2nd Workshop „Robot Vision“
RobVis '08

February 18-20, 2008
Auckland, New Zealand

The area processing unit of Caroline

Finding the way through DARPA's urban challenge

February 18th, 2008

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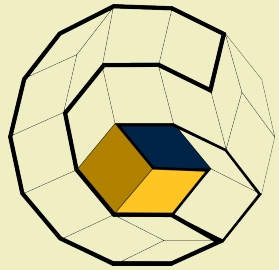
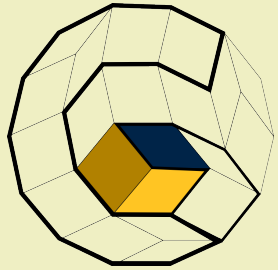
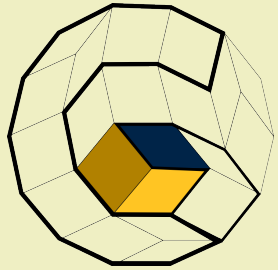


Overview



- **Area Processing**
- **Related Work**
- **Algorithm suitable to urban areas**
- **Experimental Results**

Area Processing

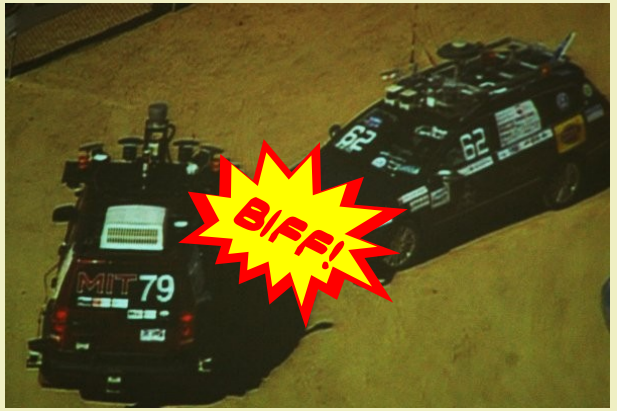


the general process

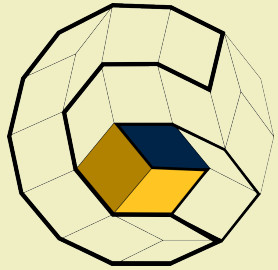
- get an image + defined drivable area
- find the overall drivable area in the image

Area Processing

... and thus help avoiding obstacles!

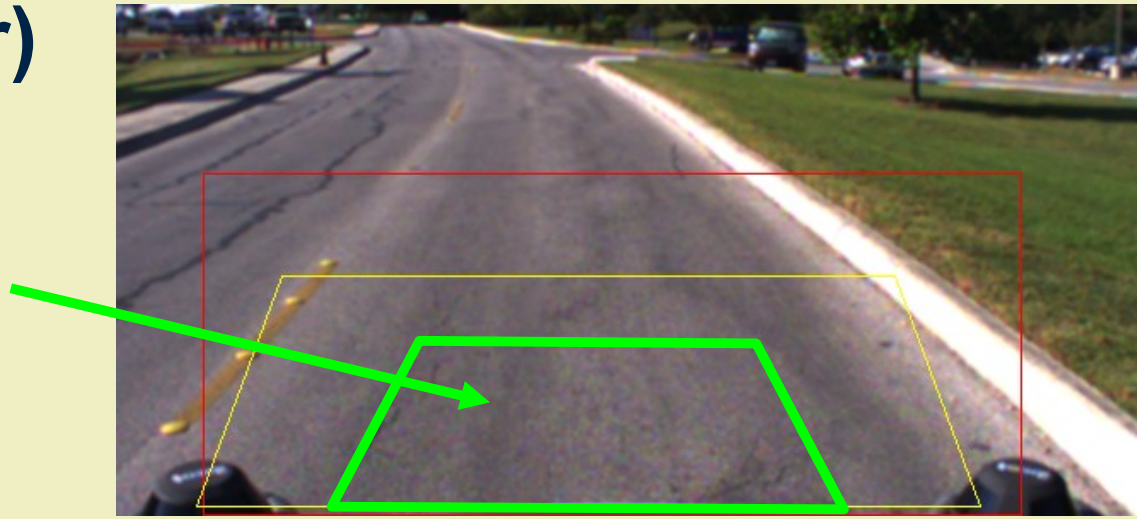


Area Processing

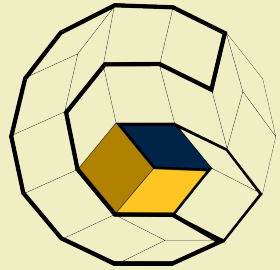


input

- an image retrieved from car's camera
- a small polygon (e.g. from laser) that marks the drivable area



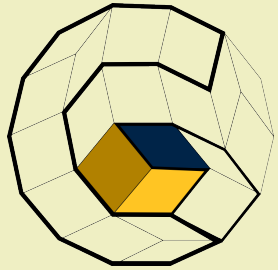
Area Processing



output

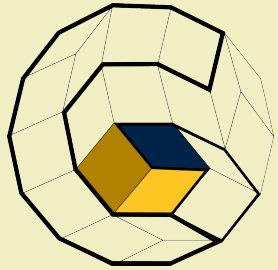
- **a Drivability Grid**
- **values range:**
  - 0 (not drivable)
  - 128 (fully drivable)
  - 1 Bit for masking
- **sent to Sensor Fusion**

Overview



- Area Processing
- Related Work
- Algorithm suitable to urban areas
- Experimental Results

Related Work

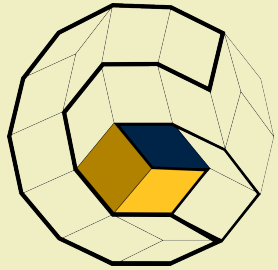


detecting drivable areas in images:

- retrieve a polygon from laser scanner:
- expand polygon by color clustering and segmentation algorithm
    - Thrun et al.[2006]

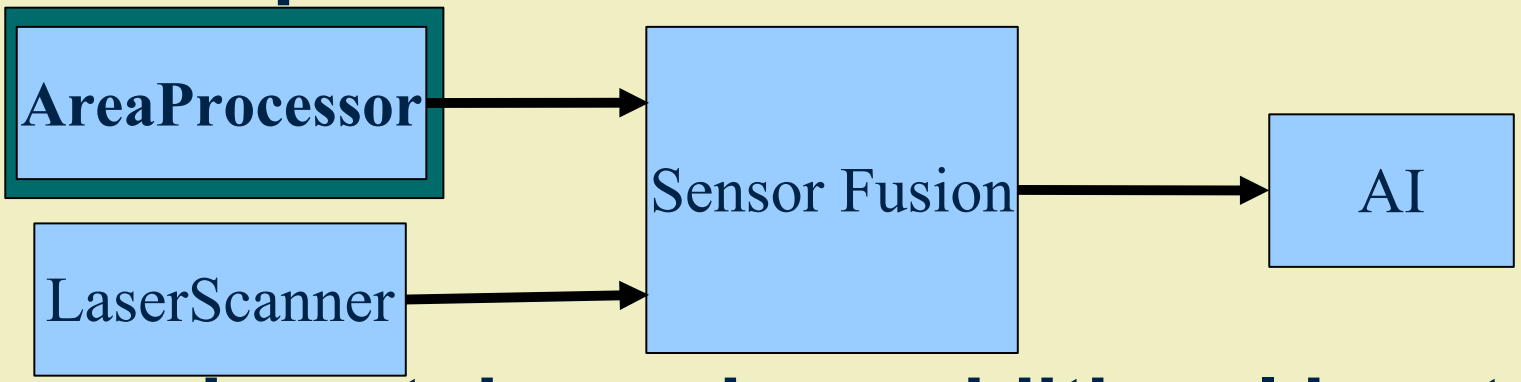
+ simple & fast
+ relative precise
- additional input
- urban artifacts
  (lane marks, shadows)
- laser scanner:
  distinction between small grass and road ?

Related Work



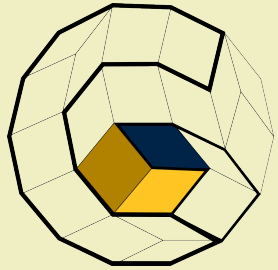
- setup of Thrun et al.

- our setup



- ... we do not depend on additional input
- ... but we may label pixels as unknown

Overview



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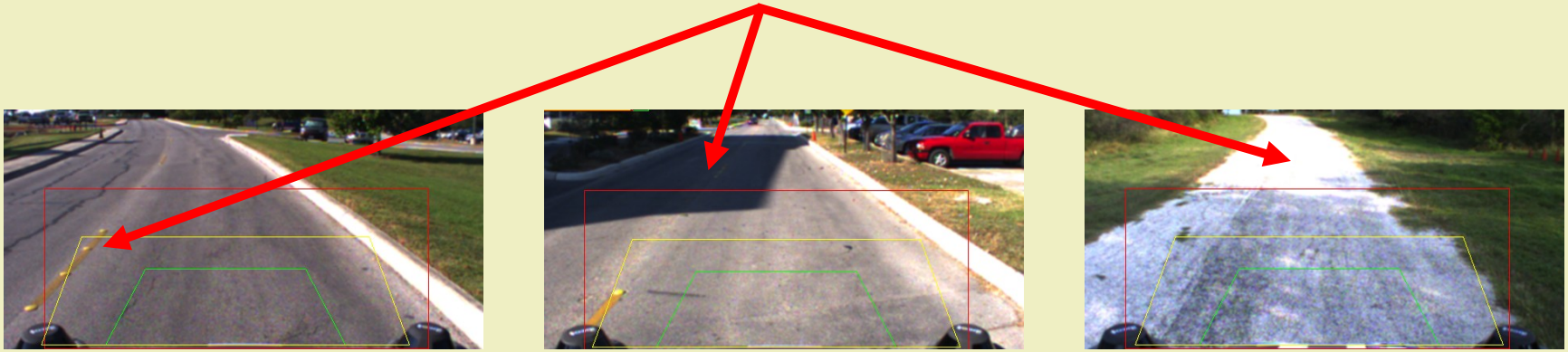
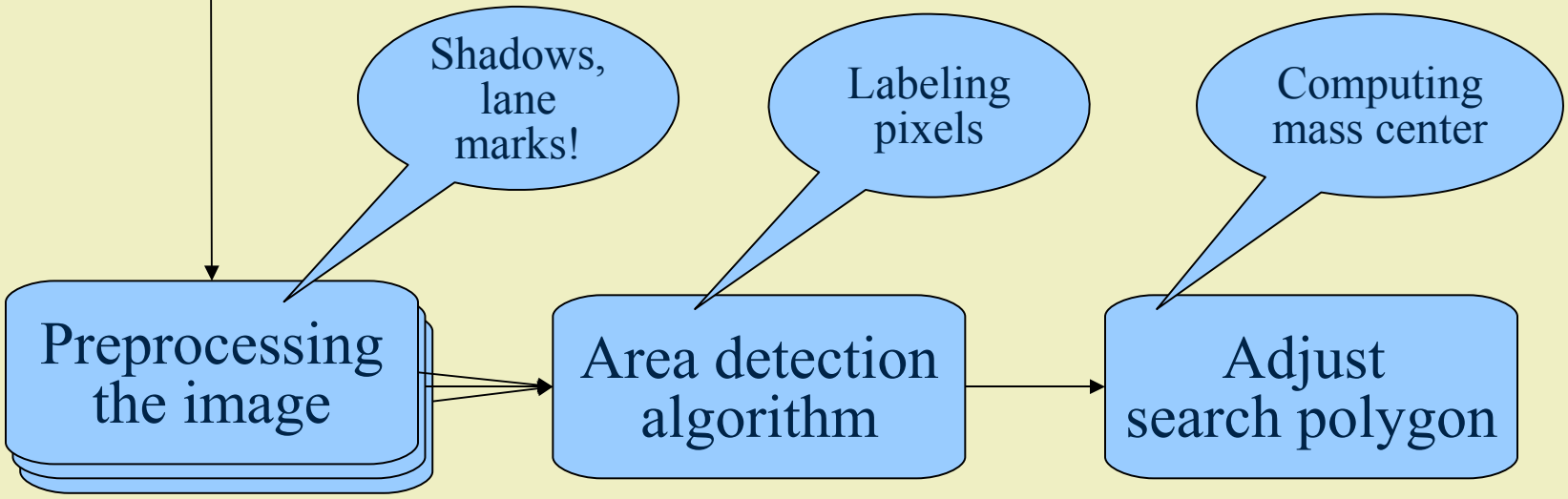
Challenges

1. cope with lane marks
2. reduce problems with shadows
3. reduce problems with overexposed images
4. ... become independent of additional sources!



Algorithm for Urban Areas



Algorithm for Urban Areas

Preprocessing (Shadows / Overexposure)

- transform to HSV-Space
- search for very high and very low Values

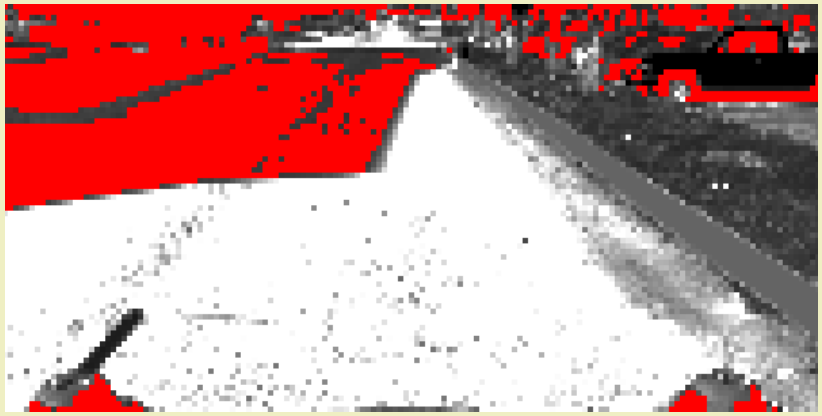
... reduces problems with (ego)shadows

... reduces problems with overexposed images

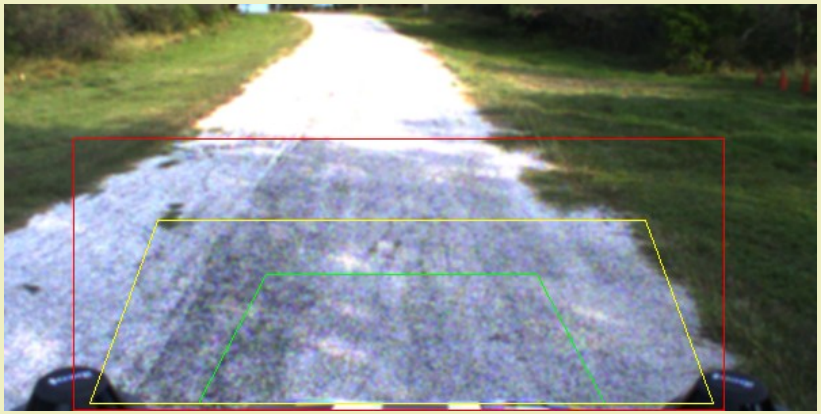
Preprocessing (Shadows)

Without

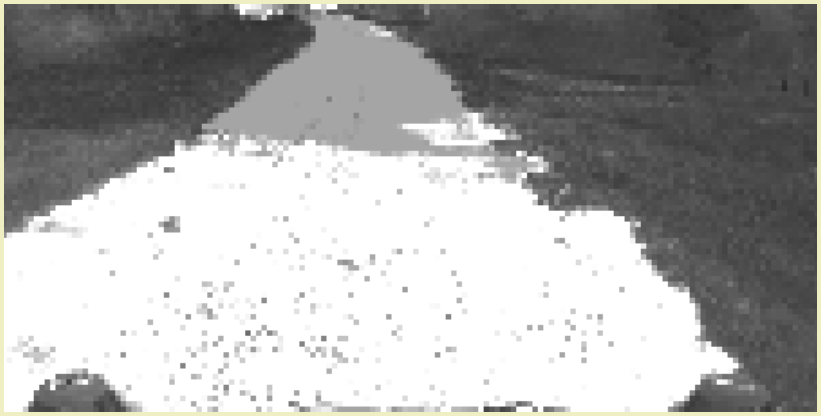
With



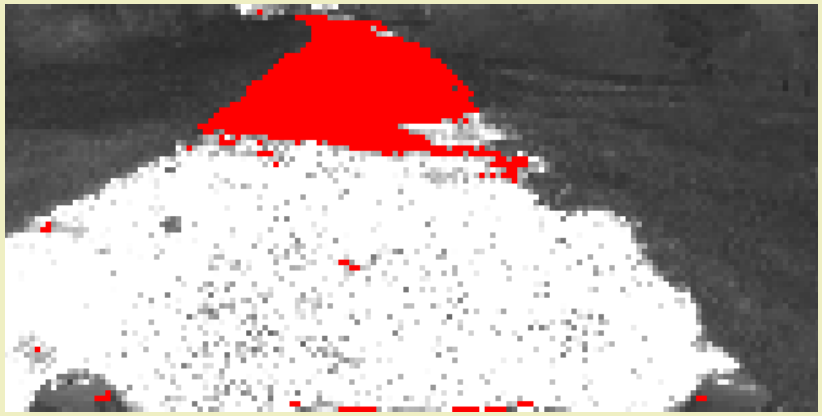
Preprocessing (Overexposure)



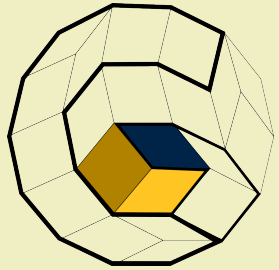
Without



With



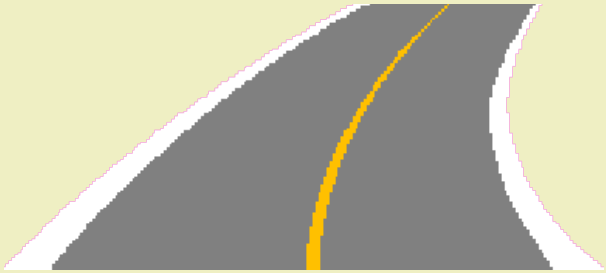
Algorithm for Urban Areas



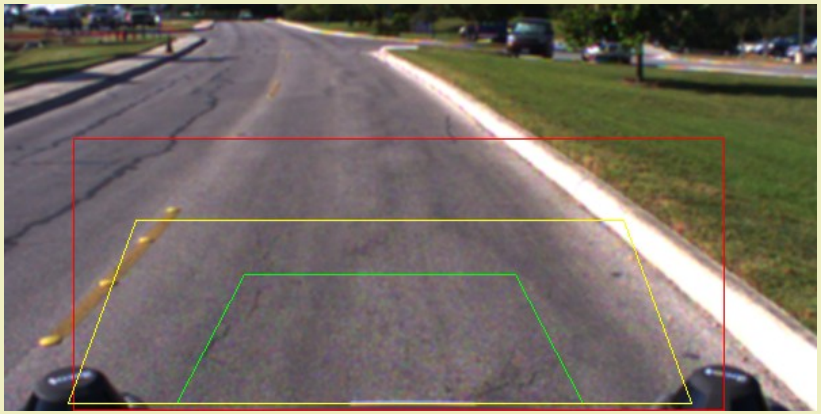
Preprocessing (Lane marks)

- use RGB-Space
- if pixels are too red or too green, they are not considered as lane marks
- rest is set to min(R,G)/B, results thresholded
- morphological operations on results remove falsely detected large yellow areas

... copes with lane marks

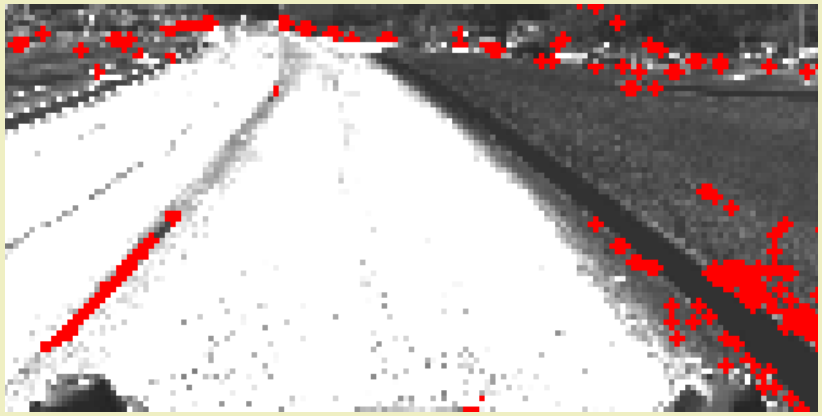


Preprocessing (Lane marks)

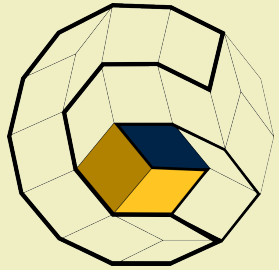


Without

With

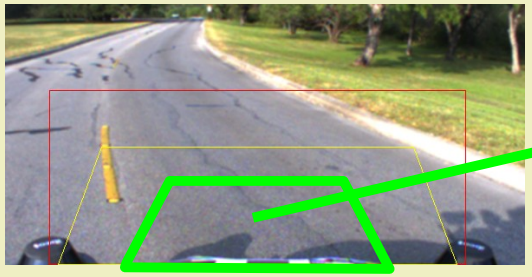


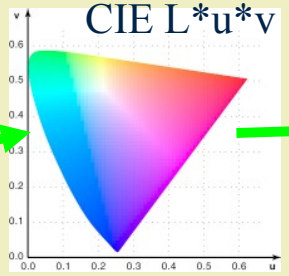
Algorithm for Urban Areas

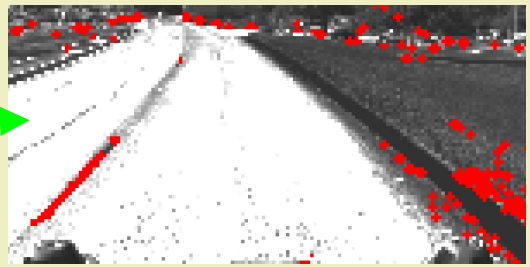


perform the area detecting algorithm

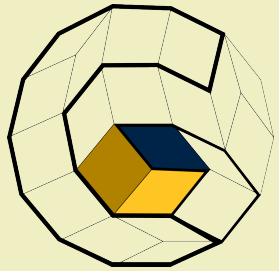
- proceed as in „The Robot That Won The DARPA Grand Challenge“ by Thrun et al.
- retrieve mean colors from small search polygon
- compare with all pixels in image
- compute in L*a*b or L*u*v space (Euclidian distance)





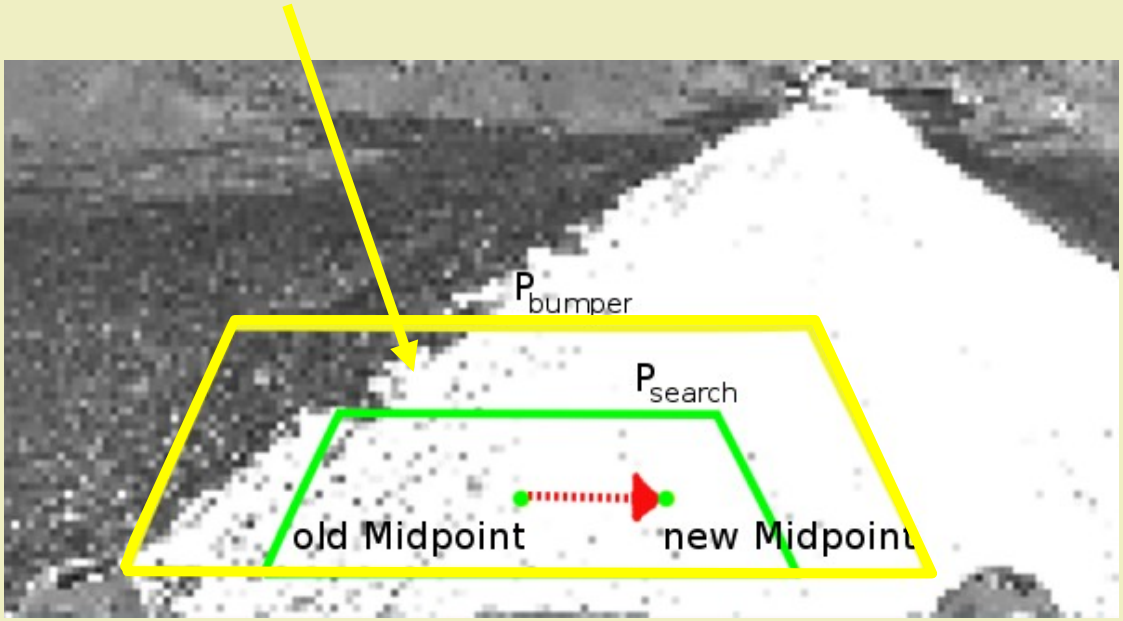


Algorithm for Urban Areas

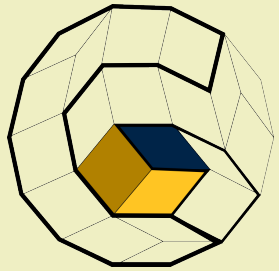


apply a dynamic search polygon

- take the resulting Drivability Grid and compute the mass center within a larger bumper polygon (yellow polygon)

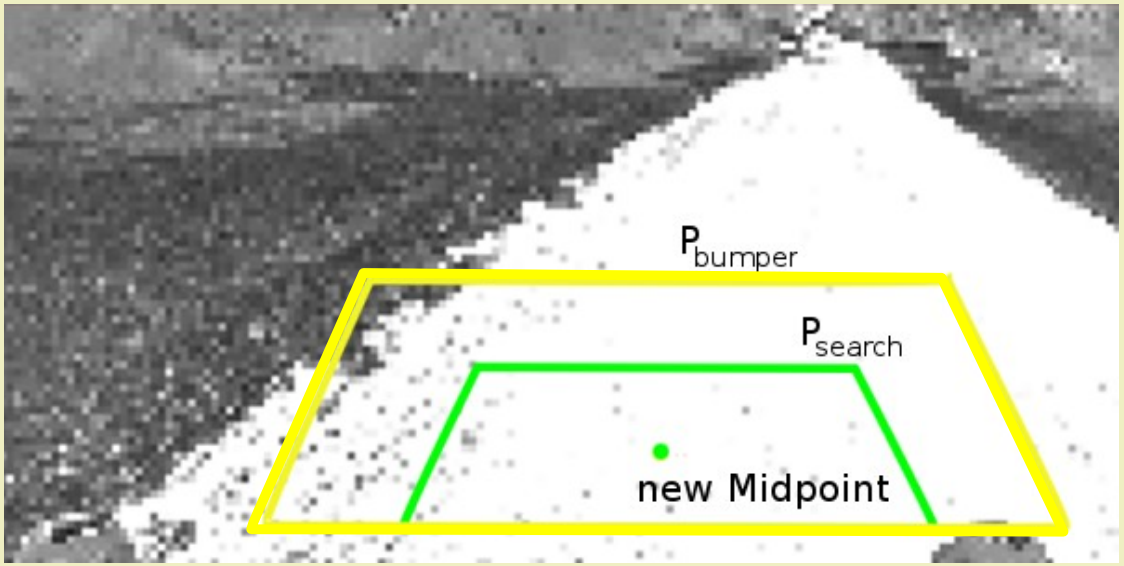


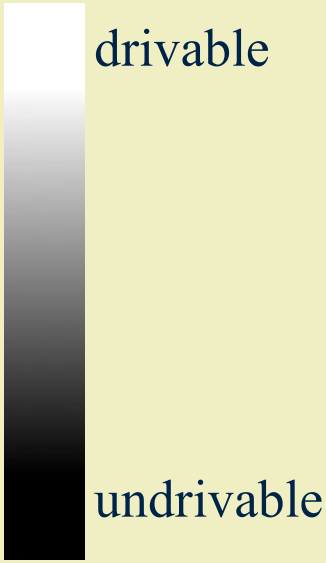
Algorithm for urban areas



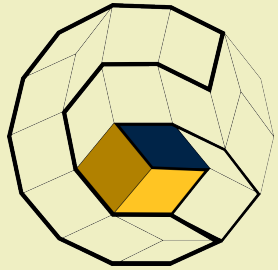
move both polygons to the new midpoint

- the search polygon becomes dynamic and the algorithm is independent of additional sources.
- succeeds in keeping the car on the road

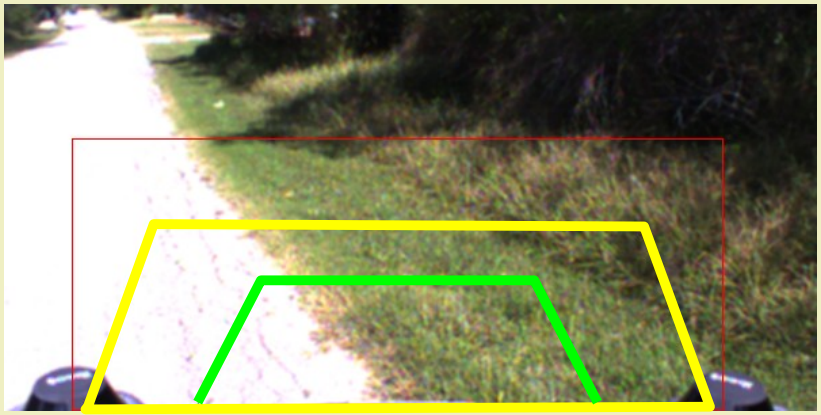




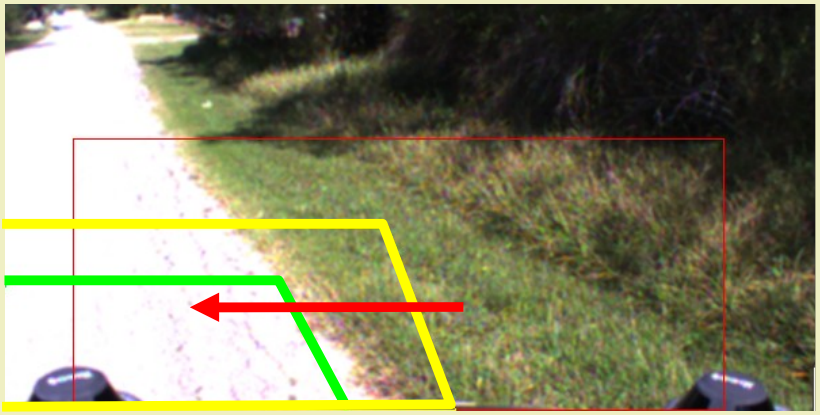
The dynamic search polygon

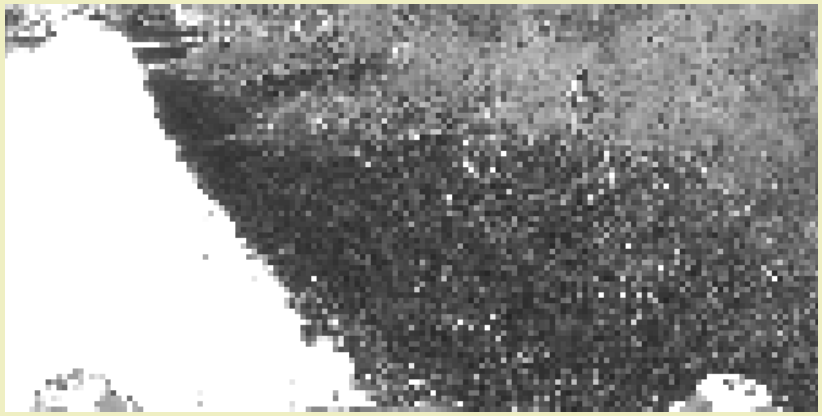


Without

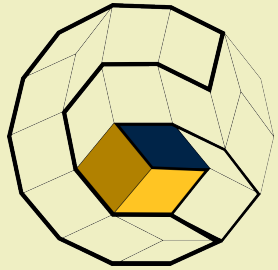


With





Overview



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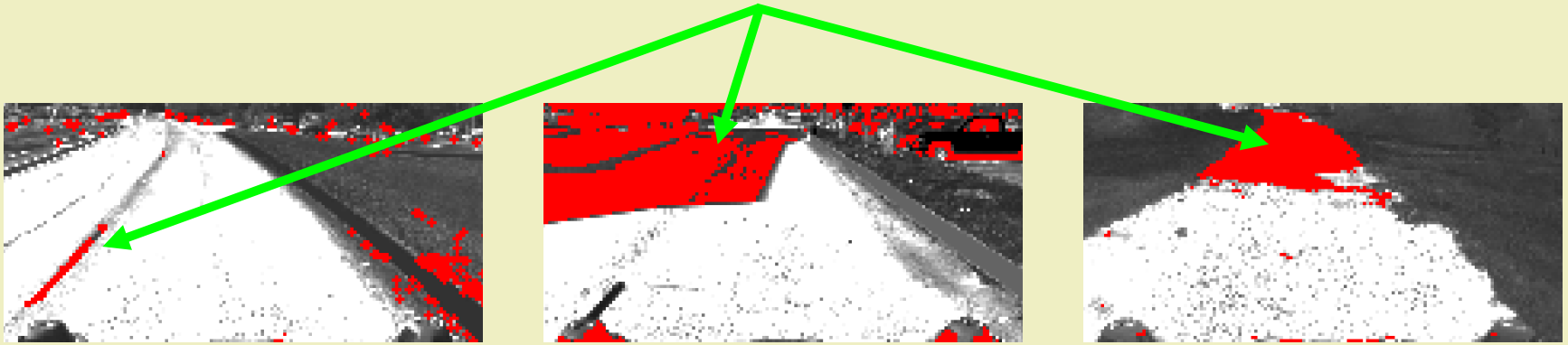
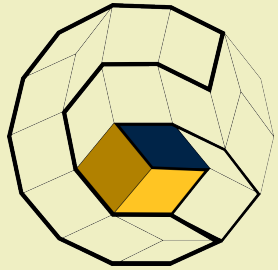
Conclusions

achieved goals

- cope with lane marks √
- reduce problems with shadows √
- reduce problems with overexposed images √
- ... become independent from additional sources! √



Conclusions



future work

- at the moment the initial position of the vehicle has to be accurate facing the street
- although the (green) search polygon can be translated, it cannot be resized yet

Thank you very much for your attention.

Contact:
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http://graphics.tu-bs.de/people/berger