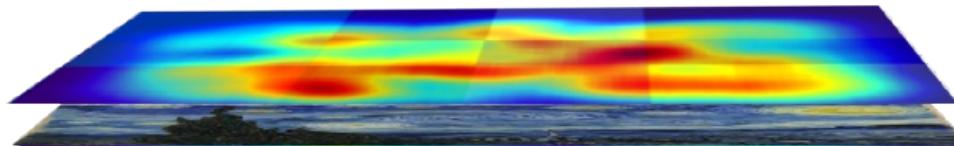


Machine Learning-based Indoor Localization for Micro Aerial Vehicles



Volker Strobel
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14th July 2016

Radboud Universiteit

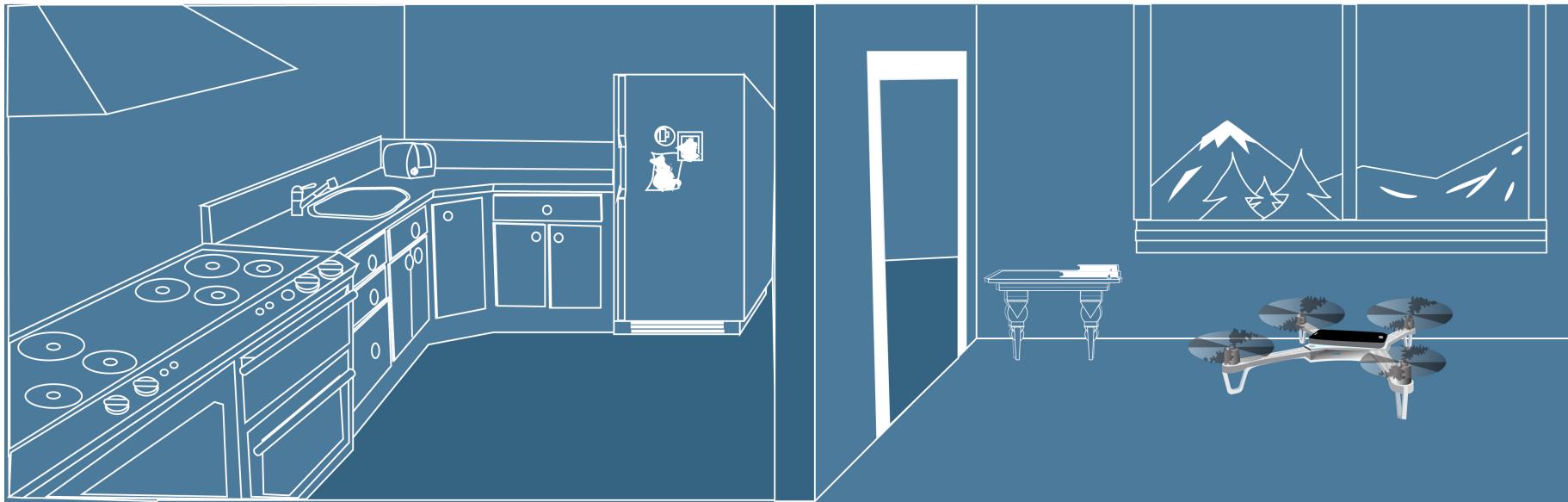


Louis Vuurpijl

TU Delft Delft
University of
Technology

Guido de Croon
Roland Meertens

MOTIVATION



MOTIVATION

Research Question

Can accurate indoor localization be done on a very limited platform?

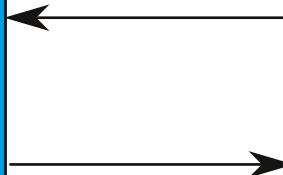
RESEARCH QUESTIONS

Research Question 1

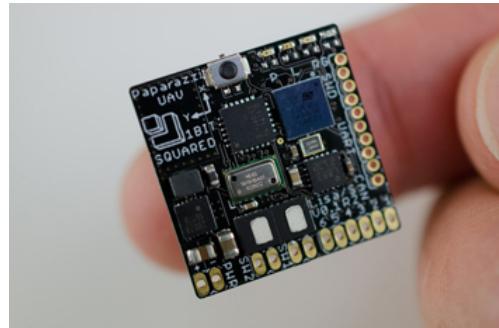
**Can accurate indoor
localization be done on a very
limited platform?**

Research Question 2

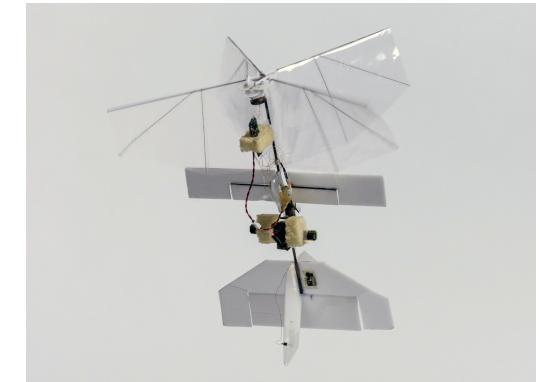
**Can we predict the suitability
of a given map for the
proposed localization
algorithm?**



Micro Air Vehicle Lab



Miniaturization



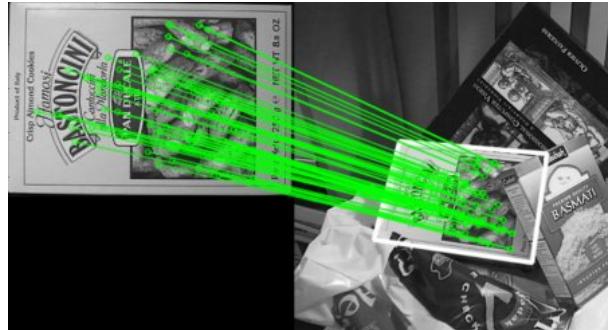
OUTLINE

- Existing Methods
- Machine Learning-based Approach
- Simulations & Flight Tests
- Discussion & General Discussion
- Conclusion & Future Work

OUTLINE

- Existing Methods
- Methods
- Experiments and Results
- Discussion
- Conclusion

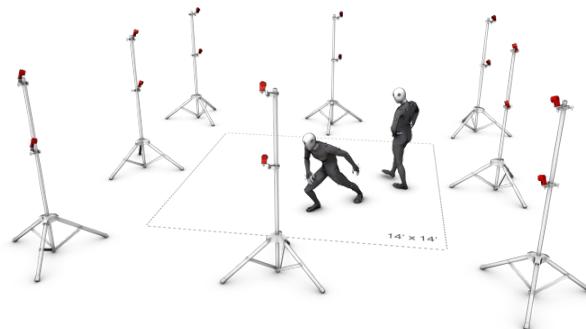
METHODS FOR INDOOR LOCALIZATION



SIFT + homography finding

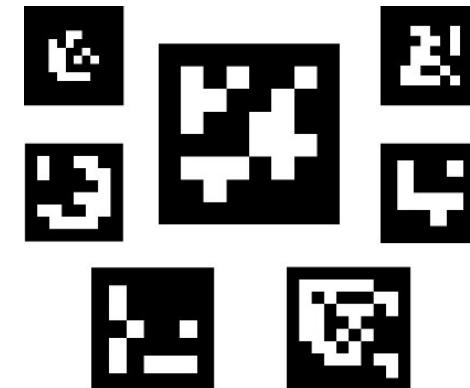


Laser range finder



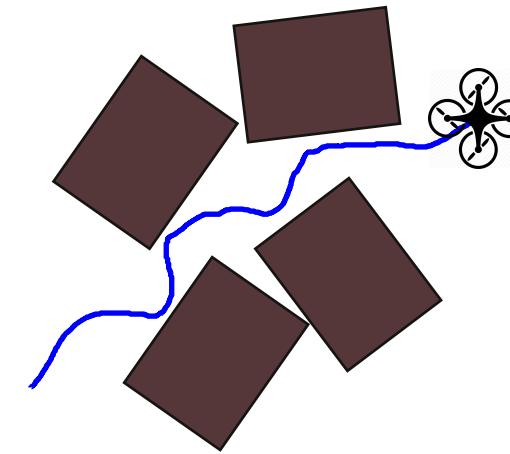
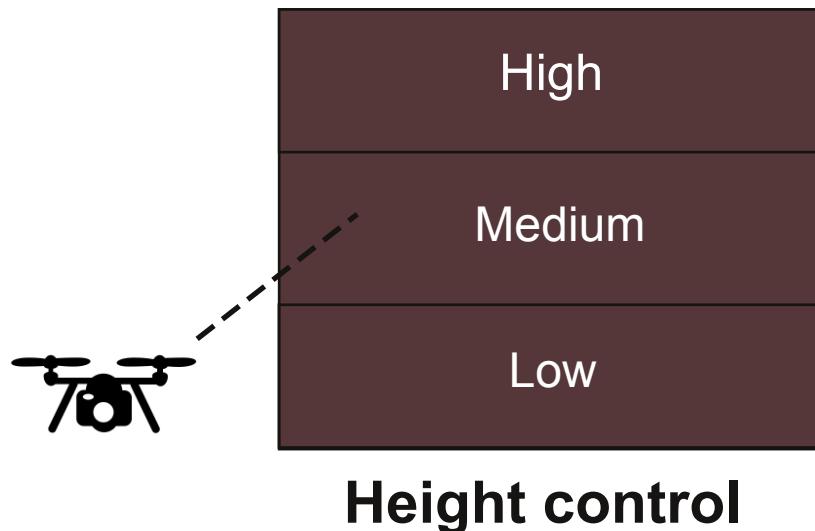
Visual odometry
(acumulating
error)

Motion tracking system

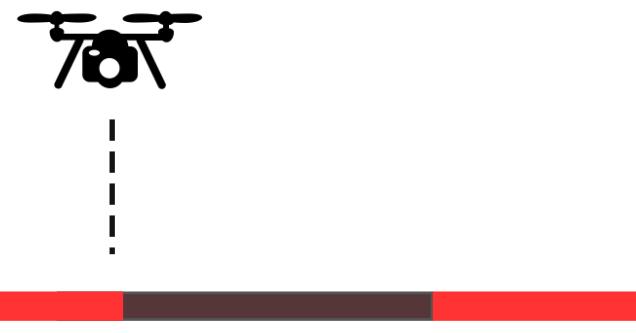


Markers

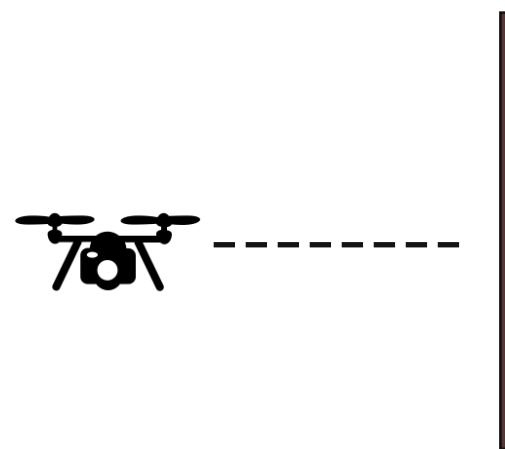
FOUNDATION



Obstacle Avoidance



Safe Landing Spot Detection



Distance Measurement

CHALLENGES / CONTRIBUTIONS

Low-performance platform



Low-level embedded
programming (C)

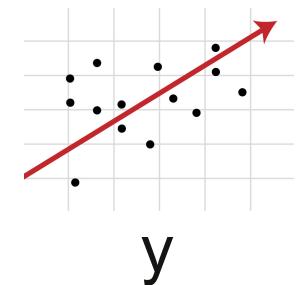
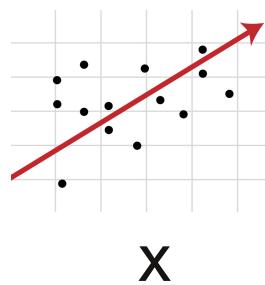


Ground truth estimation

x?
y?

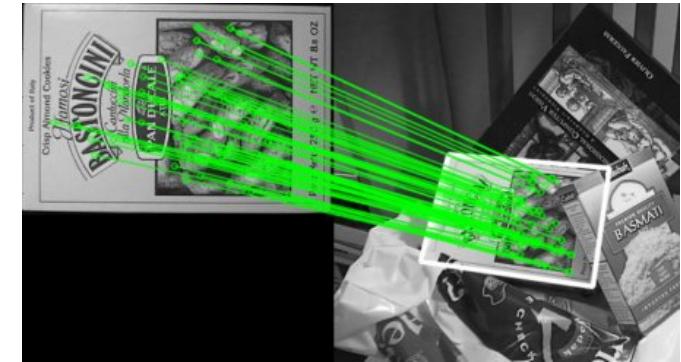


Regression with 2 dependent
variables



APPROACH

Flight phase

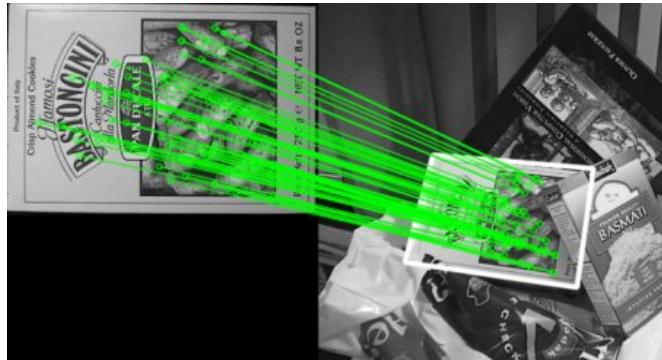


1 sec / Image

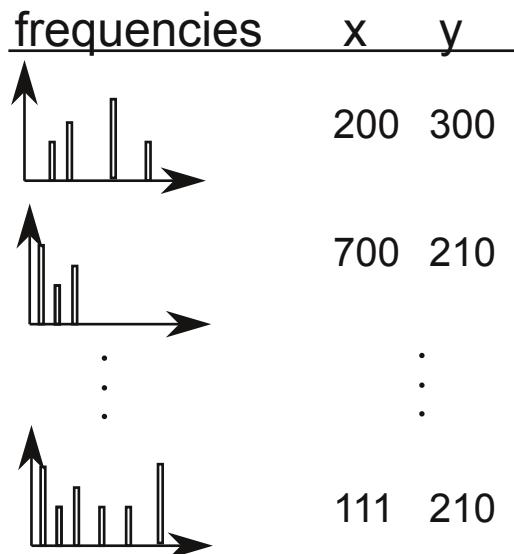


IDEA

Preflight phase

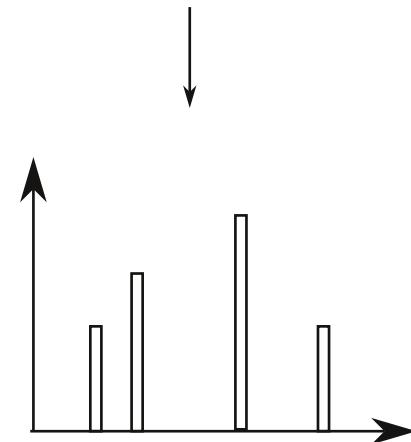


Training Data



(computational)
effort

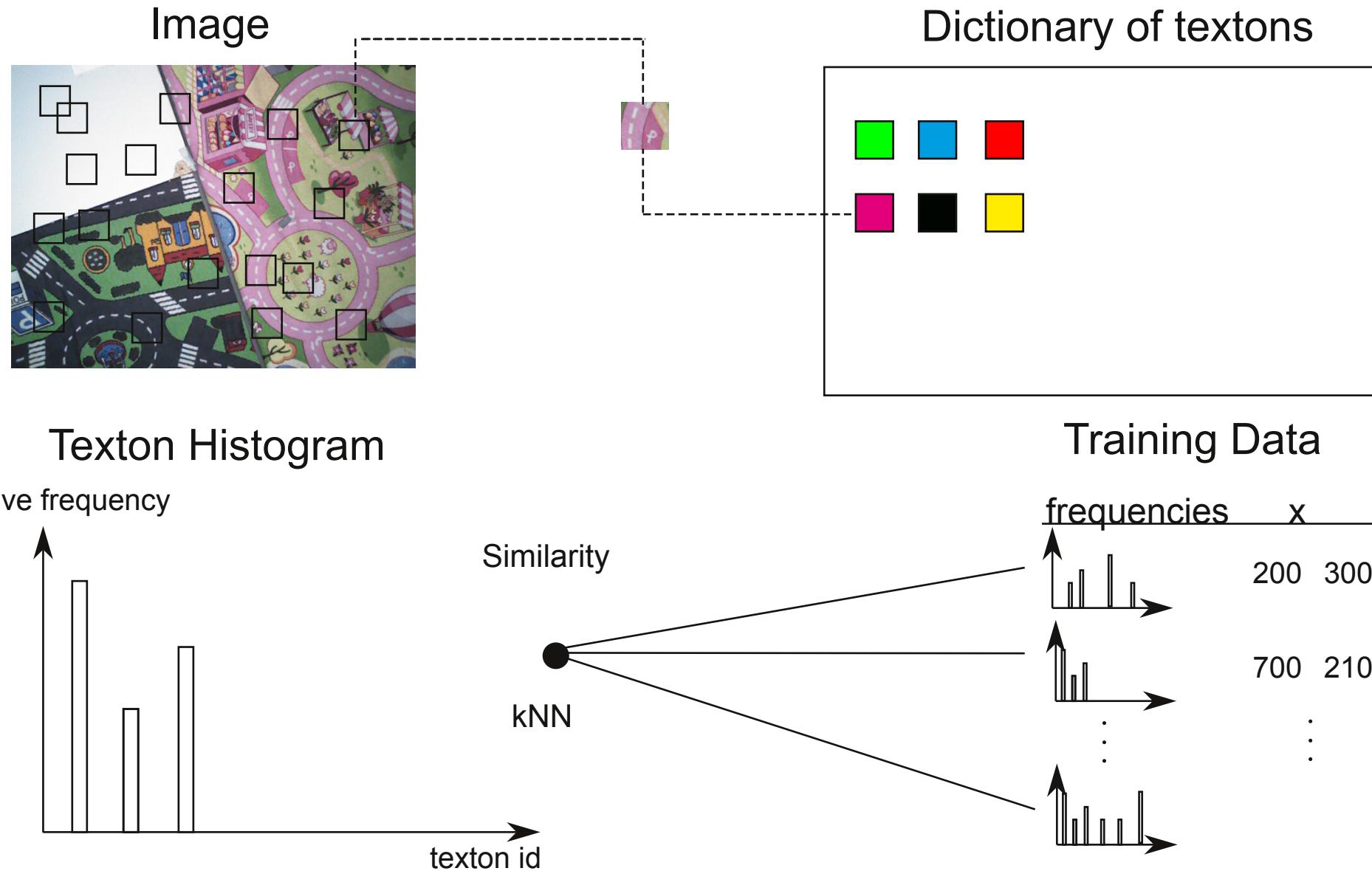
Flight phase



OUTLINE

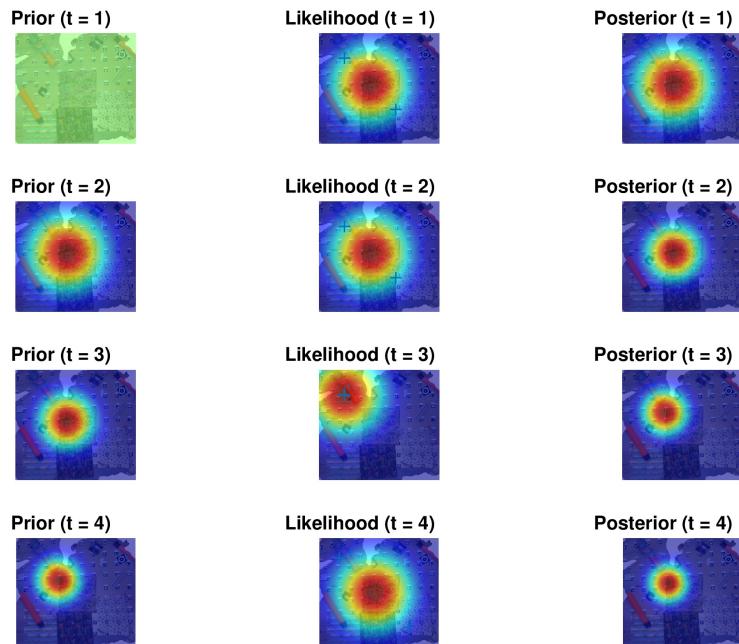
- Related Work
- Methods
- Experiments and Results
- Discussion
- Conclusion

MACHINE-LEARNING APPROACH

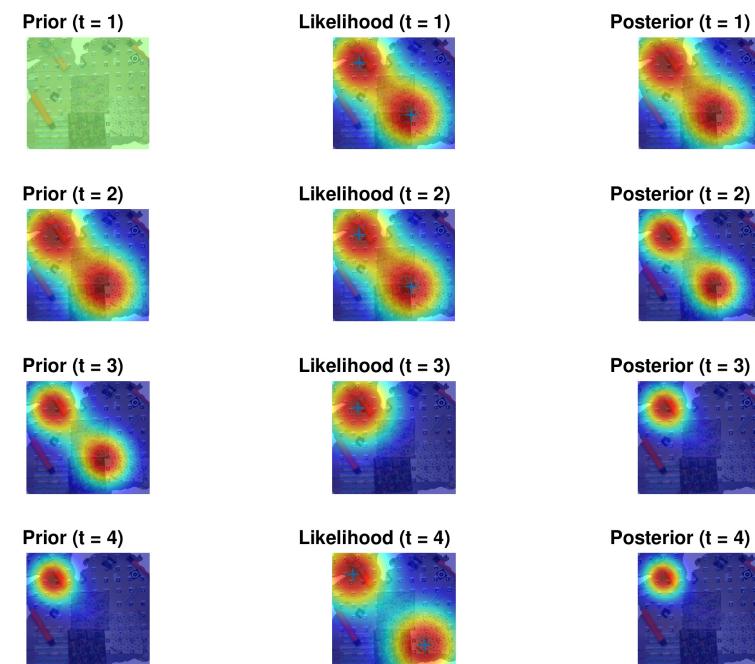


FILTERING

Kalman Filter



Particle Filter



FILTERING

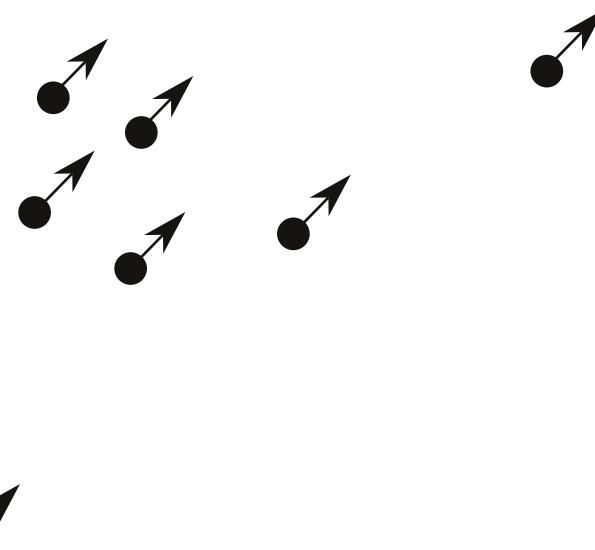
Particle Filter

Sensor model

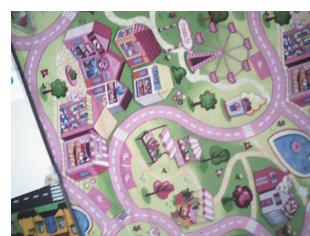
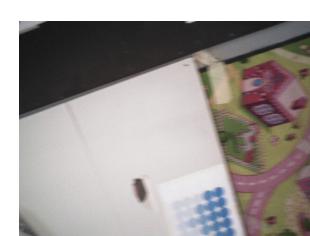
TODO

Motion model

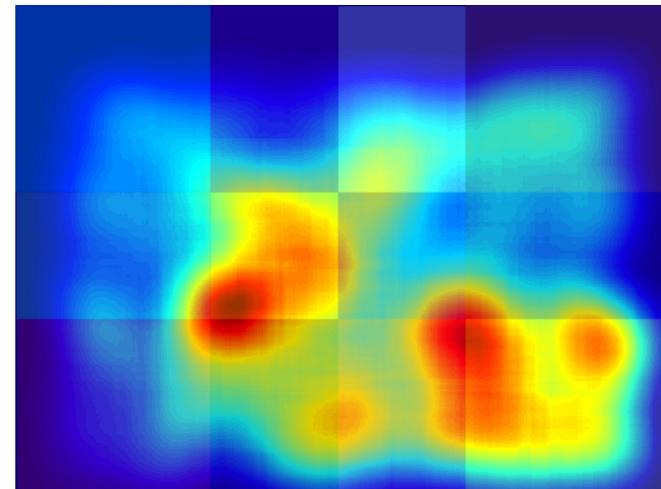
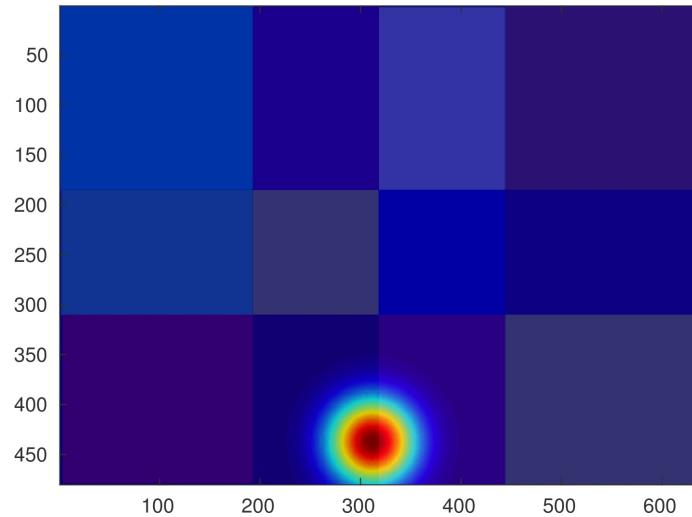
Determine optical flow and
add noise $\sim N(0, 10)$



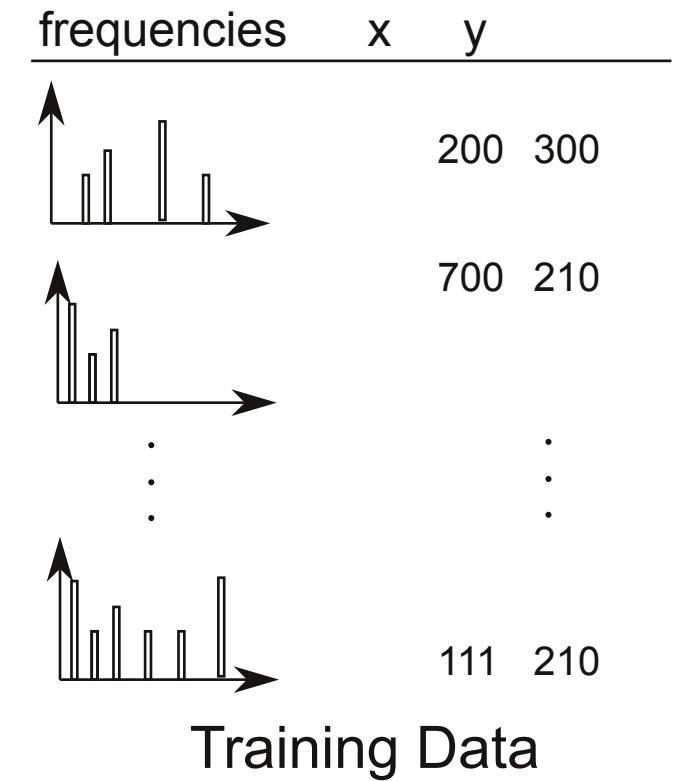
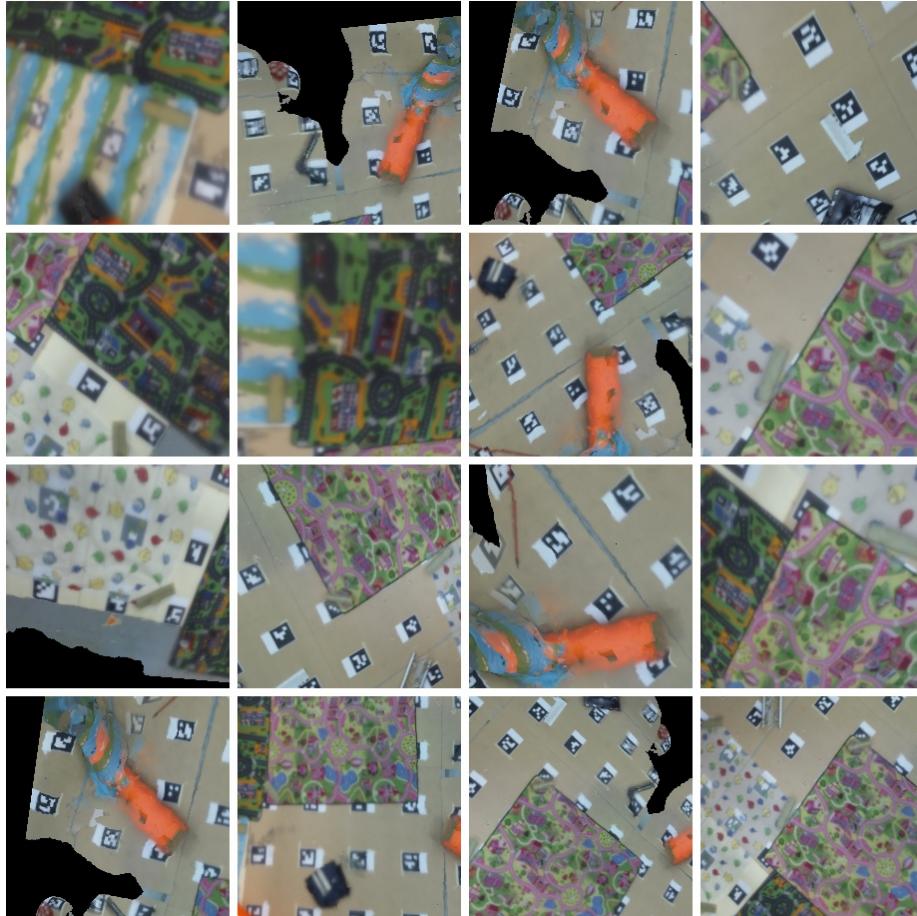
GROUND TRUTH ESTIMATION



MAP EVALUATION



SYNTHETIC FLIGHT



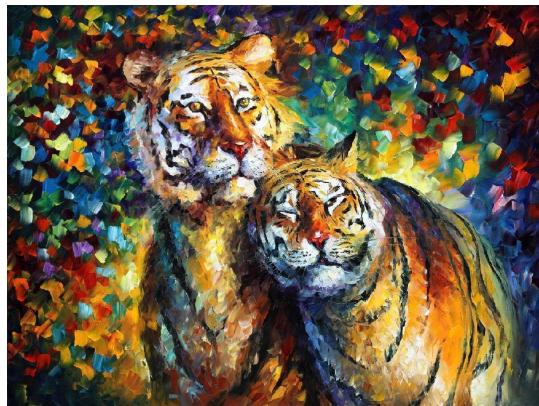
OUTLINE

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EXPERIMENTS

- Simulated flights
- Map evaluation
- Real-world Target Landing
- Real-world Navigation

MAP EVALUATION



MAP EVALUATION



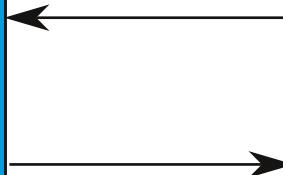
RESEARCH QUESTIONS

Research Question 1

Can accurate indoor localization be done on a very limited platform?

Research Question 2

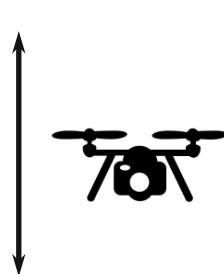
Can we predict the suitability of a given map for the proposed localization algorithm?



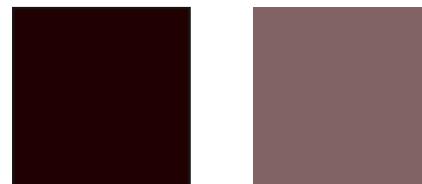
DISCUSSION

Limitations:

- assumes constant height and no rotations



- robustness to different lighting conditions



- Particle filter does not include velocity or heading

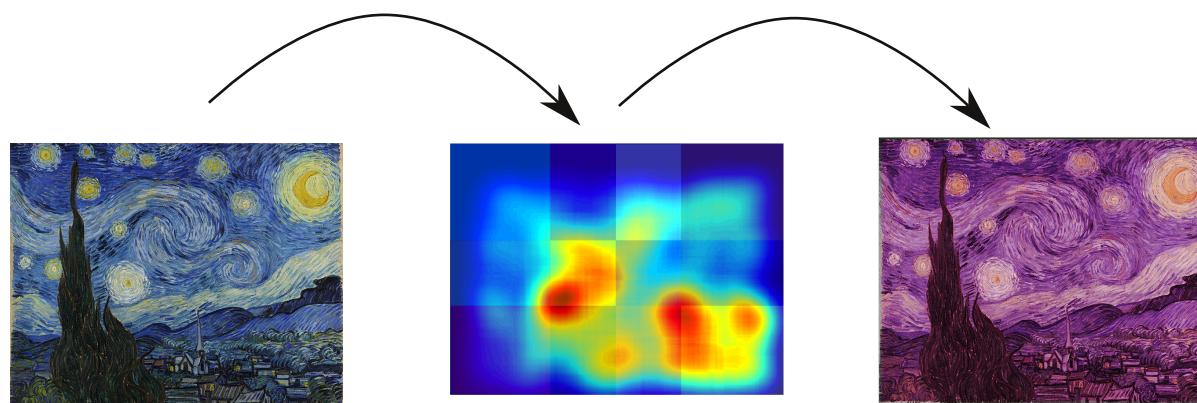
DISCUSSION

Future research:

- bridge reality gap



- automatic map generation (evolutionary algorithm)



CODE CONTRIBUTIONS

- Image augmentation with synthetic views (C++)

<https://github.com/Pold87/draug>

- Map evaluation (MATLAB)

<https://github.com/Pold87/evaluation-thesis>

- Localization: SIFT matching, particle filter, texton-based approach (C)

C: <https://github.com/Pold87/paparazzi>

Python: <https://github.com/Pold87/treXton>



CONCLUSION

EFFICIENT INDOOR LOCALIZATION

