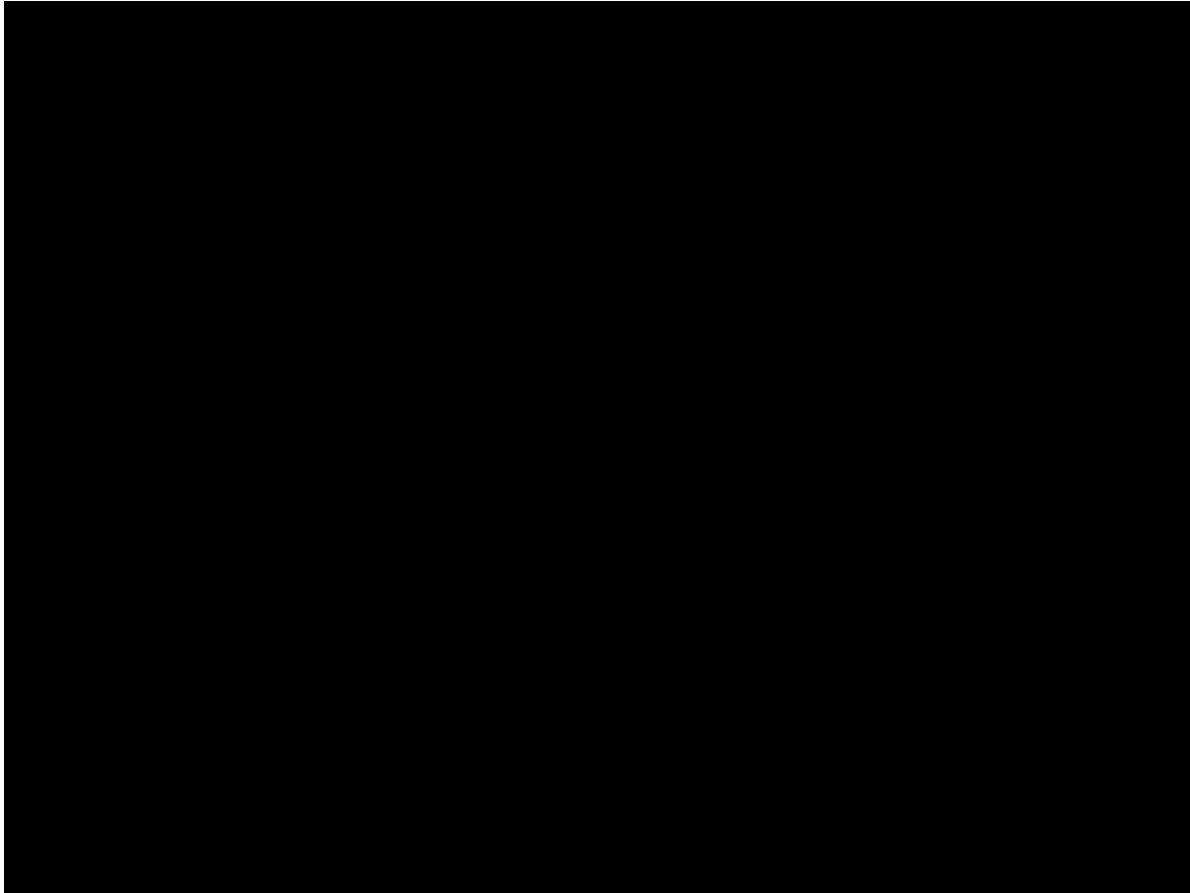
Dynamics, Control and Planning

Agressive Maneuvring / Minimum Snap Trajectory



Mellinger and Kumar, ICRA 2011

Real-Time planning

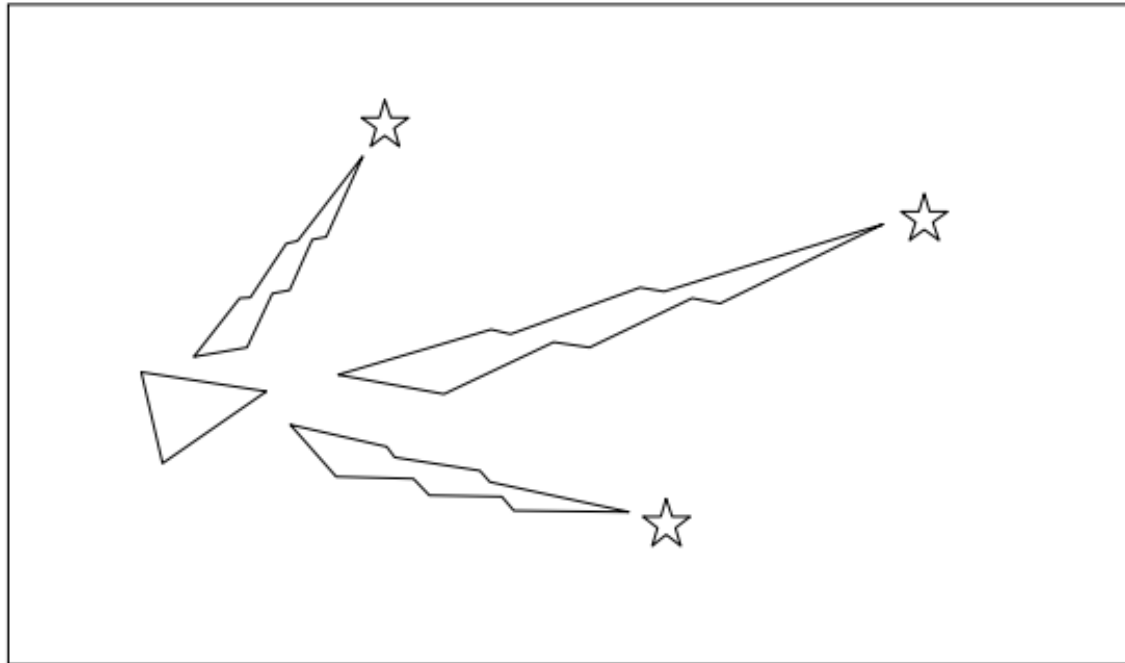


Mellinger and Kumar, ICRA 2011

Technologies

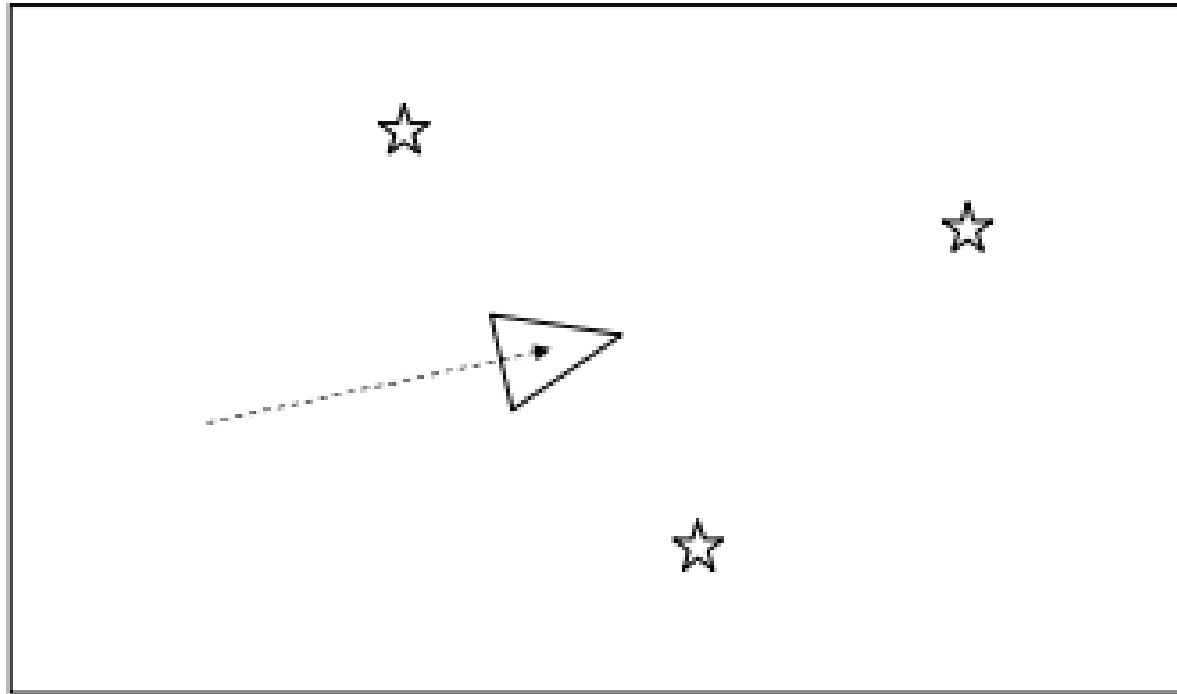
State Estimation

Simultaneous Localization And Mapping (SLAM)



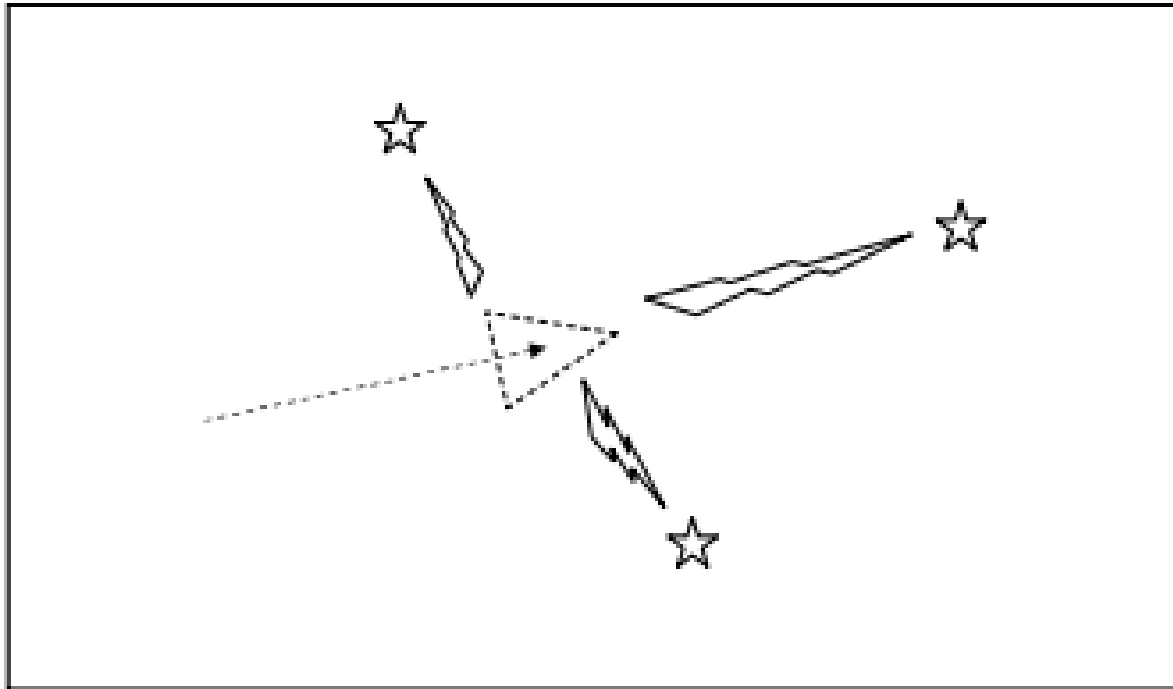
Søren Riisgaard and Morten Rufus Blas

Simultaneous Localization And Mapping (SLAM)



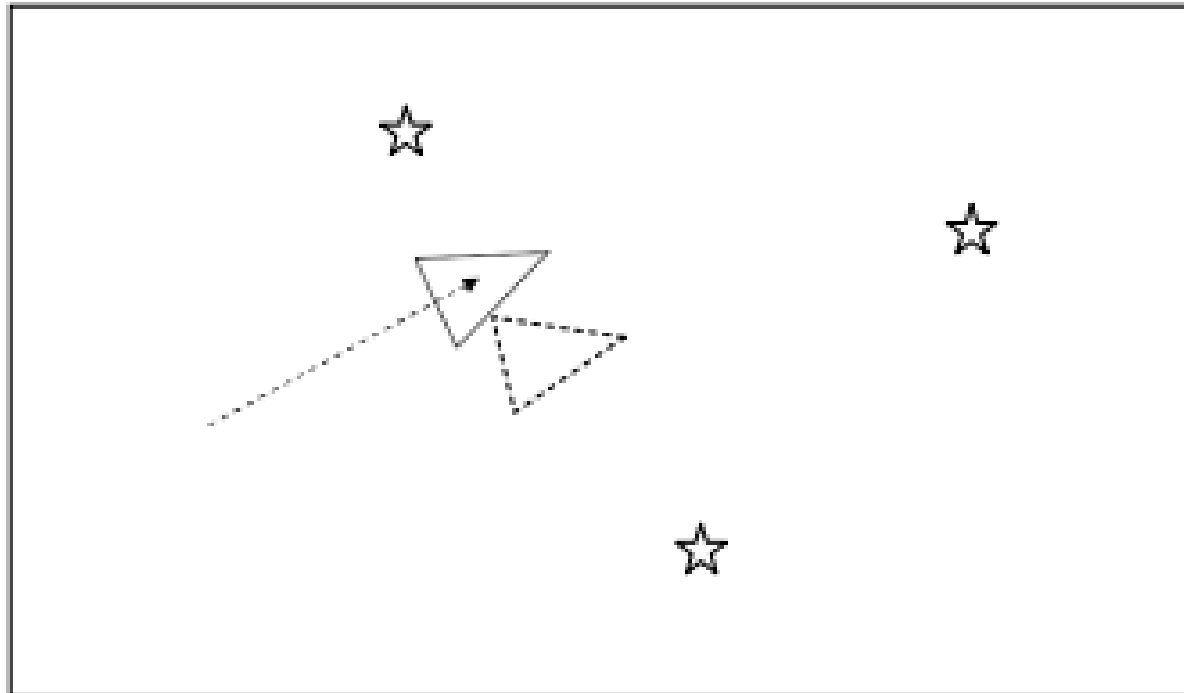
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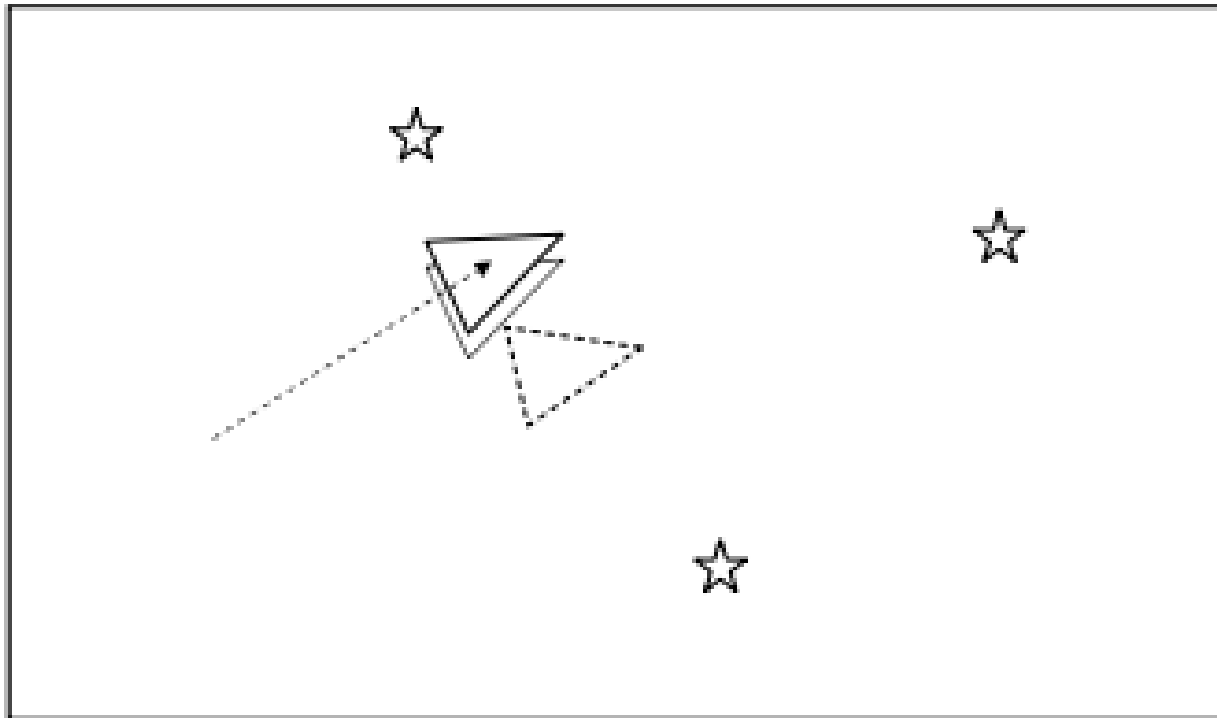
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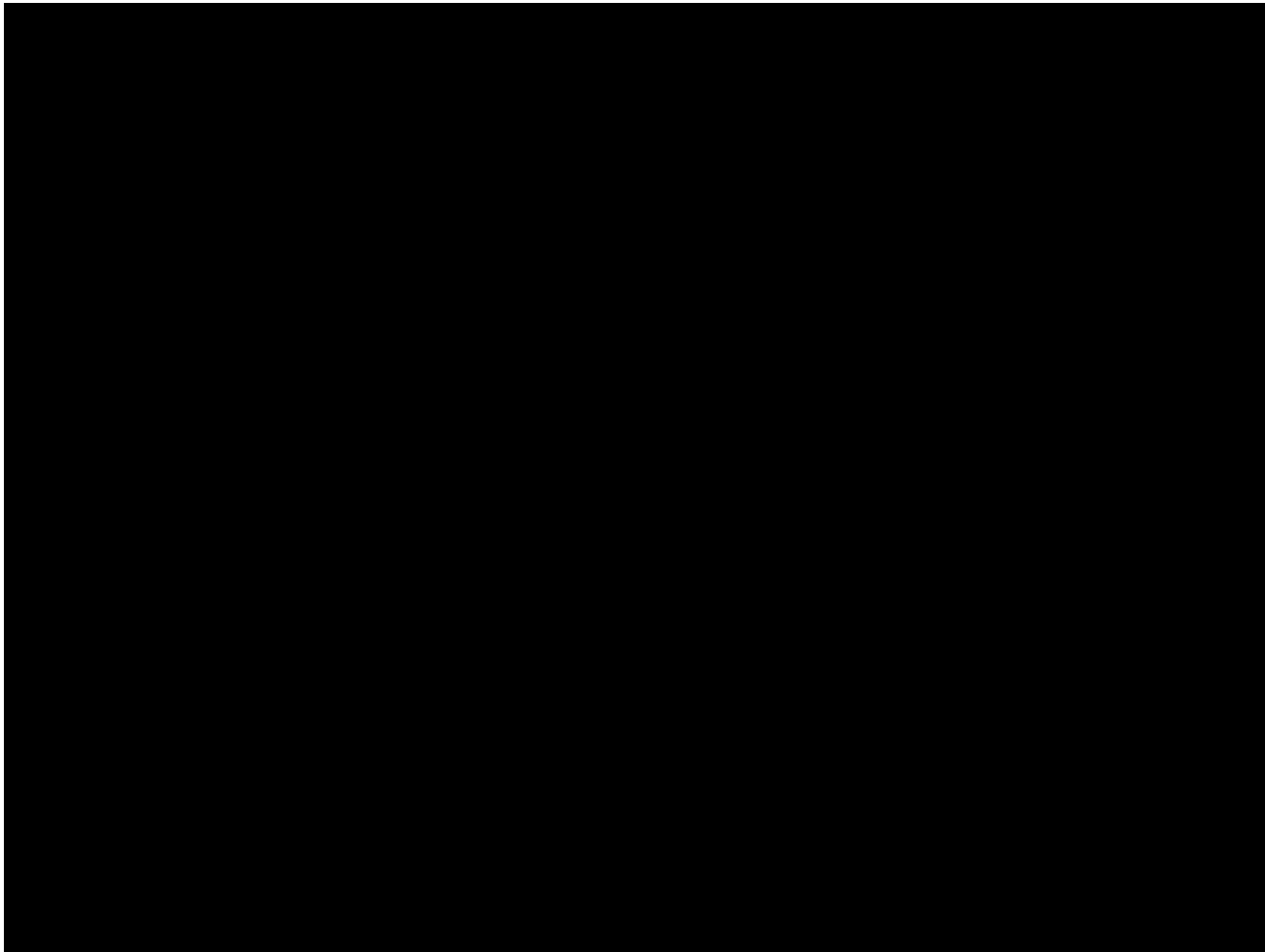
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Simultaneous Localization And Mapping (SLAM)



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Onboard State Estimation



Korbinian Schmid and Haiko Hirschmüller

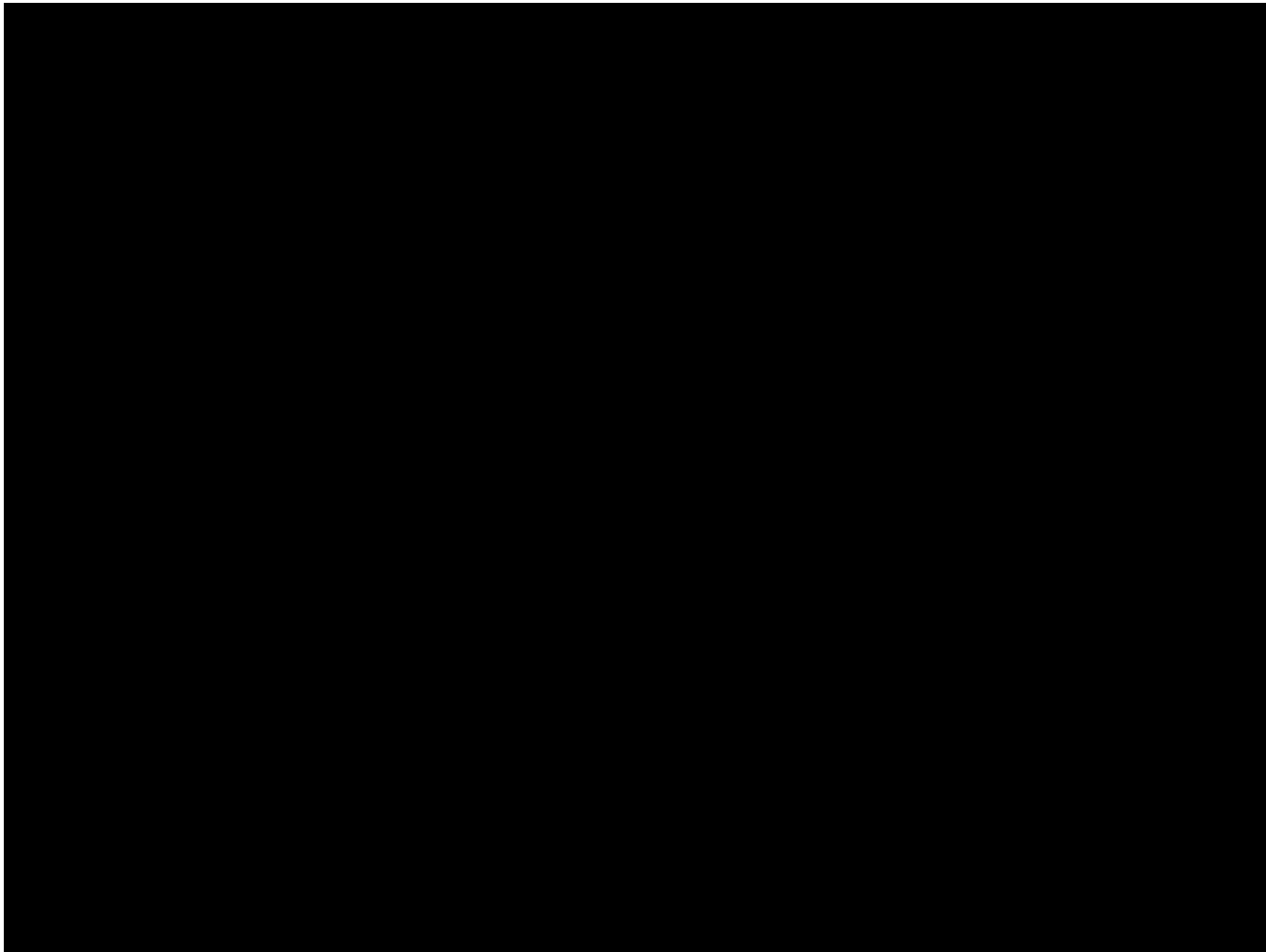
Technologies

Swarm Technology

Swarm technology

- Act independently
- Require only local information
- Anonymous behavior

Control of Formation Shape and Group Motion



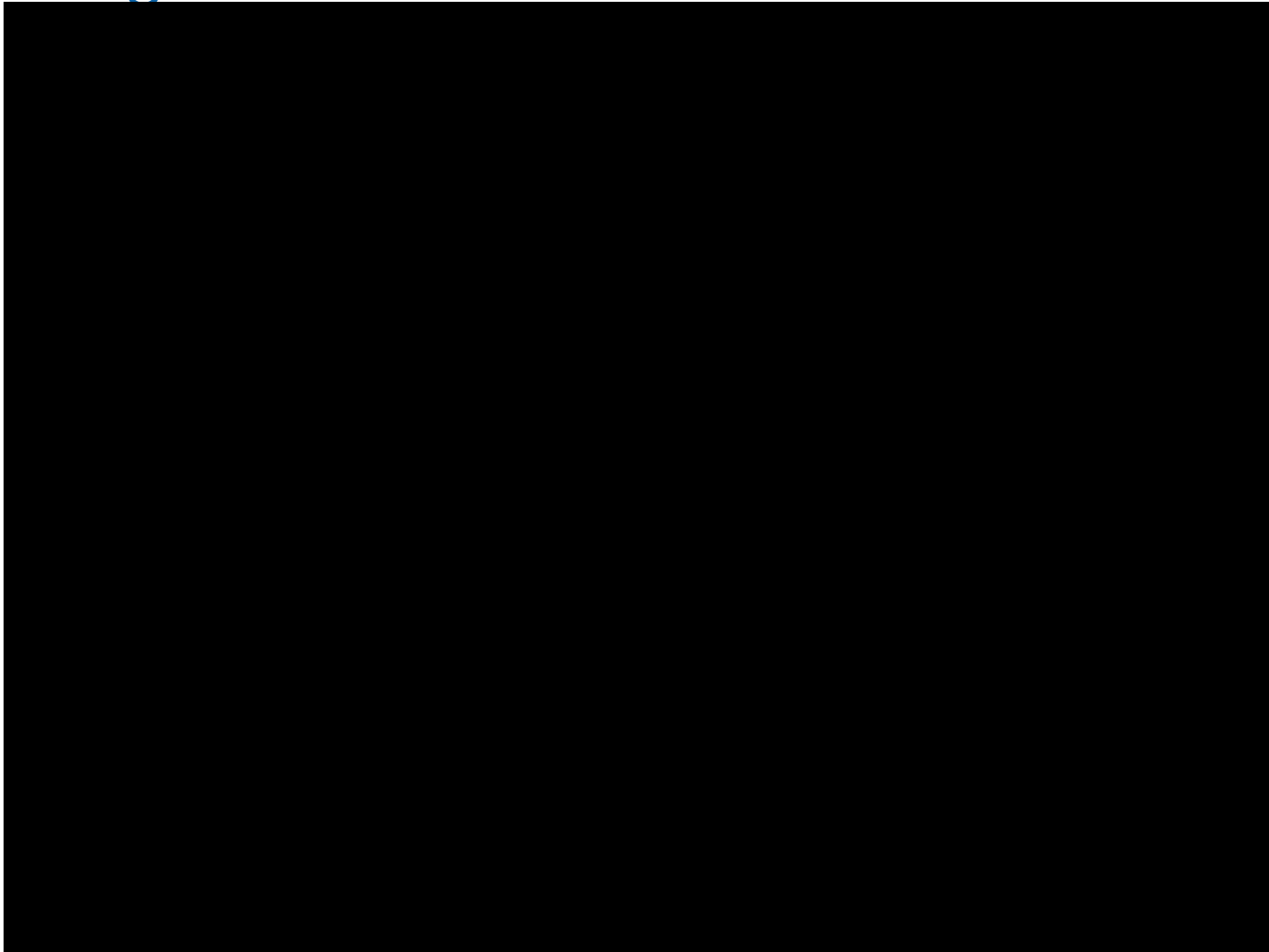
Kushleyev, Mellinger and Kumar 2012

Conclusion

Conclusion

- In the last two years flight controller consistency and reliability improved
- Cameras improved
- Batteries need to be improved

Amazing in Motion



Kmelrobotics / Lexus

Questions ?

