

# Micro Maneuvers: Obstacle Detection for Standing Vehicles using Monocular Camera

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The 25<sup>th</sup> IEEE International Conference on Intelligent Transportation Systems  
Oct 8<sup>th</sup> - 12<sup>th</sup>, 2022



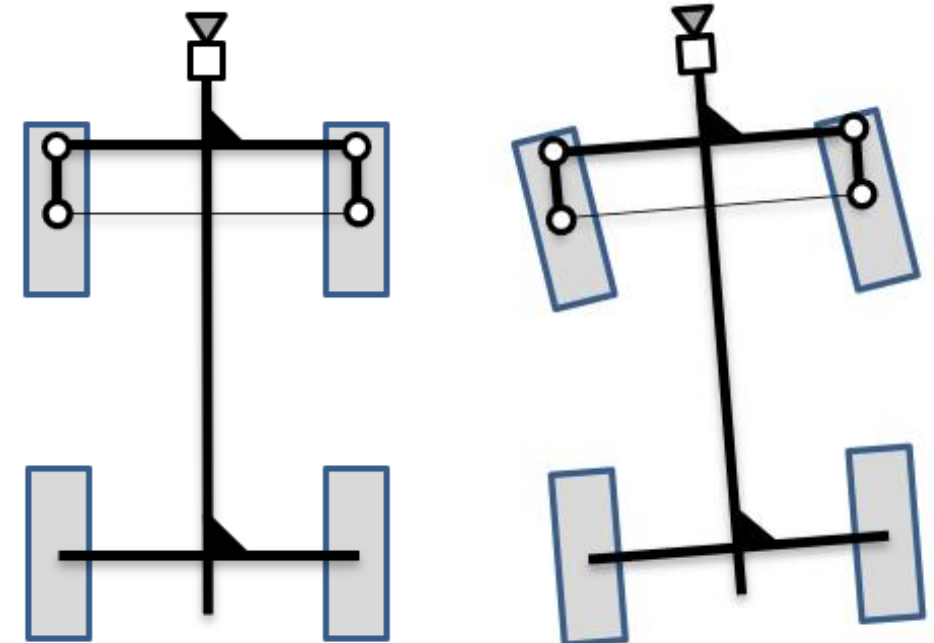
# Motivation

## Monocular Structure-from-Motion (SfM)

- Reconstruction of vehicle surrounding
  - Obstacle detection
- **Requires camera motion**

## Monocular SfM for Standing Vehicles

- Required for autonomous driving
- **Idea:** generate camera motion
  - Wheel steering
  - Engine torque



(a) Central position

(b) Left steering

# Contribution

- Proposal of *Micro Maneuvers*
  - $\mathcal{M}_a$  Wheel steering from the left position to the right, and back to the left
  - $\mathcal{M}_{b1}$  Wheels pointing to the left, use handbrake, engine start, engine torque, engine stop
  - $\mathcal{M}_{b2}$  Wheels pointing straight forward, use handbrake, engine start, engine torque, engine stop
- Experimental evaluation (SfM)
  - Comparison of keyframe selection techniques
  - Camera motion analysis
  - Obstacle detection

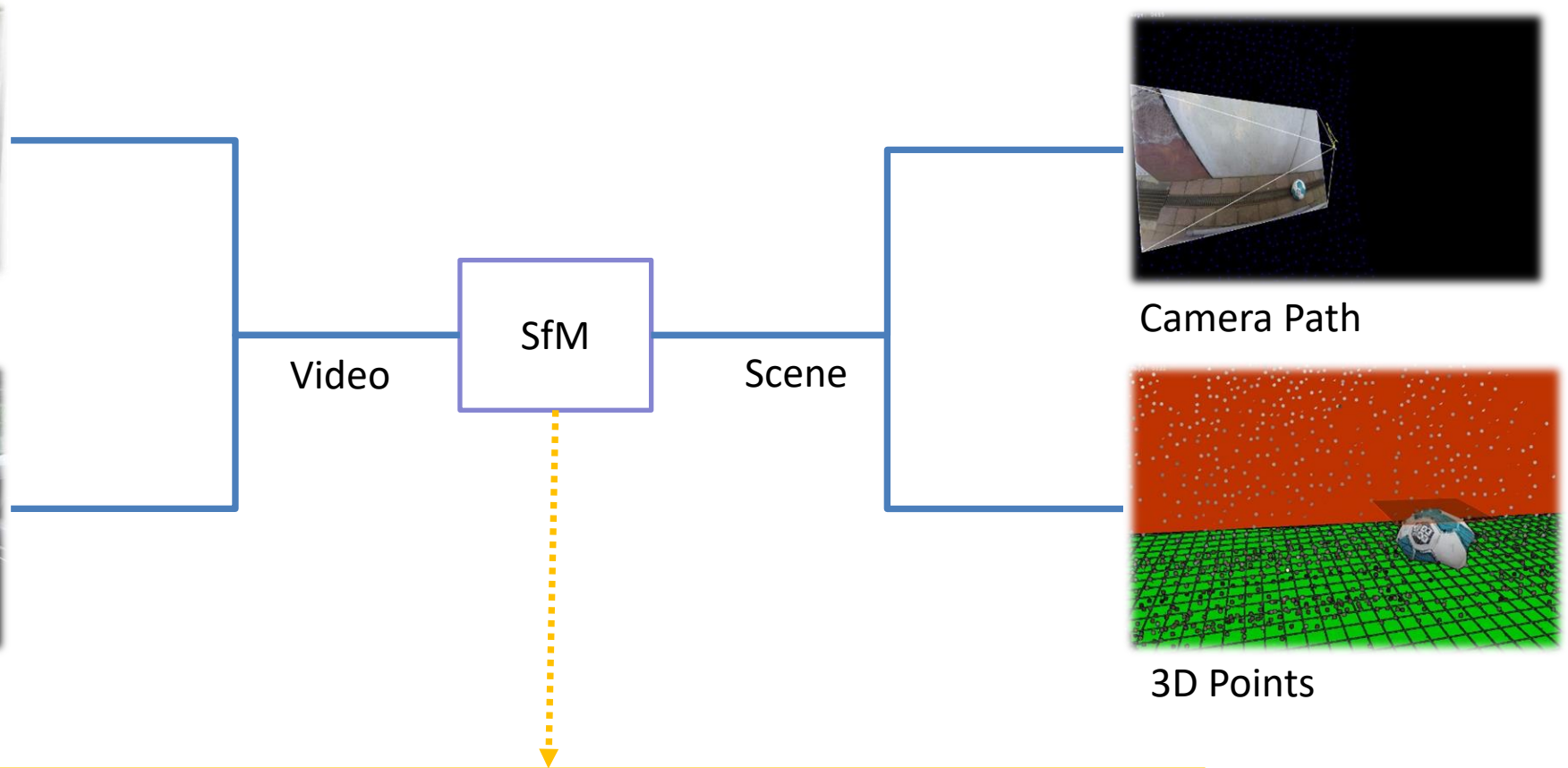
# Experiment: Obstacle Detection



Monocular Camera



Motion on Standing Car



- Motion sufficient for accurate scene reconstruction ?
  - Keyframe selection for initial reconstruction
- Which maneuver provides the most suitable motion ?

## Experiment: Demonstration Video

# Micro Maneuvers: Obstacle Detection for Standing Vehicles using Monocular Camera

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# Experiment: Demonstration Video

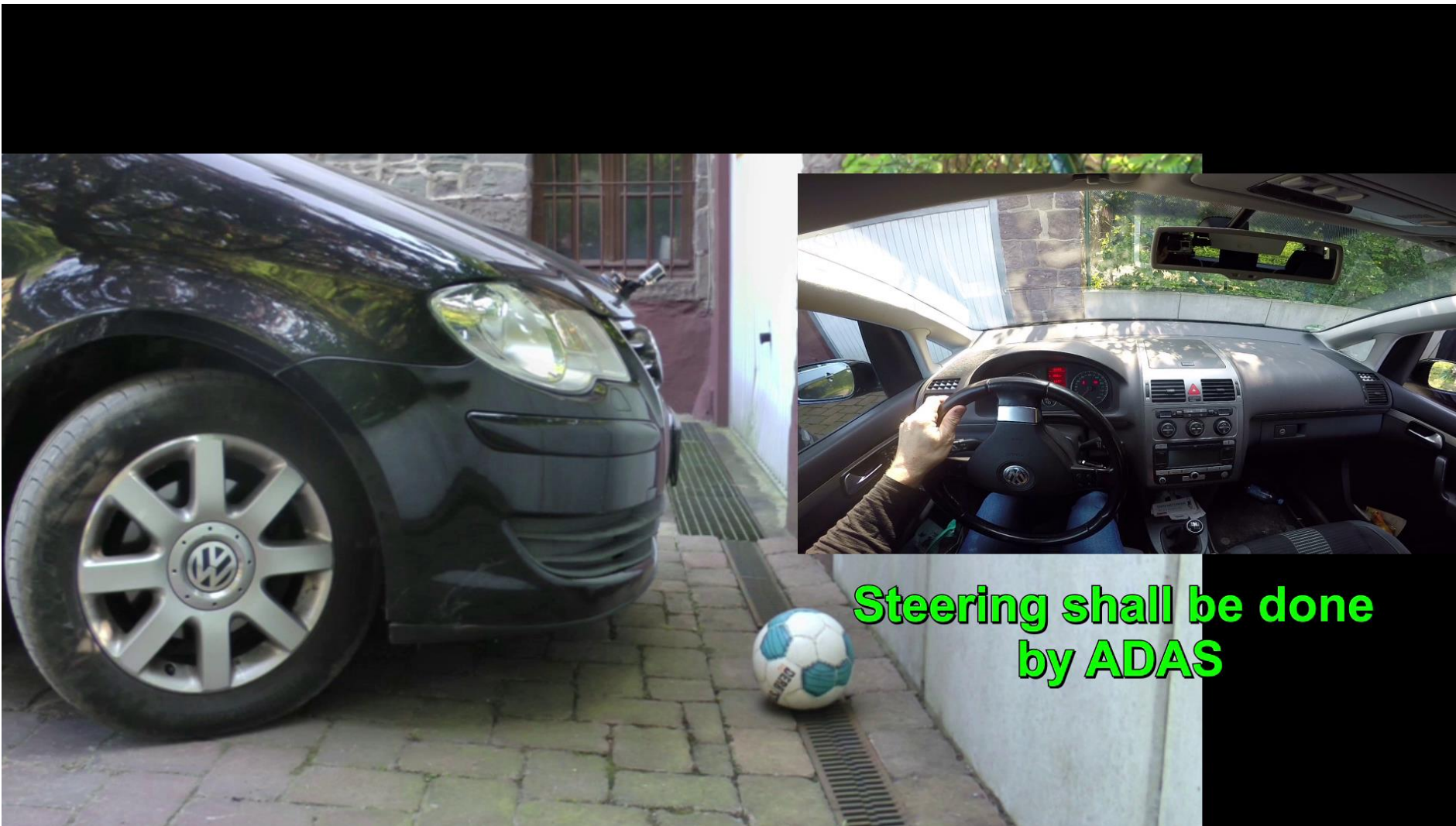


Steering shall be done  
by ADAS

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# Experiment: Demonstration Video

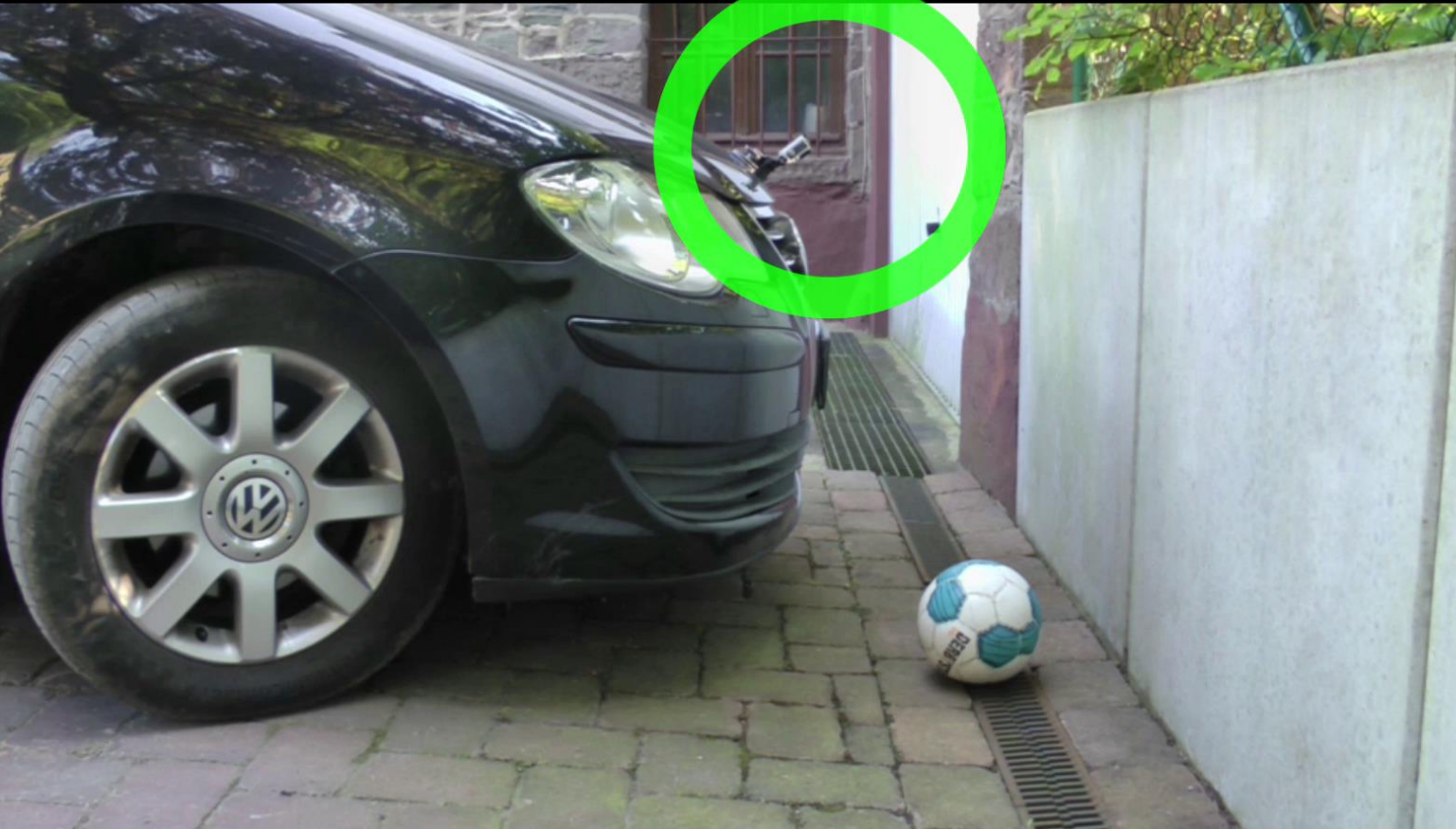


Steering shall be done  
by ADAS

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## Experiment: Demonstration Video

**Monocular Camera**



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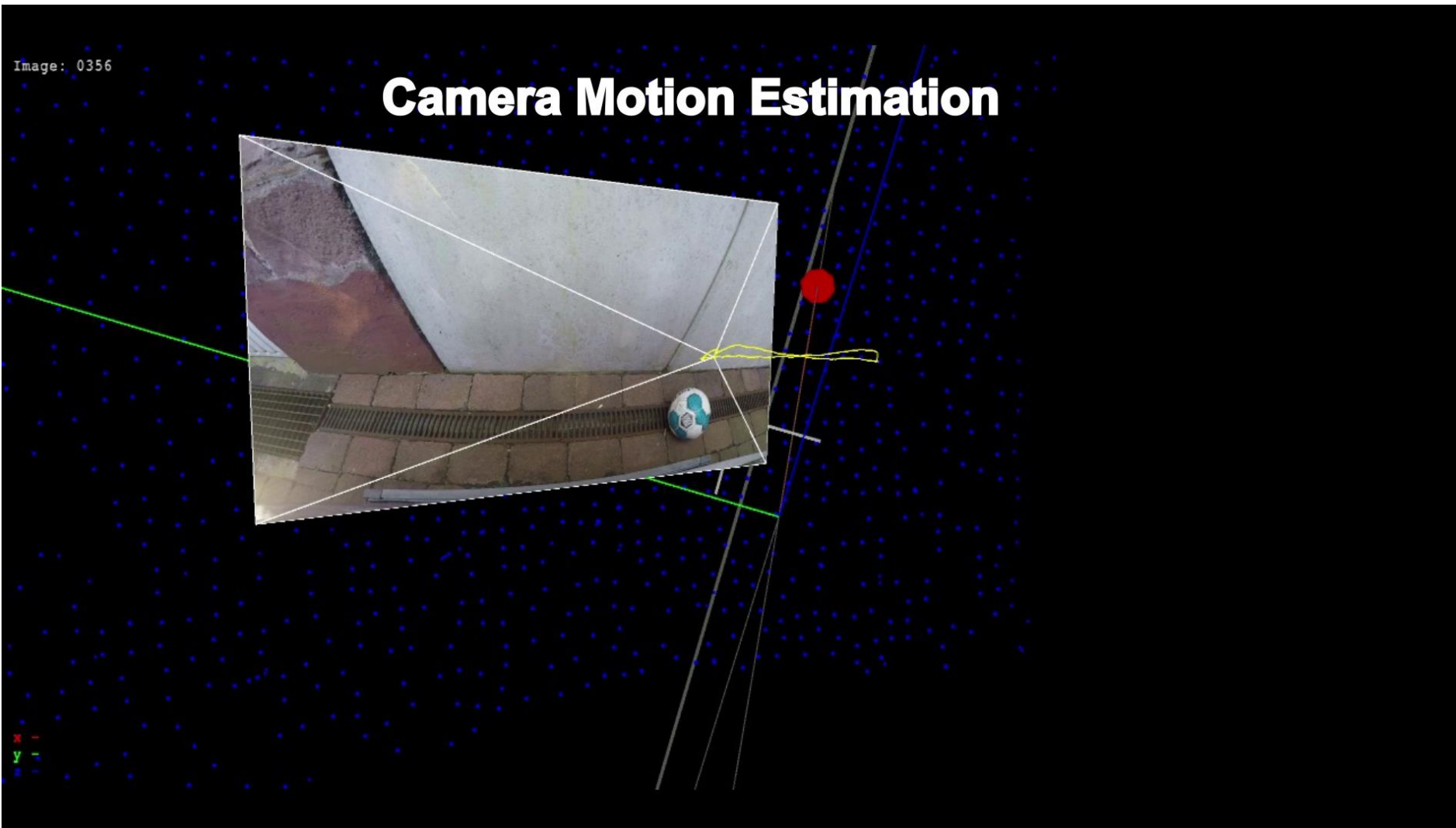
# Experiment: Demonstration Video

Feature Tracks



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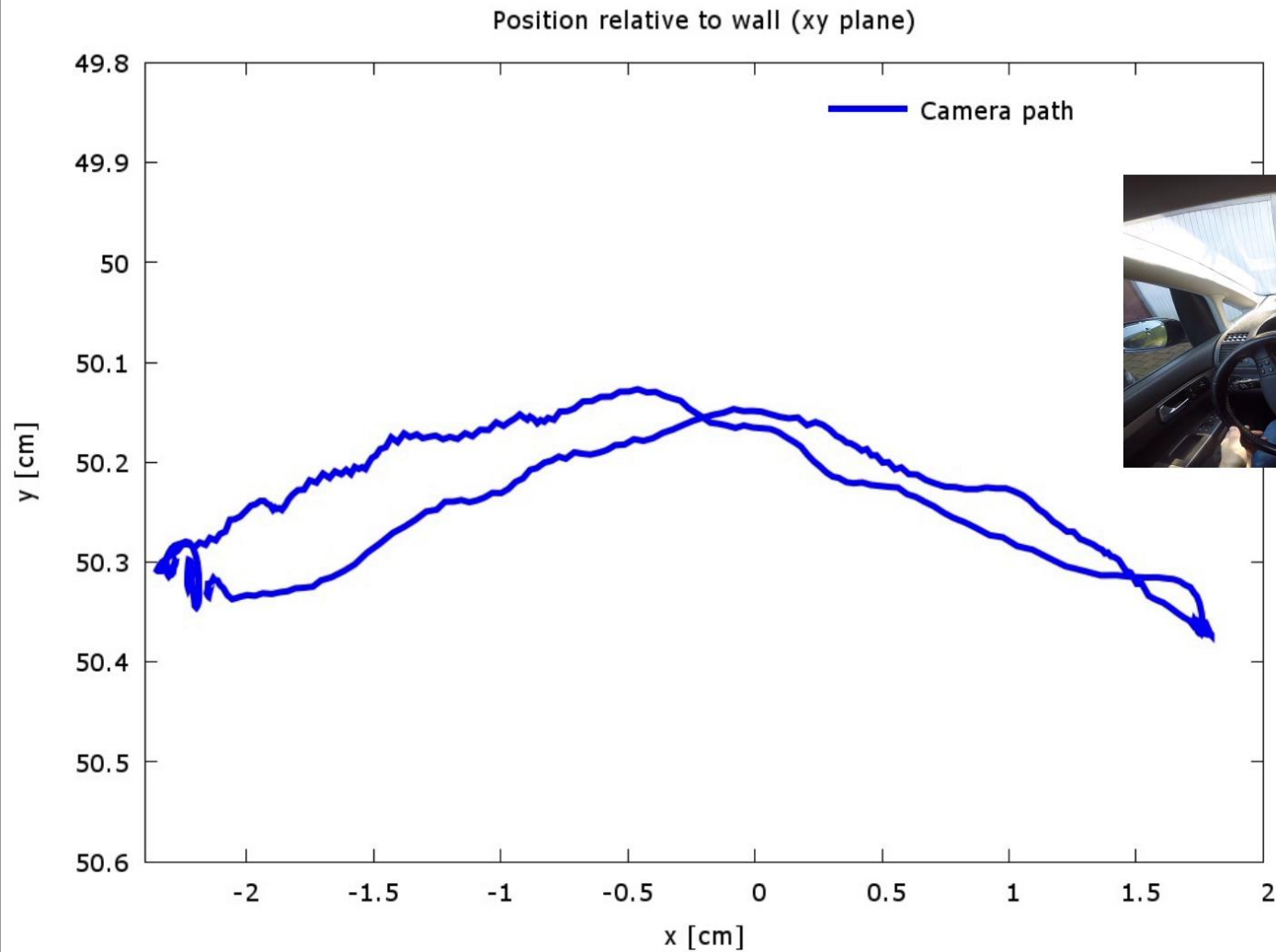
# Experiment: Demonstration Video



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# Experiment: Demonstration Video



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## Experiment: Demonstration Video



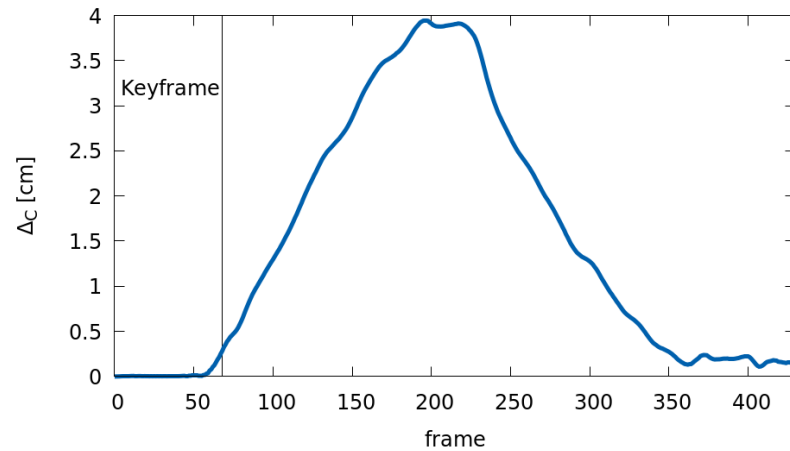
Image: 0273

**Resulting obstacle height: 19.5cm**  
**Ball diameter: 20cm**

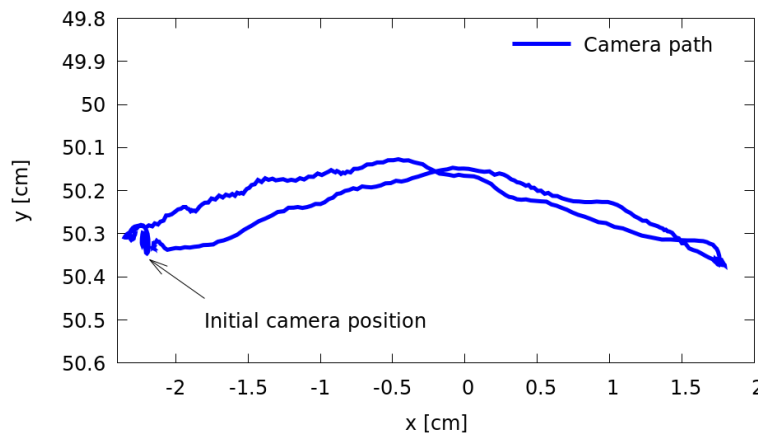
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# Results: Keyframe Selection / Camera Motion



Distance to initial camera  $\Delta_c$



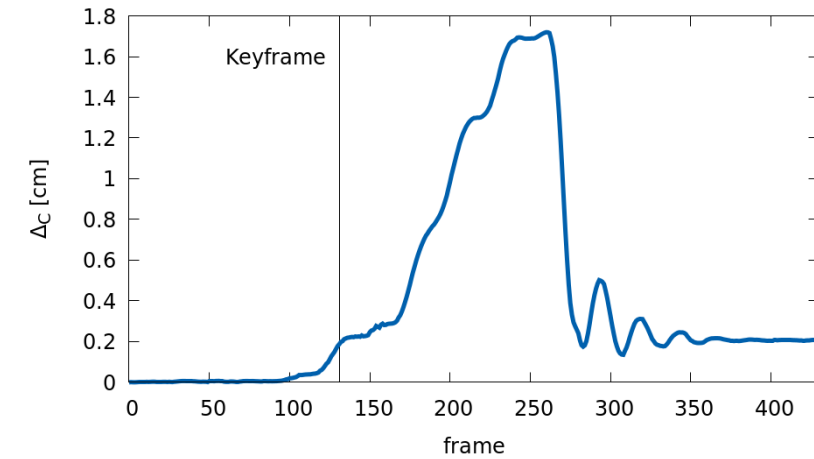
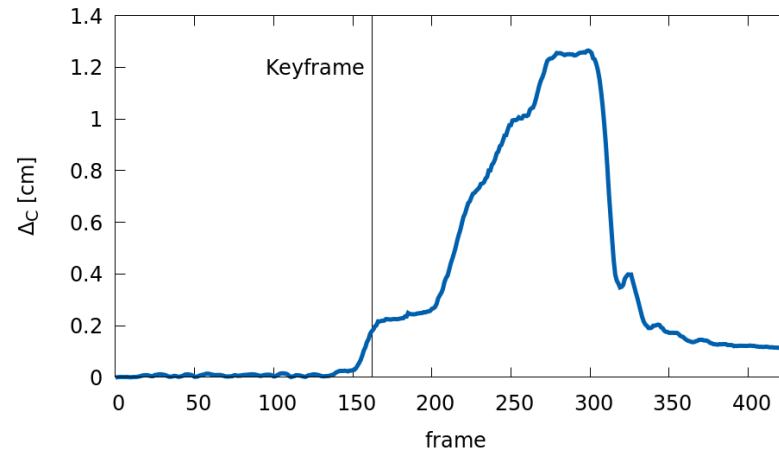
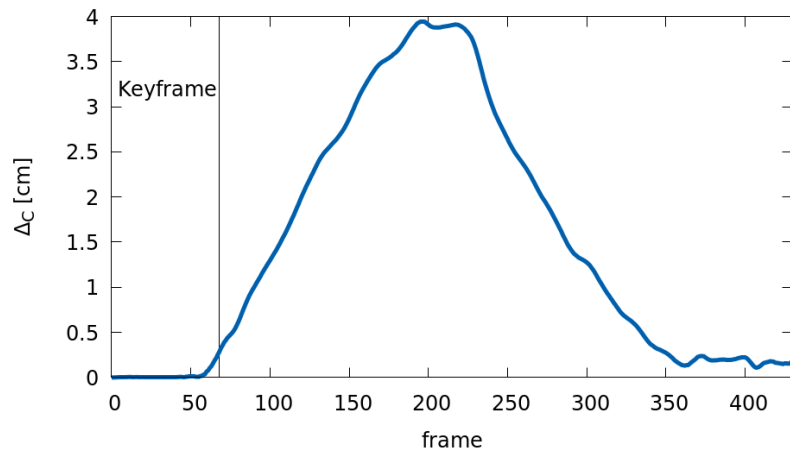
Reconstructed camera positions projected to the ground plane.

$\mathcal{M}_a$  Wheel steering from the left position to the right, and back to the left

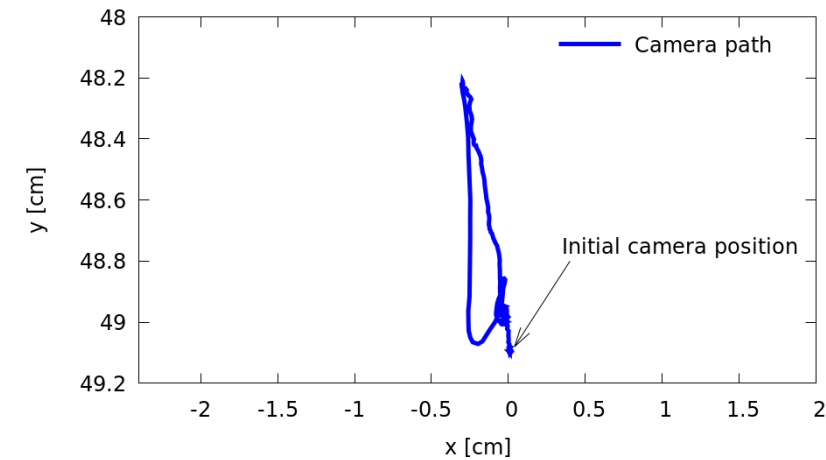
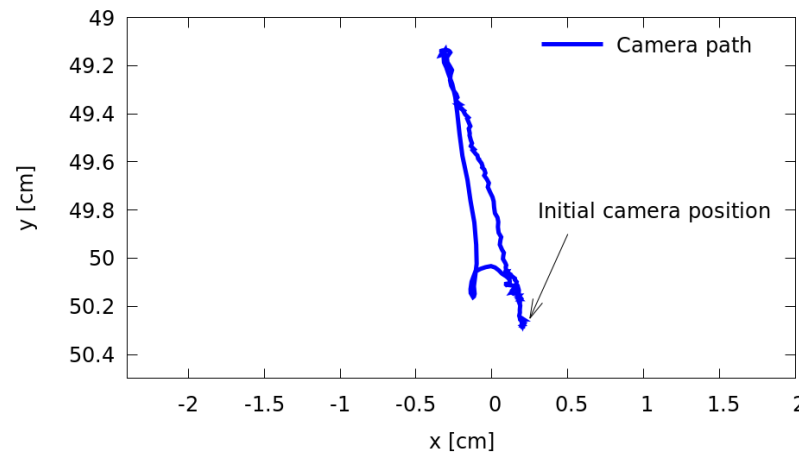
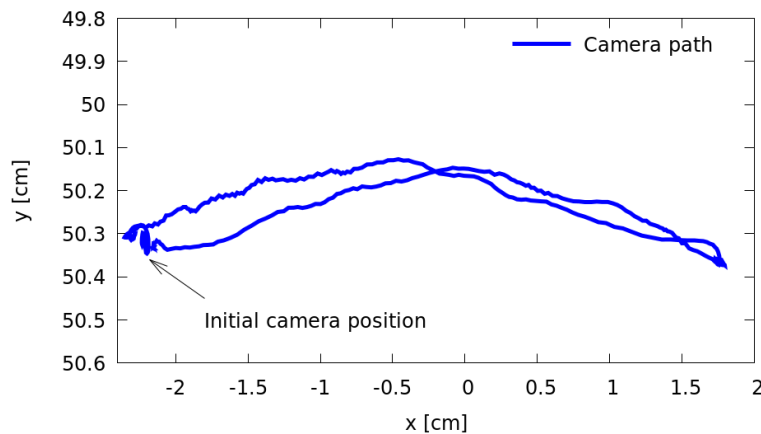
$\mathcal{M}_{b1}$  Wheels pointing to the left, use handbrake, engine start, engine torque, engine stop

$\mathcal{M}_{b2}$  Wheels pointing straight forward, use handbrake, engine start, engine torque, engine stop

# Results: Keyframe Selection / Camera Motion



Distance to initial camera  $\Delta_c$



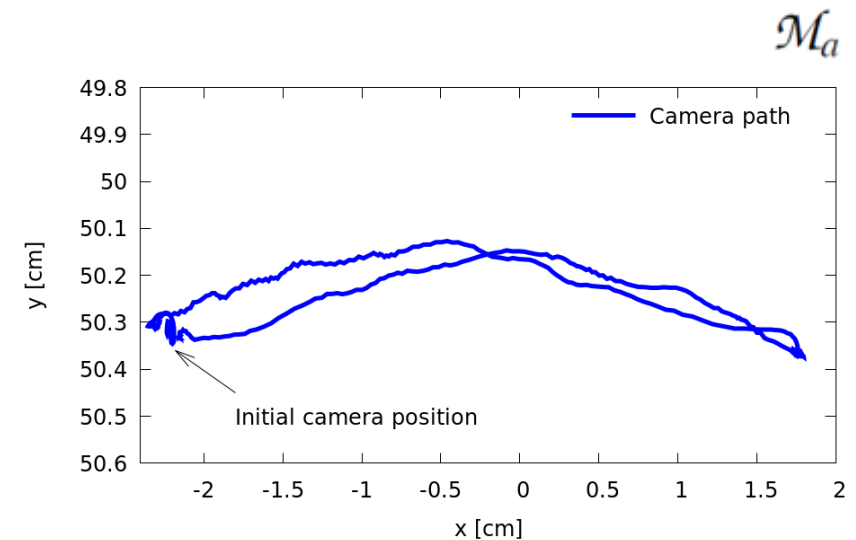
Reconstructed camera positions projected to the ground plane.

## Results: Keyframe Selection / Camera Motion

- $\mathcal{M}_a$  Wheel steering from the left position to the right, and back to the left
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Camera path elongations

	$\mathcal{M}_a$	$\mathcal{M}_{b1}$	$\mathcal{M}_{b2}$
lateral	3.9 cm	0.5 cm	0.4 cm
longitudinal	0.2 cm	1.2 cm	0.8 cm



## Results: Obstacle Reconstruction

- $\mathcal{M}_a$  Wheel steering from the left position to the right, and back to the left
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- $\mathcal{M}_{b2}$  Wheels pointing straight forward, use handbrake, engine start, engine torque, engine stop



Obstacle height  $h$ ,  $h_{GT} = 20\text{cm}$

	$\mathcal{M}_a$	$\mathcal{M}_{b1}$	$\mathcal{M}_{b2}$
$h$	19.51 cm	18.77 cm	18.22 cm



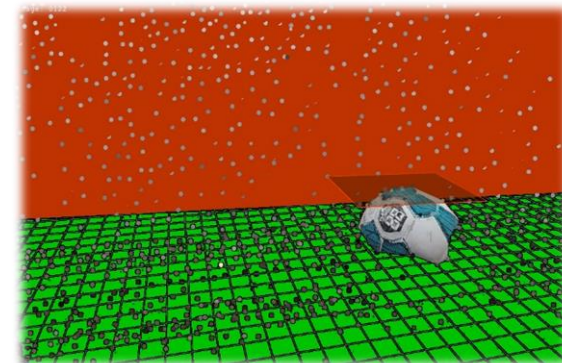
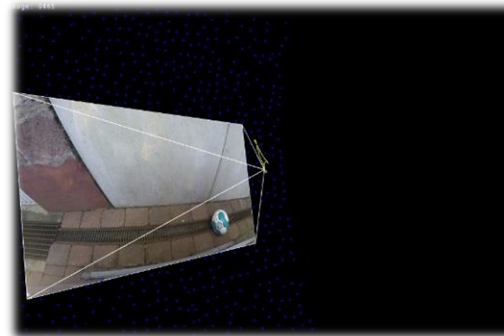
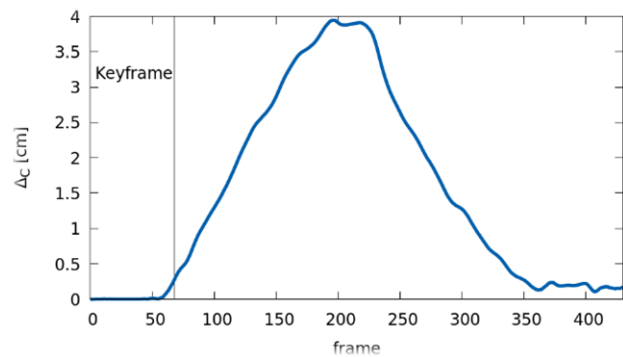
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# Conclusions

## Summary

- SfM on *Micro Maneuvers* leads to
  - Reasonable keyframe selection
  - Accurate camera motion estimation
  - Reliable obstacle detection
- $\mathcal{M}_a$  leads to most satisfying results
  - Camera path
  - Reconstructed scene



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