TextureCam: Onboard Image Analysis for Rapid Astrobiology Surveys

David R. Thompson
William Abbey
Abigail Allwood
Dmitriy Bekker
Benjamin J. Bornstein
Nathalie A. Cabrol
Tara Estlin
Thomas Fuchs
Kiri Wagstaff

1Jet Propulsion Laboratory, California Institute of Technology
2SETI Institute / NASA Ames
3California Institute of Technology

Contact: david.r.thompson@jpl.nasa.gov

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Extremophile habitat can be sparse

Atacama Desert, Chile [Warren-Rhodes et al., JGR 2007]
Mobility permits fast reconnaissance

Single-cycle traverse length

1m  10m  10^2 m  10^3 m  10^4 m


single-site  multiple-site  over-the-horizon  ARTIST CONCEPTS

2020s and beyond
Multiple scales for a smart camera

Navigation imagery to 20m
Multiple scales for a smart camera

Navigation imagery to 20m

Classify geologic surfaces

Images: Caltech / NASA / JPL / Alliance Space Systems

NASA ASTID / Caltech / JPL / Instrument Software and Science Data Systems
Multiple scales for a smart camera

Navigation Imagery to 20m

Classify geologic surfaces

Priority locations for approach, followup measurements

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Multiple scales for a smart camera

- Navigation imagery to 20m
- Classify geologic surfaces
- Priority locations for approach, followup measurements
- Context images to 10m
Multiple scales for a smart camera

- Navigation imagery to 20m
- Classify geologic surfaces
- Priority locations for approach, followup measurements
- Context images to 10m
- Maps of stratigraphy, weathering and exposure
Multiple scales for a smart camera

Navigation imagery to 20m

Classify geologic surfaces

Priority locations for approach, followup measurements

Context images to 10m

Maps of stratigraphy, weathering and exposure

Selective sampling by remote and arm-mounted instruments

Images: Caltech / NASA / JPL / Alliance Space Systems

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How it works

A. In advance
Build statistical models of geologic surface appearance

Original image: NASA/JPL/Caltech/Cornell
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Classify new image pixels

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Ancillary data (here, stereo height)
Single- or multichannel images

Analyze local patterns

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Single- or multichannel images

Analyze local patterns

Surface classification for new scene

Manual labels

Original image: NASA/JPL/Caltech/Cornell
Typical result

Original image: NASA/JPL/Caltech/Cornell
Classification exploits any available input data

- Classification based on pixel intensity data only
- Classification incorporating stereo data (most important for large protruding rocks)

ROC Performance for Legacy panorama

[Thompson et al., iSAIRAS 2012, submitted]
Probability maps

Confidence scores add flexibility, reduce risk

Stromatolite
Western Australia

Stratigraphic probability
[Thompson et al., LPSC 2012]
This study: a sampling “exposure index”

1. No significant dust deposition
2. Smooth, fracture-free
   • Labeled good surfaces on a single training image, along with some examples of sediment
   • Image space only
Result on PIA-014132

A

B
Other applications

- Volcanic Plume detection [McLaren et al., SPIE 2012]
- Rock detection [Thompson et al. i-SAIRAS 2012]
- Layer detection
- Morphology analyses for Primitive Bodies Exploration

Plume detection for height analysis, Eyjafjallajökull volcano
Thanks!

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Contact
david.r.thompson@jpl.nasa.gov

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