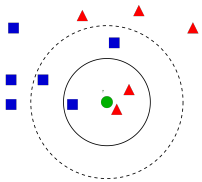


Machine Learning-based Indoor Localization for Micro Aerial Vehicles

Volker Strobel
volker.strobel87@gmail.com

27th July 2016

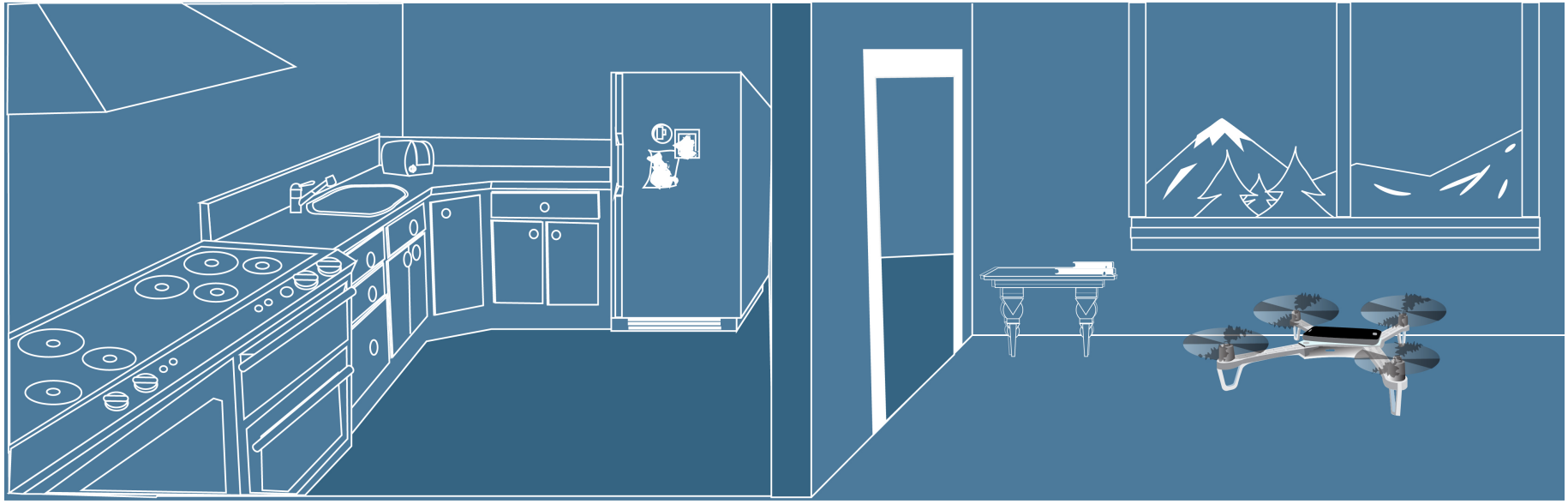
Radboud Universiteit

TU Delft Delft University of Technology

Louis Vuurpijl

Guido de Croon
Roland Meertens

MOTIVATION

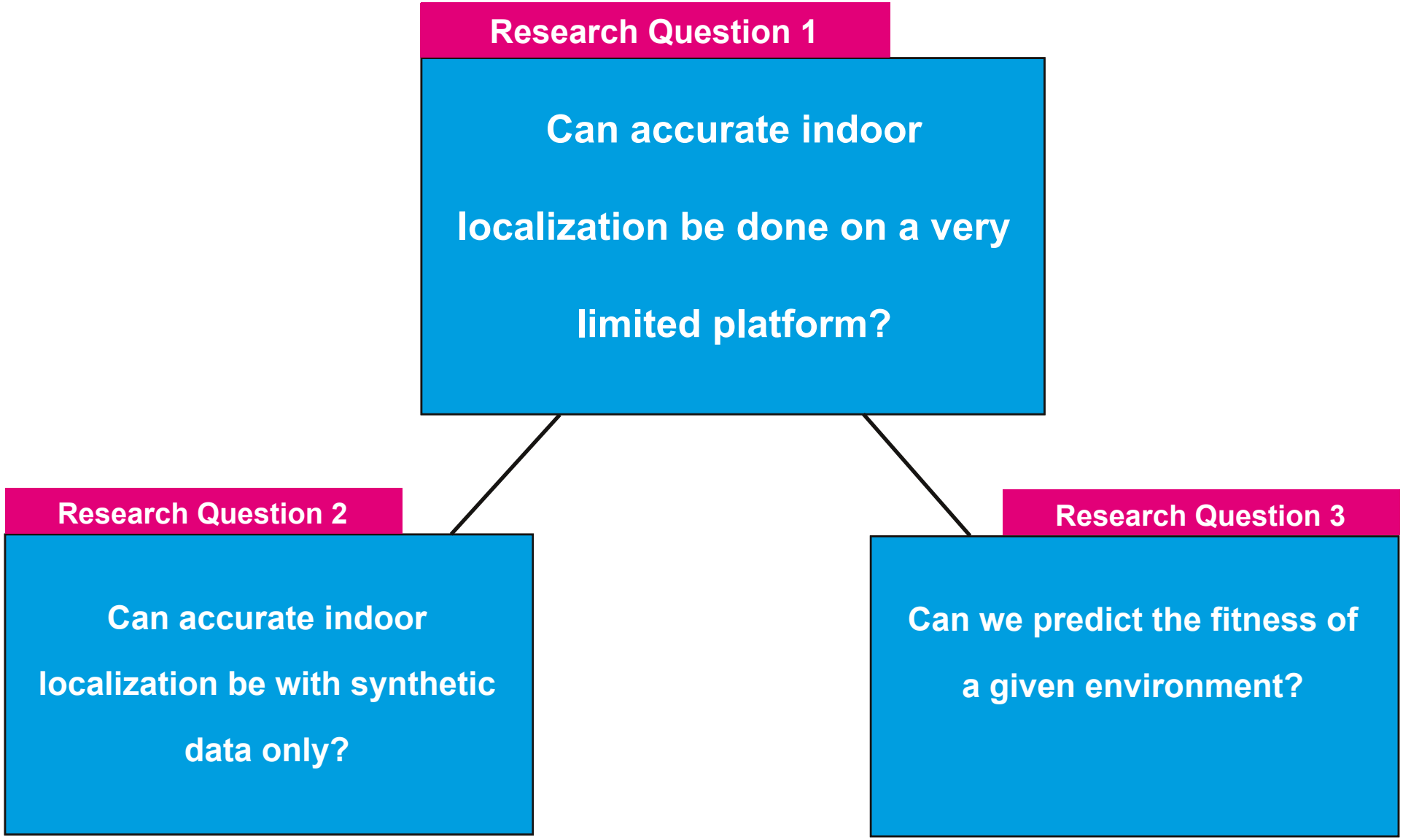


MOTIVATION

Research Question

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

RESARCH QUESTIONS



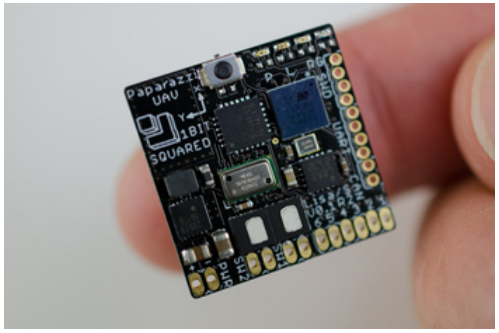
OUTLINE

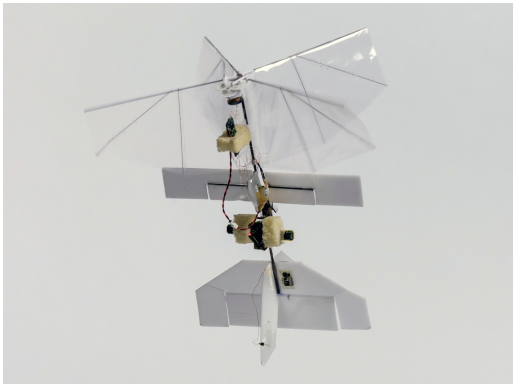
- Existing Methods
- Machine Learning-based Approach
- Flight Tests & Simulations
- Discussion & General Discussion
- Conclusion & Future Work

Micro Air Vehicle Lab

TU Delft Delft University of Technology

MAVLab™





Minituarization

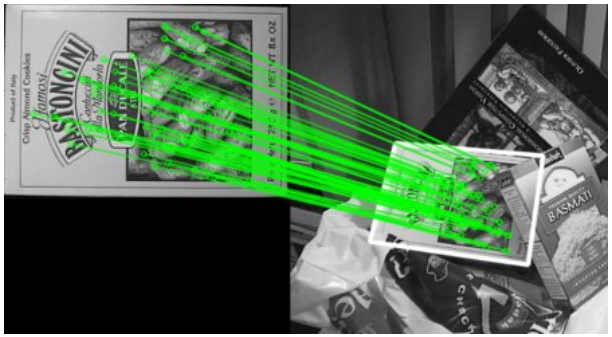
Radboud Universiteit

TU Delft Delft University of Technology

OUTLINE

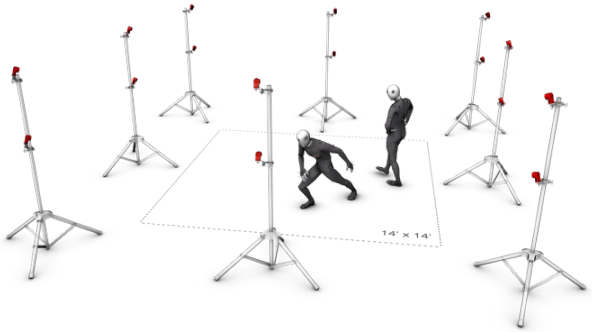
- Existing Methods
- Methods
- Experiments and Results
- Discussion
- Conclusion

METHODS FOR INDOOR LOCALIZATION

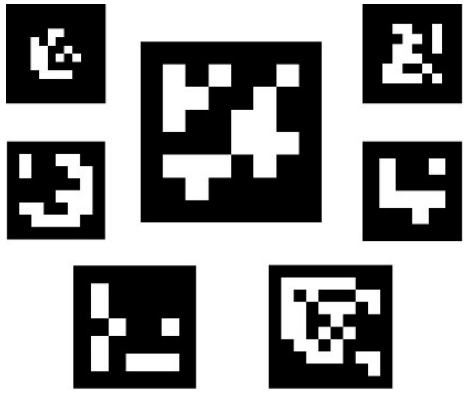


SIFT + homography finding

Laser range finder

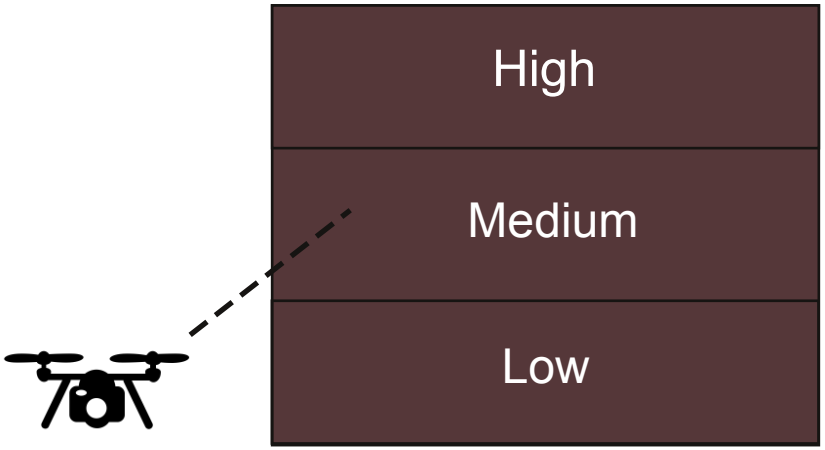


Motion tracking system

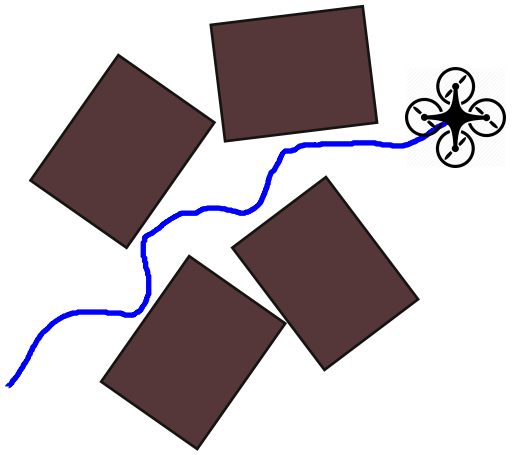


Markers

FOUNDATION

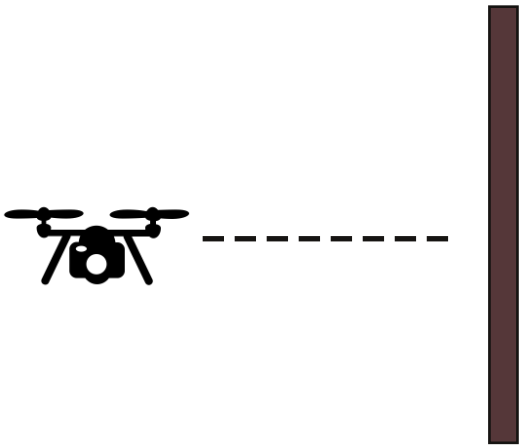


Height control



Obstacle Avoidance

Safe Landing Spot Detection



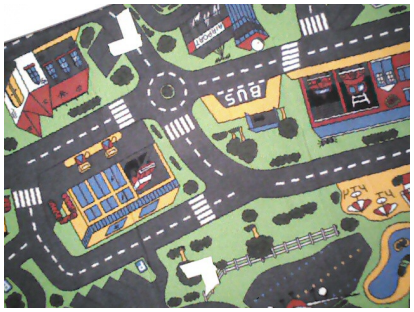
Distance Measurement

CHALLENGES / CONTRIBUTIONS

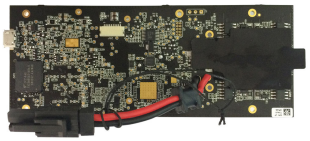
Low-performance platform

Ground truth estimation

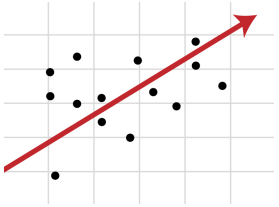
x?
y?



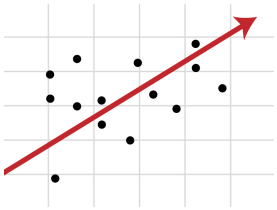
Low-level embedded programming (C)



Regression with 2 dependent variables



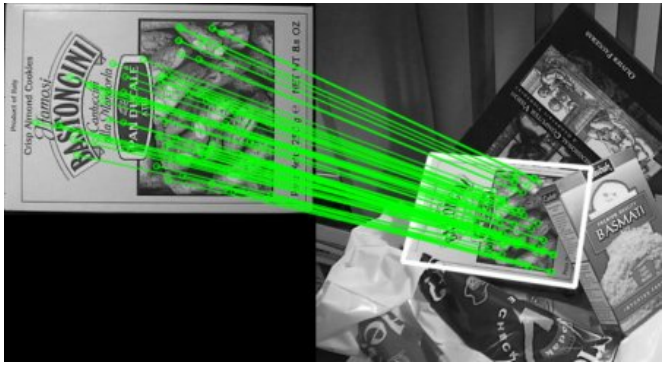
x



y

Approach

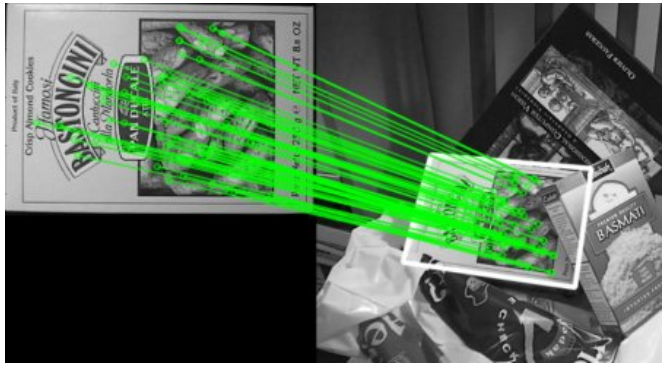
Flight phase



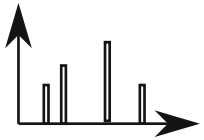
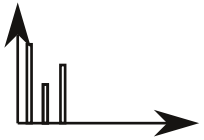
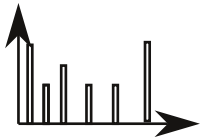
1 sec / Image

IDEA

Preflight phase

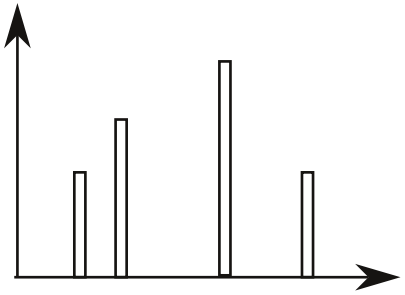


Training Data

frequencies	x	y
	200	300
	700	210
⋮	⋮	⋮
	111	210

(computational) effort

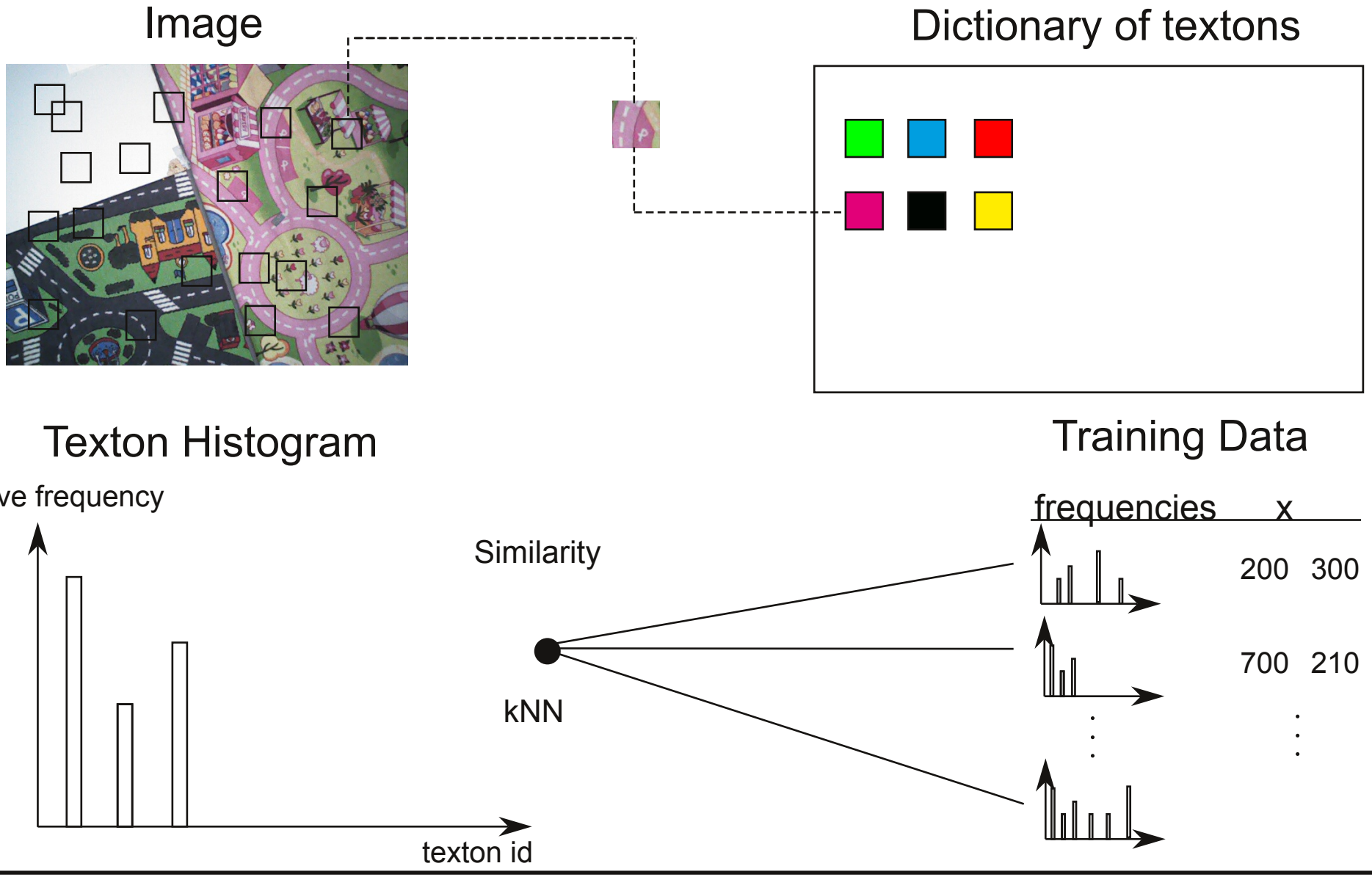
Flight phase



OUTLINE

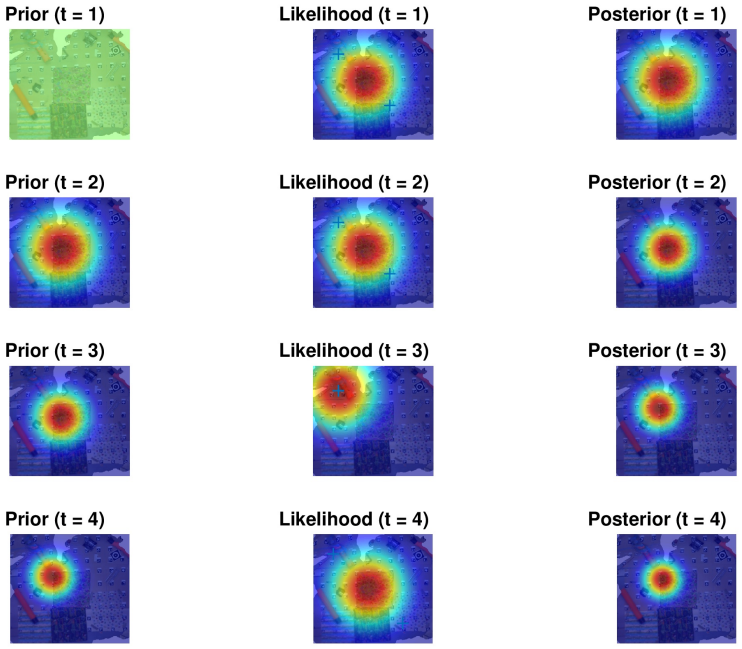
- Related Work
- **Methods**
- Experiments and Results
- Discussion
- Conclusion

MACHINE-LEARNING APPROACH

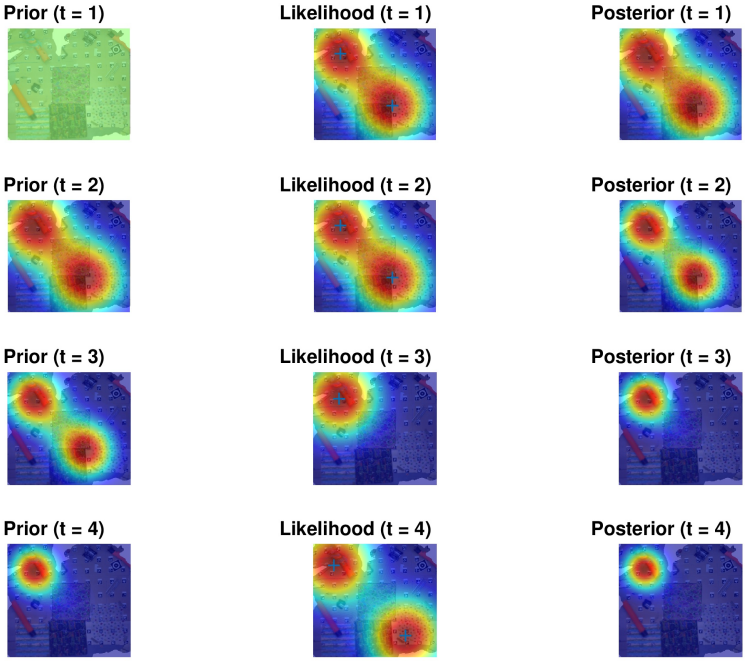


FILTERING

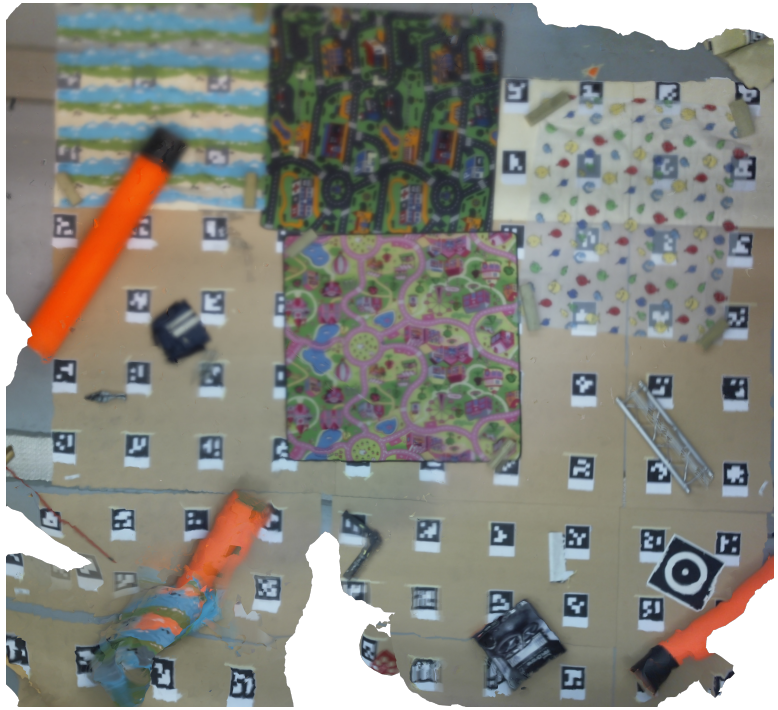
Kalman Filter



Particle Filter

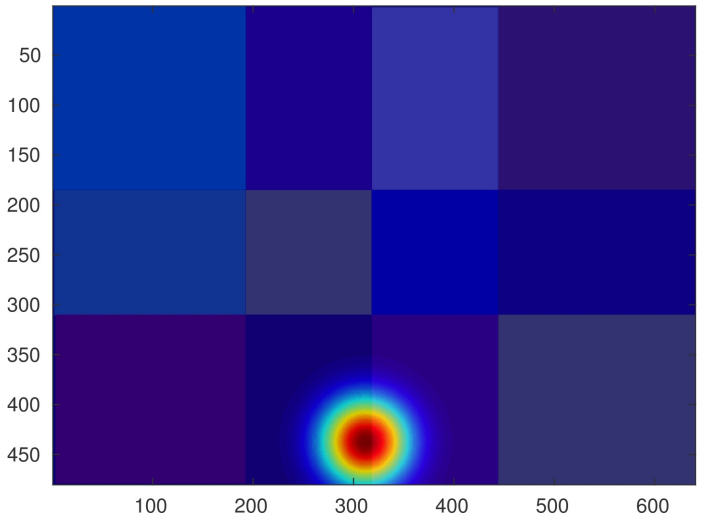


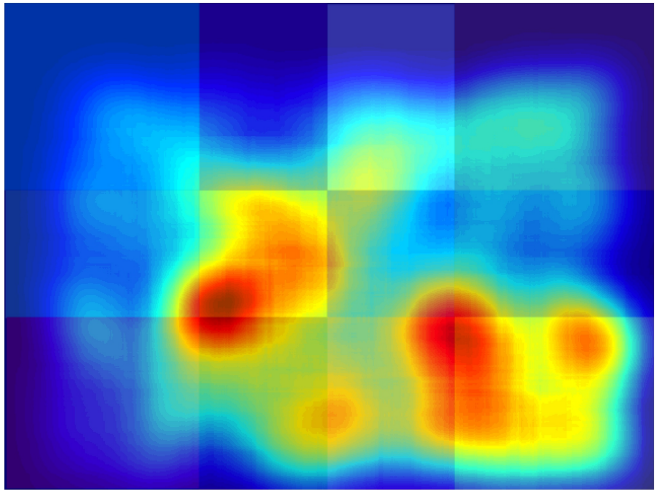
GROUND TRUTH ESTIMATION



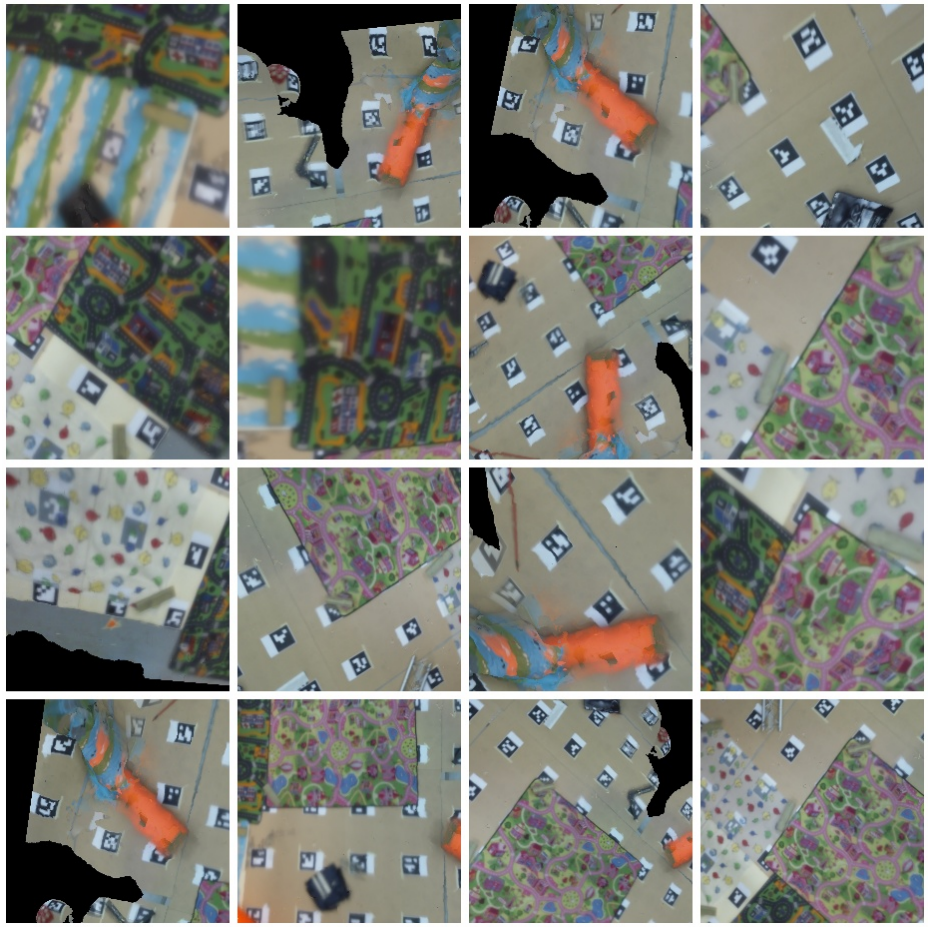
ENVIRONMENTAL MODIFICATION

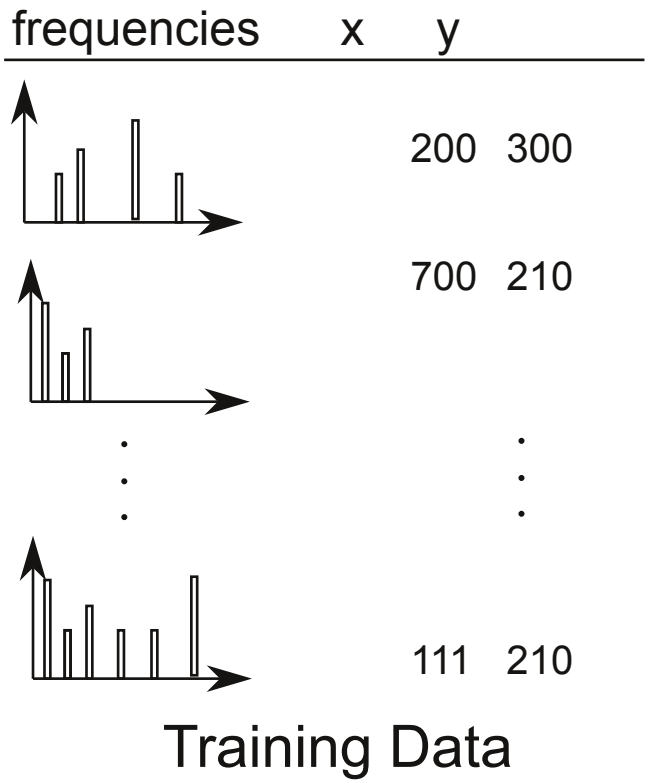
MAP EVALUATION





SYNTHETIC FLIGHT





Training Data

OUTLINE

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

EXPERIMENTS

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

FLIGHT ACCURACY

Average distance

OptiTrack vs. treXton

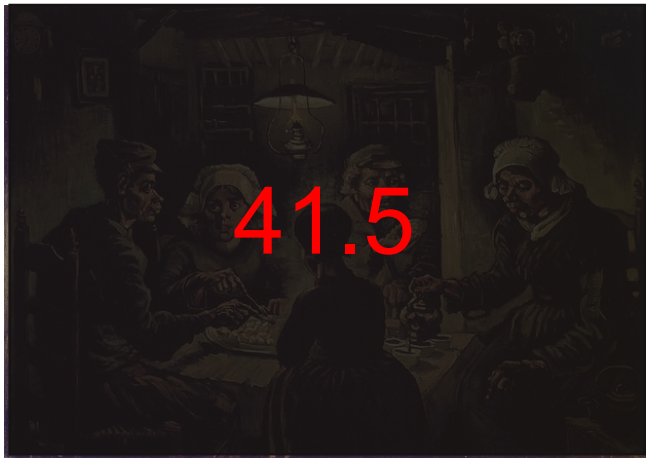
TARGET LANDING

MAP EVALUATION

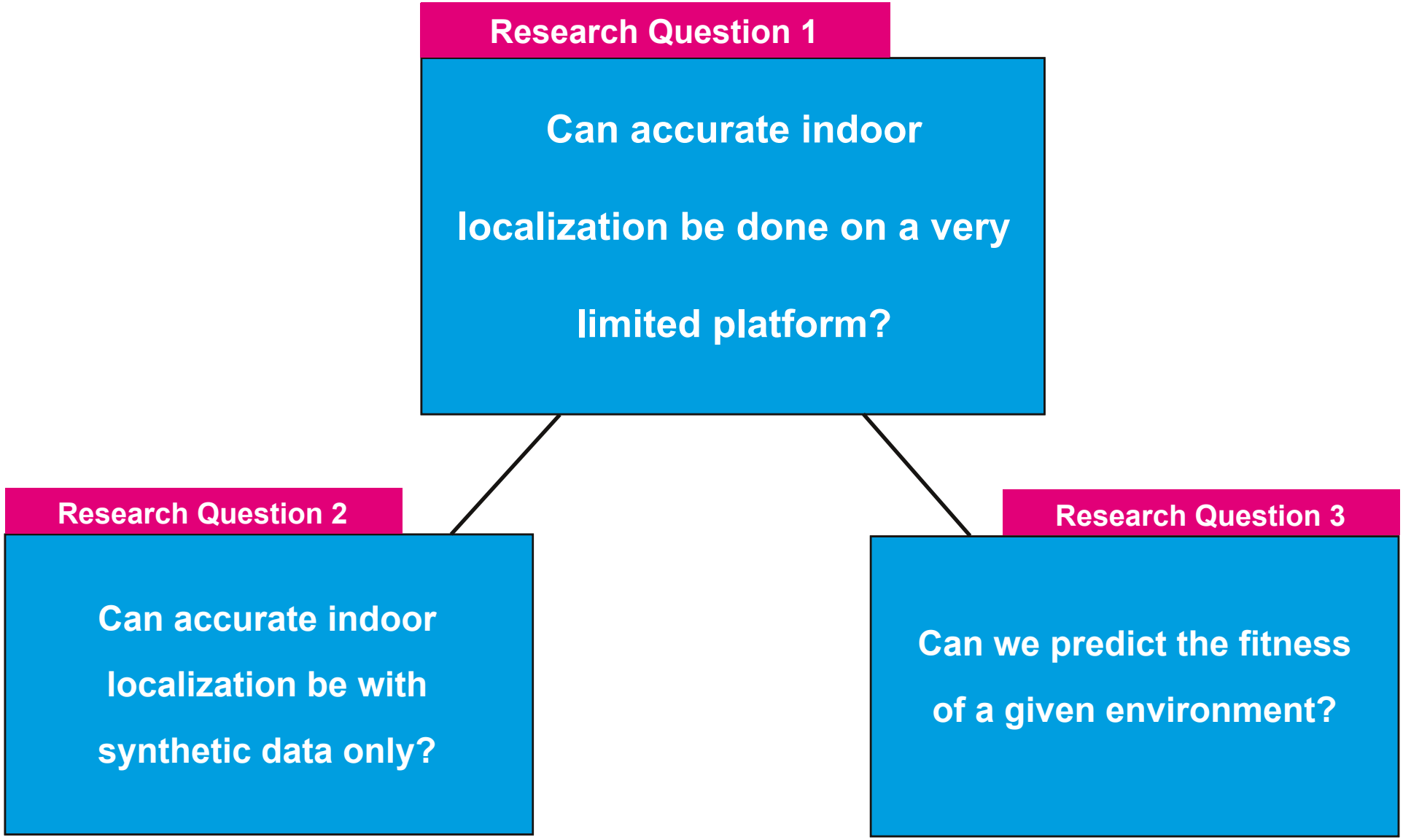





MAP EVALUATION



DISCUSSION


Research Question 1
Can accurate indoor localization be done on a very limited platform?
Research Question 2
Can accurate indoor localization be with synthetic data only?
Research Question 3
Can we predict the fitness of a given environment?

DISCUSSION

Implications:

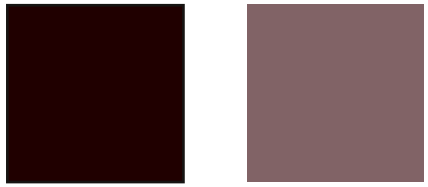
-

DISCUSSION

Limitations:

- assumes constant height and no rotations

- robustness to differerent lighting conditions



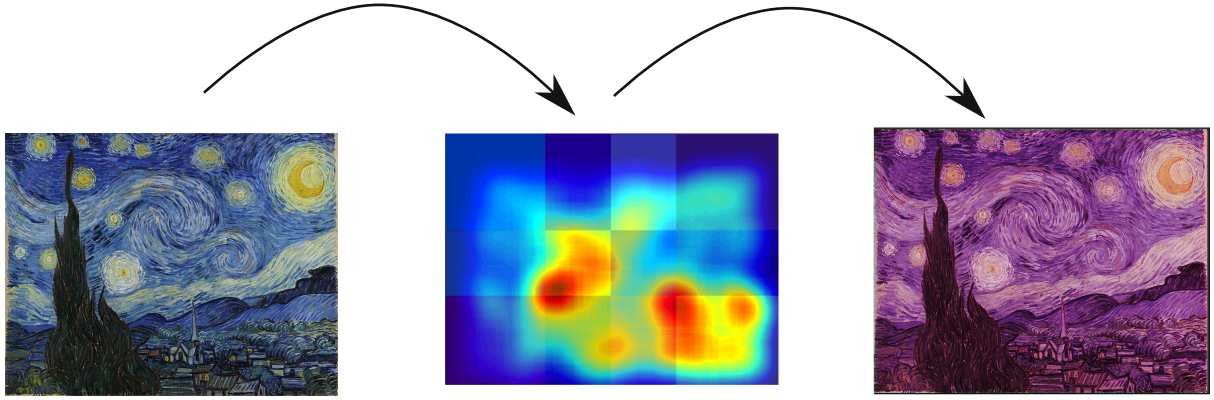
- Particle filter does not include velocity or heading

DISCUSSION

Future research:

- bridge reality gap

- automatic map generation (evolutionary algorithm)



CODE CONTRIBUTIONS

- Image augmentation with synthetic views (C++)

  https://github.com/Pold87/draug

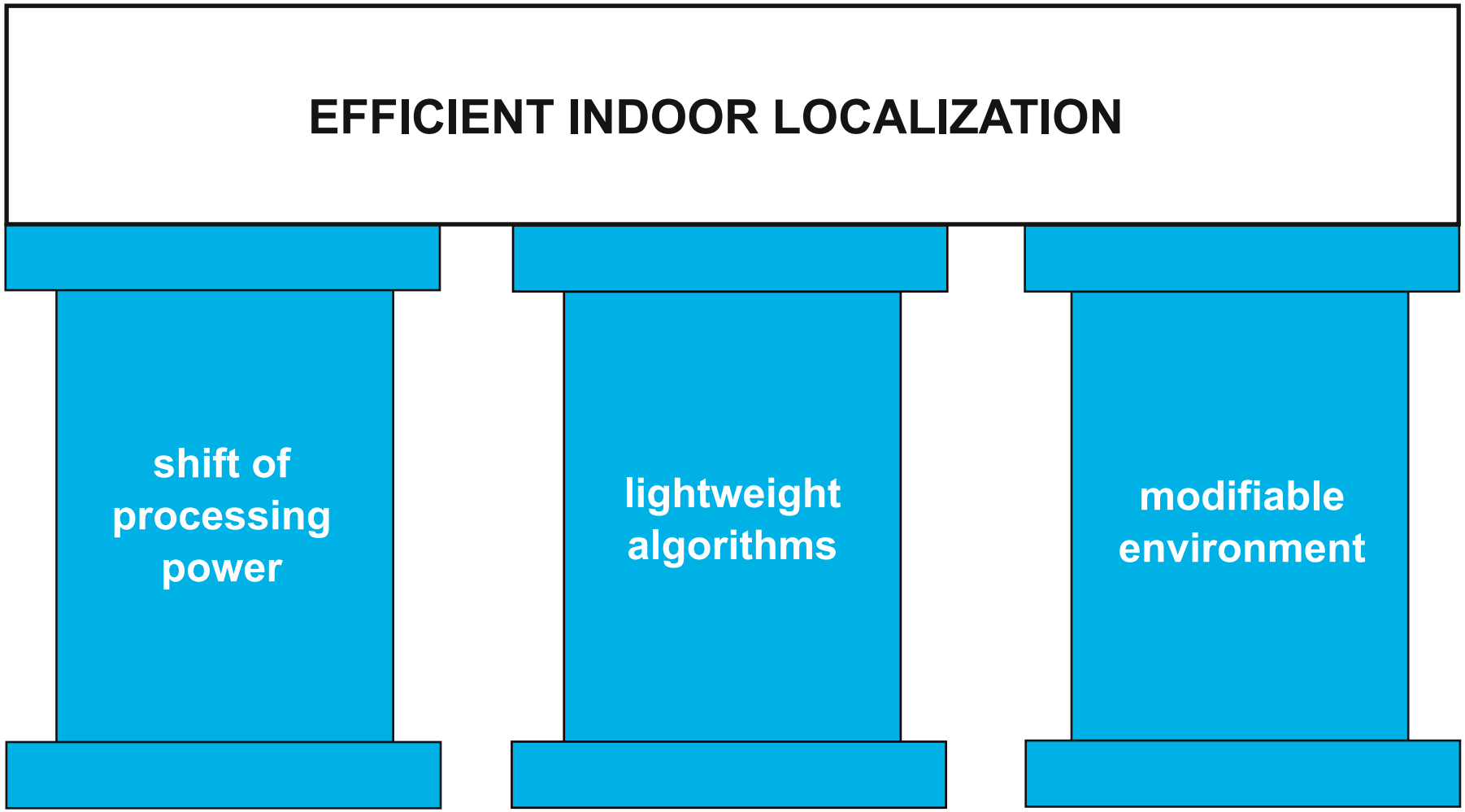
- Map evaluation (MATLAB)

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

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

  https://github.com/Pold87/paparazzi

CONCLUSION


EFFICIENT INDOOR LOCALIZATION
shift of processing power
lightweight algorithms
modifiable environment