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Terrace Climbing of the Alacrane Mobile Robot with Cooperation of its Onboard Arm

Javier Serón, Jorge L. Martínez, Anthony Mandow, Alfonso García-Cerezo, Jesús Morales, Antonio Reina and Jesús García*

Departamento de Ingeniería de Sistemas y Automática

University of Malaga, Spain

**Universidad Nacional Experimental del Táchira, Venezuela*

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OUTLINE

1. INTRODUCTION
2. CLIMBING MANEUVER
3. SLOPE PERCEPTION
4. EXPERIMENTAL RESULTS
5. CONCLUSIONS

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1.
INTRODUCTION

Mobile Robotics in Natural Environments

- **It is necessary to surmount elevations like terraces, rubble mounds or steps**

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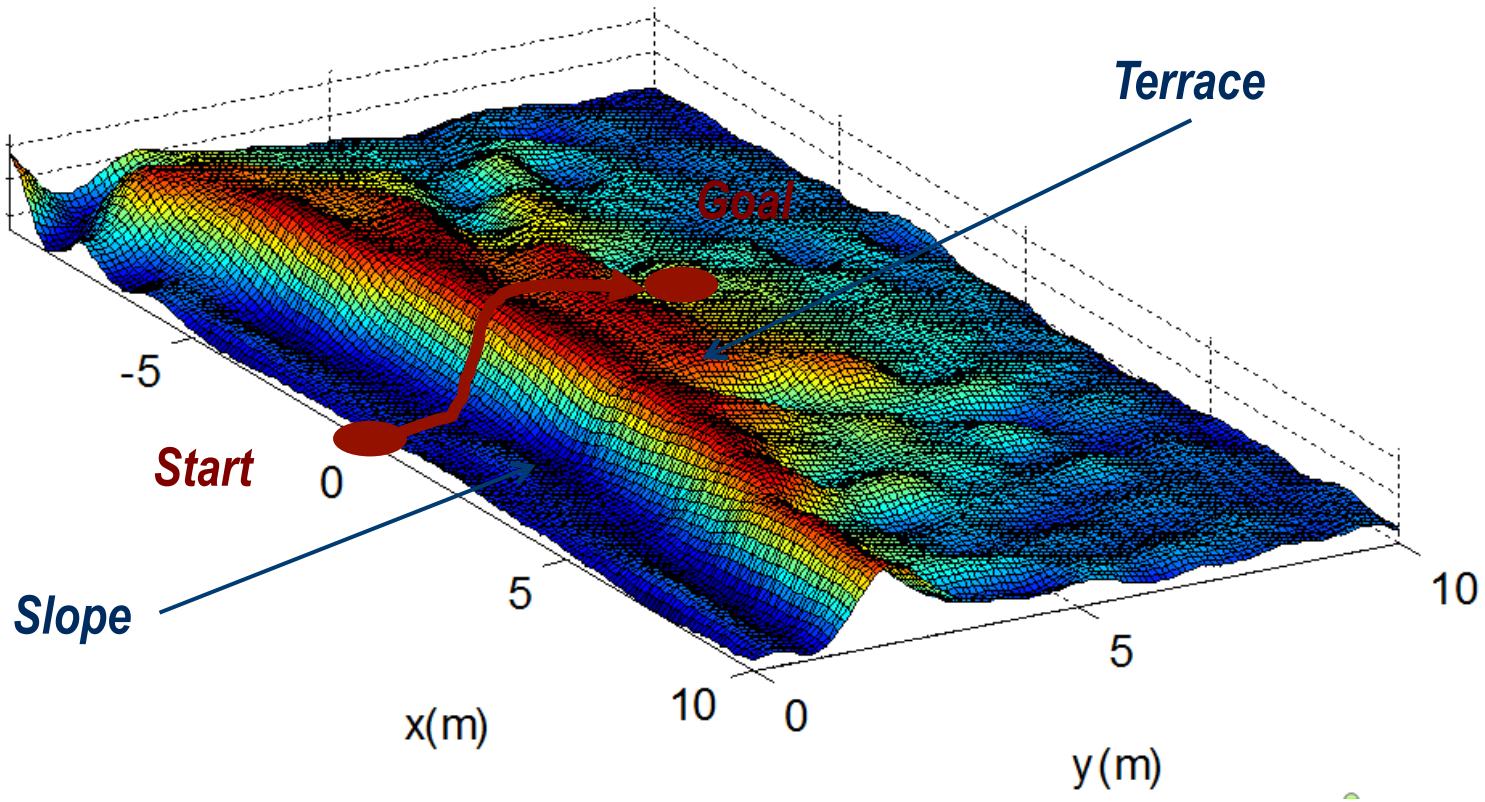
Terraces in natural environments

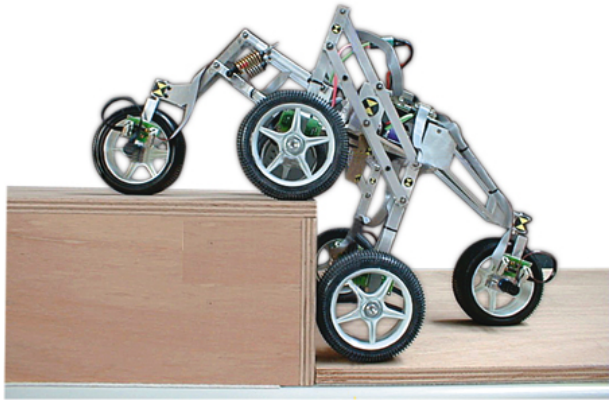


- **Finding and following an alternative path, if it exits, can be very time consuming**

Step Negotiation

- *Problem with conventional tracked or wheeled vehicles*

- *Passive/active suspension systems*



- *Cooperation with an arm:*

The Alacrane Mobile Manipulator

- **Maximum speed:**
  - *0.41m/s*
- **Maximum arm payload:**
  - *50 Kg to 380 Kg.*
- **Working modes:**
  - *Navigation*
    - Tracks
    - Arm base rotation
  - *Arm*
    - All arm joints
    - Outriggers

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Aims of this work

- Automation of the terrace climbing maneuver for the Alacrane mobile robot avoiding teleoperation
- With cooperation of its powerful onboard arm
- Using an onboard 3D laser scanner, an IMU and joint absolute encoders

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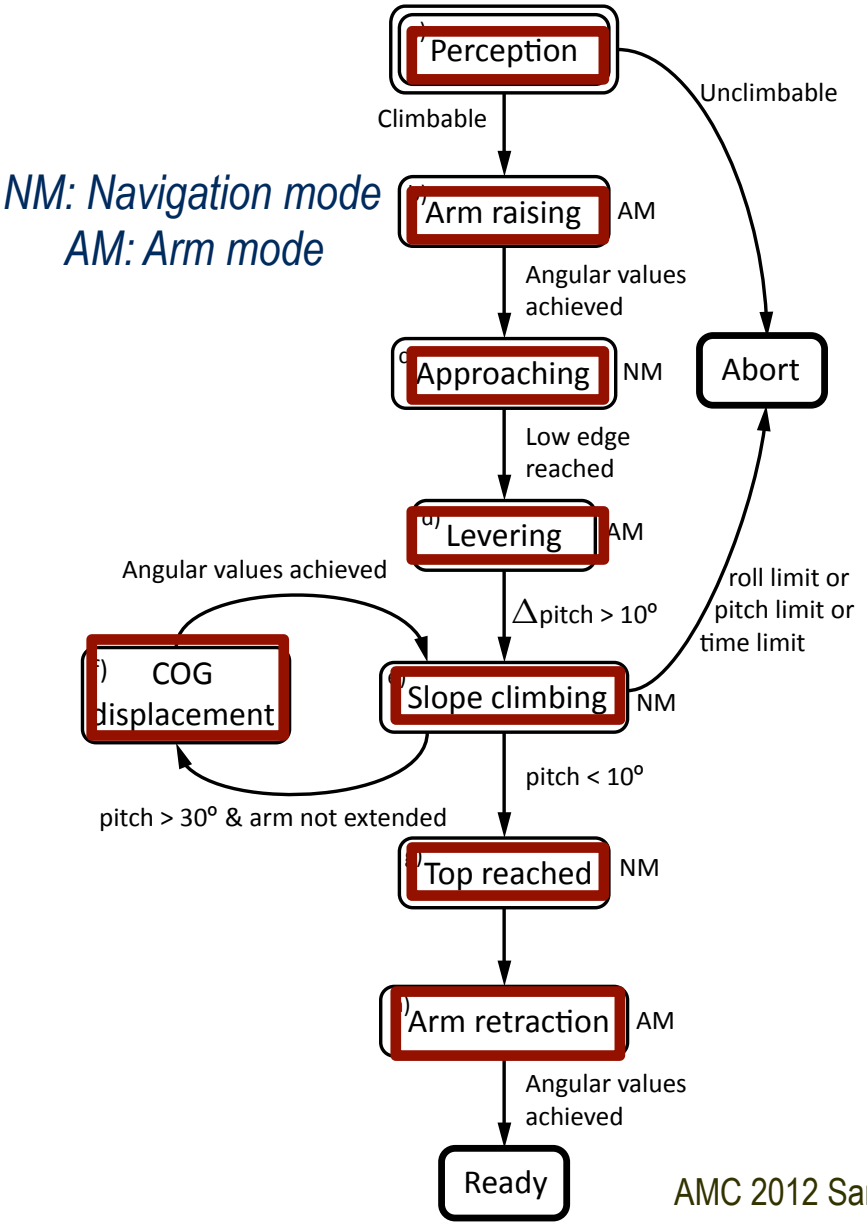
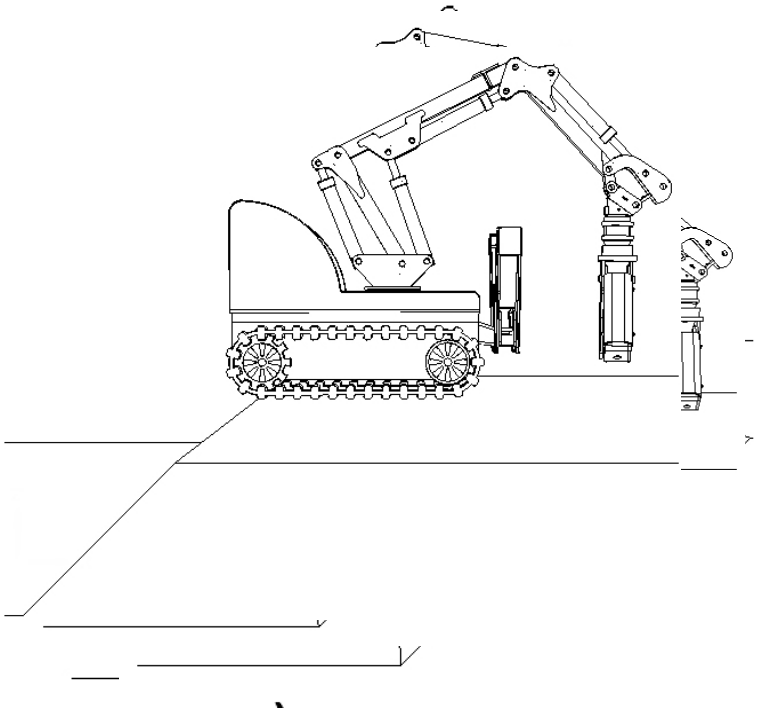
2.
CLIMBING MANEUVER

States





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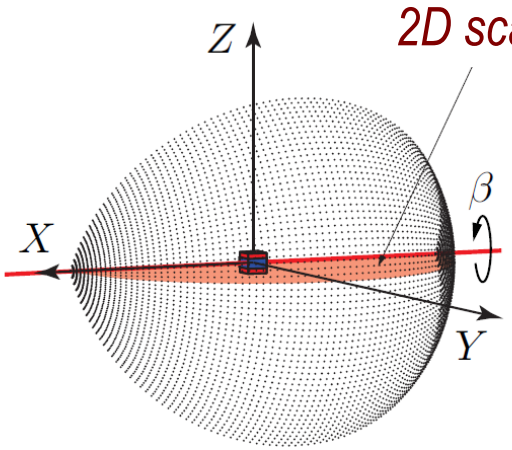
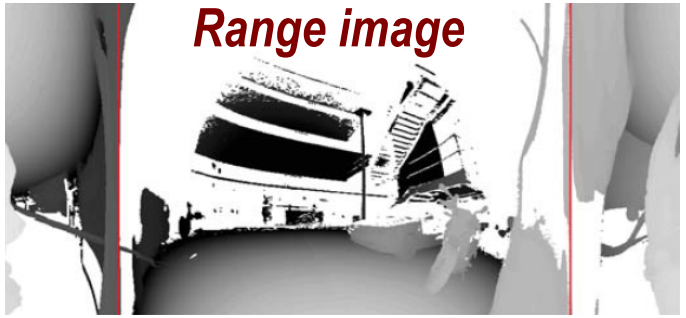
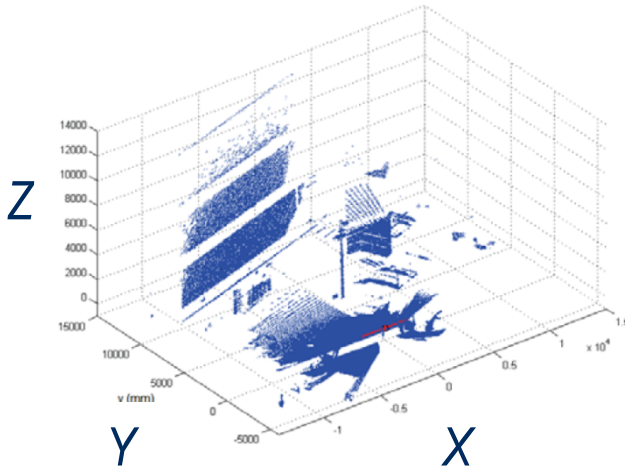
4.
SLOPE PERCEPTION

3D Laser Scanning



3D laser device





Point cloud

Terrace Detection from Range Image

- Firstly, 5 vertical slices of the 3D range image are selected from the forward motion direction. Each slice is composed of 8 adjacent vertical columns.
- Then, the Cartesian coordinates of the points of each slice are averaged and approximated with a polynomial.
- Based on the first and second derivatives of each polynomial, points of the low and high edges are obtained.
- Finally, straigth lines are adjusted to the estimated points of the low and high edges.

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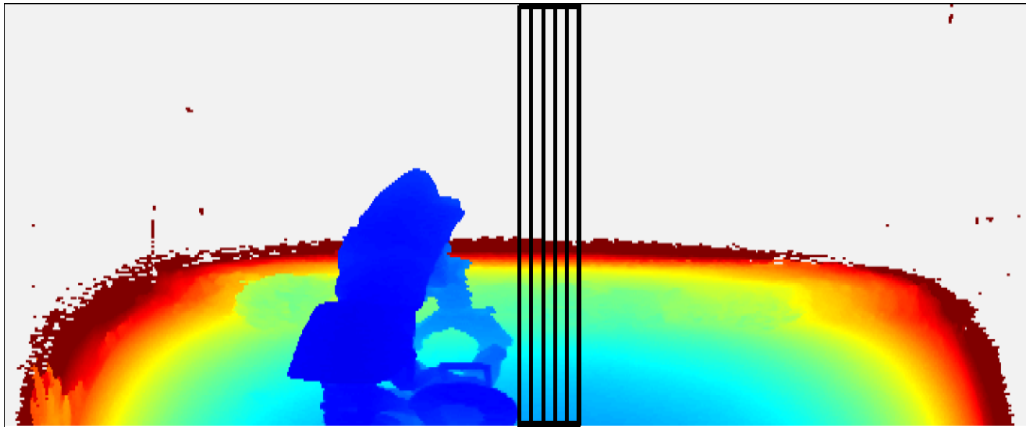
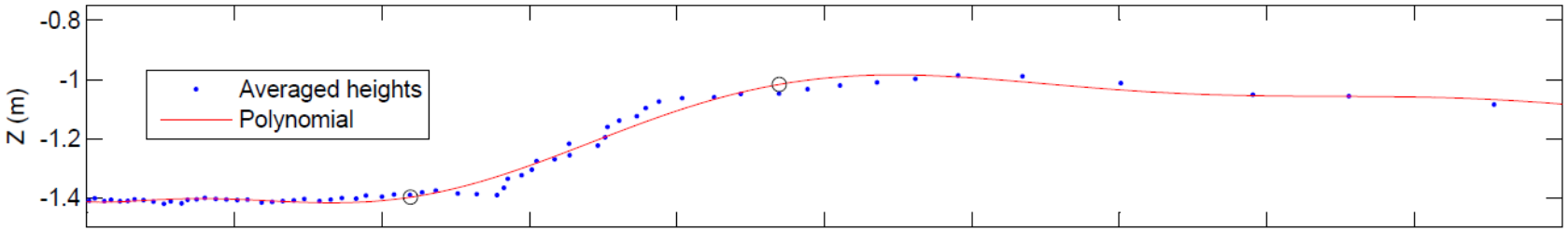
5.
EXPERIMENTAL RESULTS

Terrace Perception

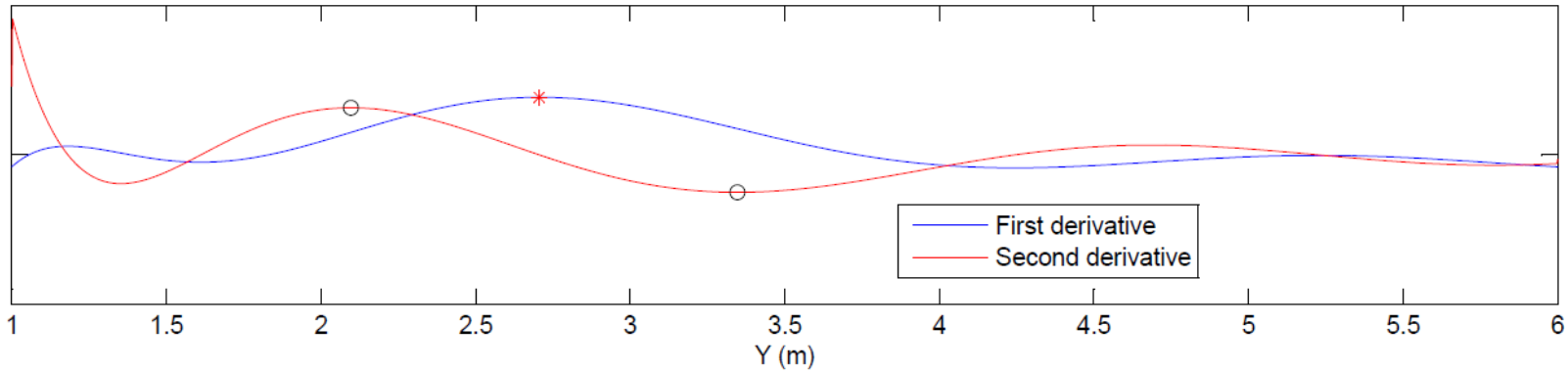


Selected vertical slices

Fitting a Polynomial for each Slice

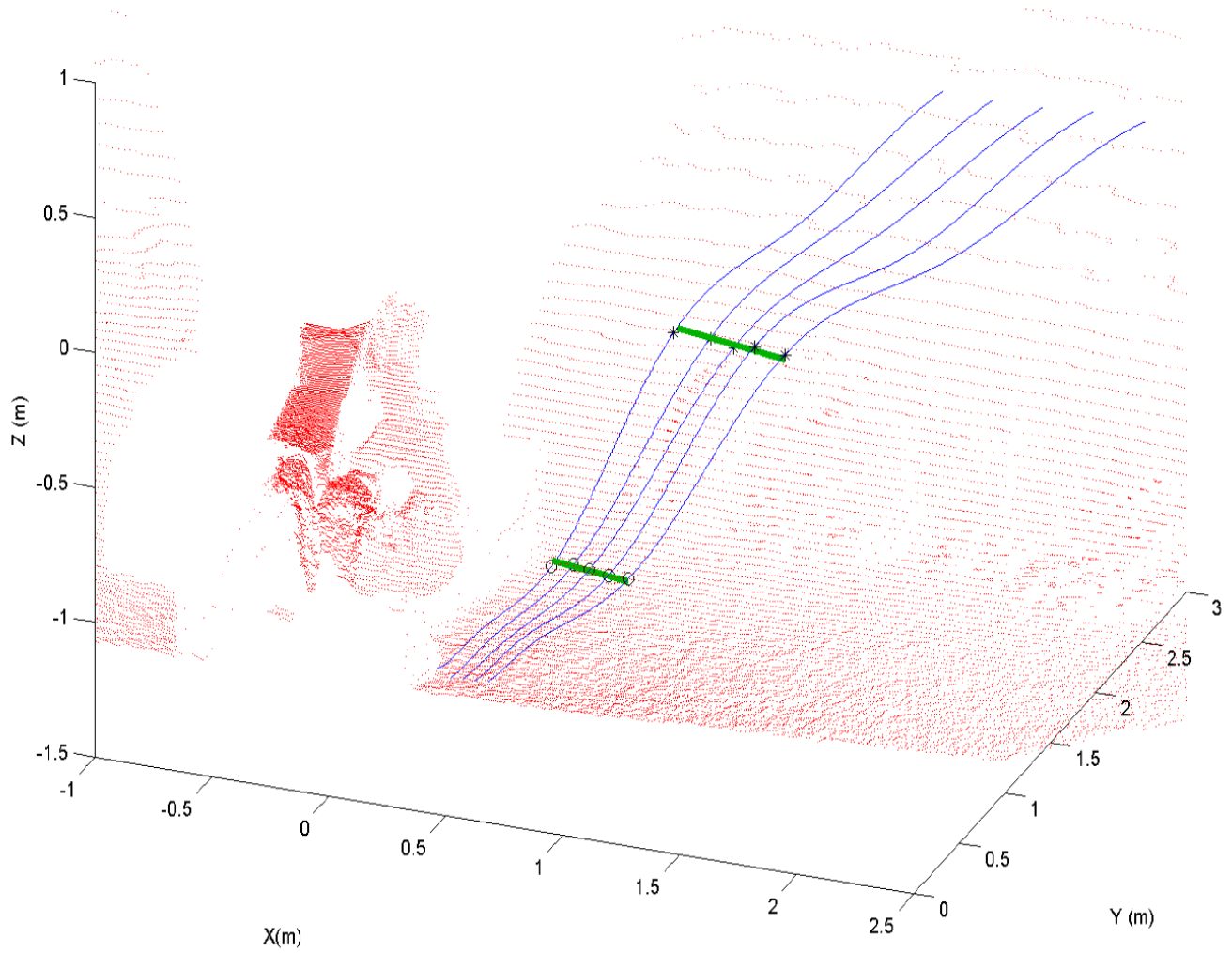


Forward motion direction Y (m)



Polynomial of order 11

Edges of the terrace



Estimated heigh: 0.41 m

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Video


Maniobra de subida autónoma
Robot ALACRANE
Universidad de Málaga
CICYT DPI2008-00553

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6.
CONCLUSIONS

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Conclusions

- **Automation of the terrace climbing maneuver for the Alacrane mobile robot**
- **Cooperation of its powerful onboard arm to**
  - *Push it againts the ground*
  - *Modify the COG of the robot*
- **Fast processing of a 3D range image**
- **Future work:**
  - *Incorporting new reliability tests*
  - *Automation of the terrace descent maneuver*

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Thank you!