Event Based Sensors for Space Applications

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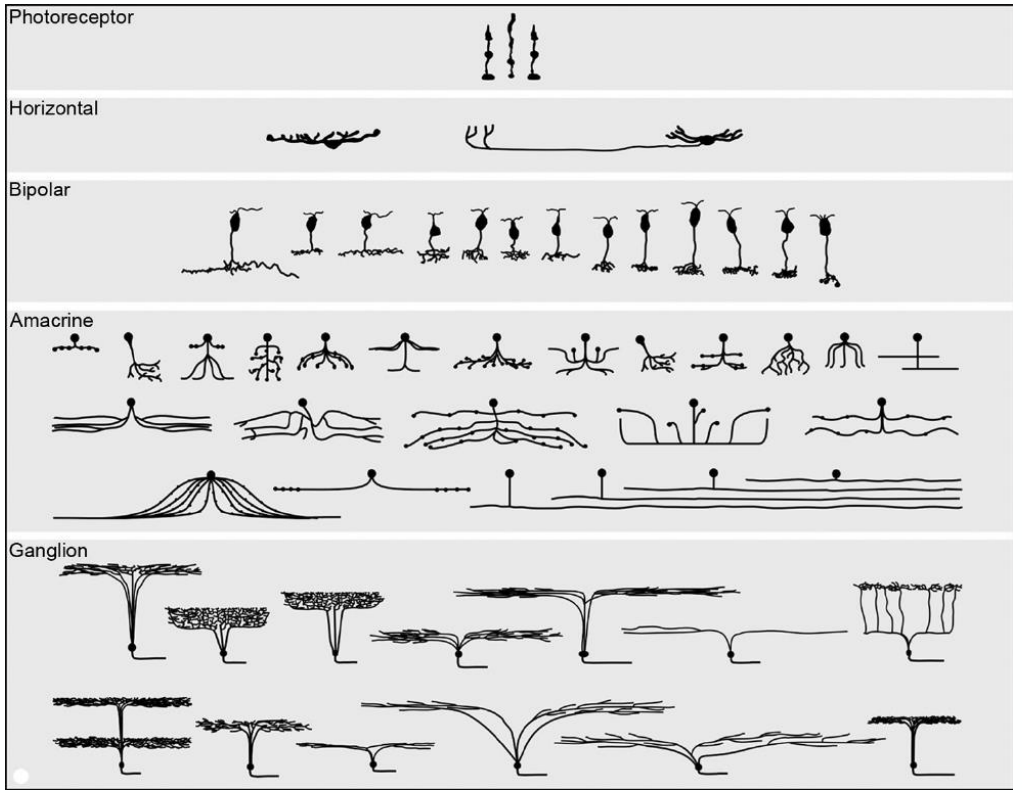
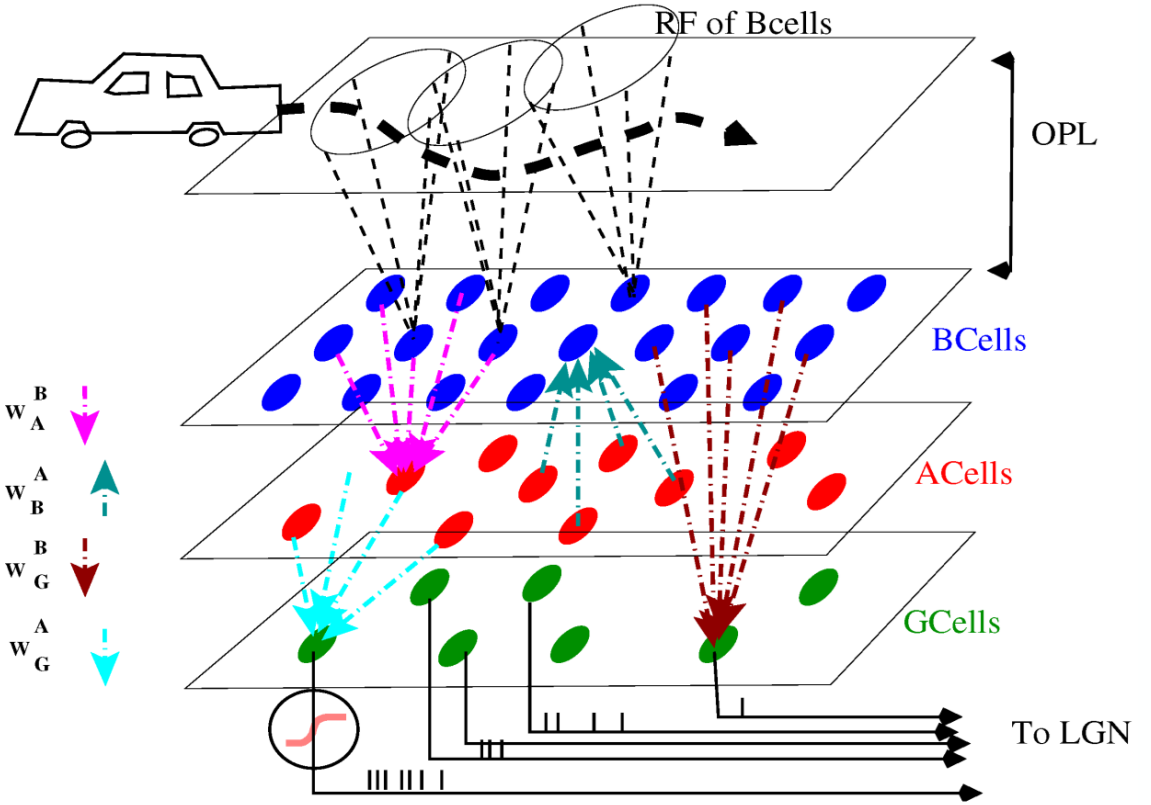
Biologically inspired retinal models



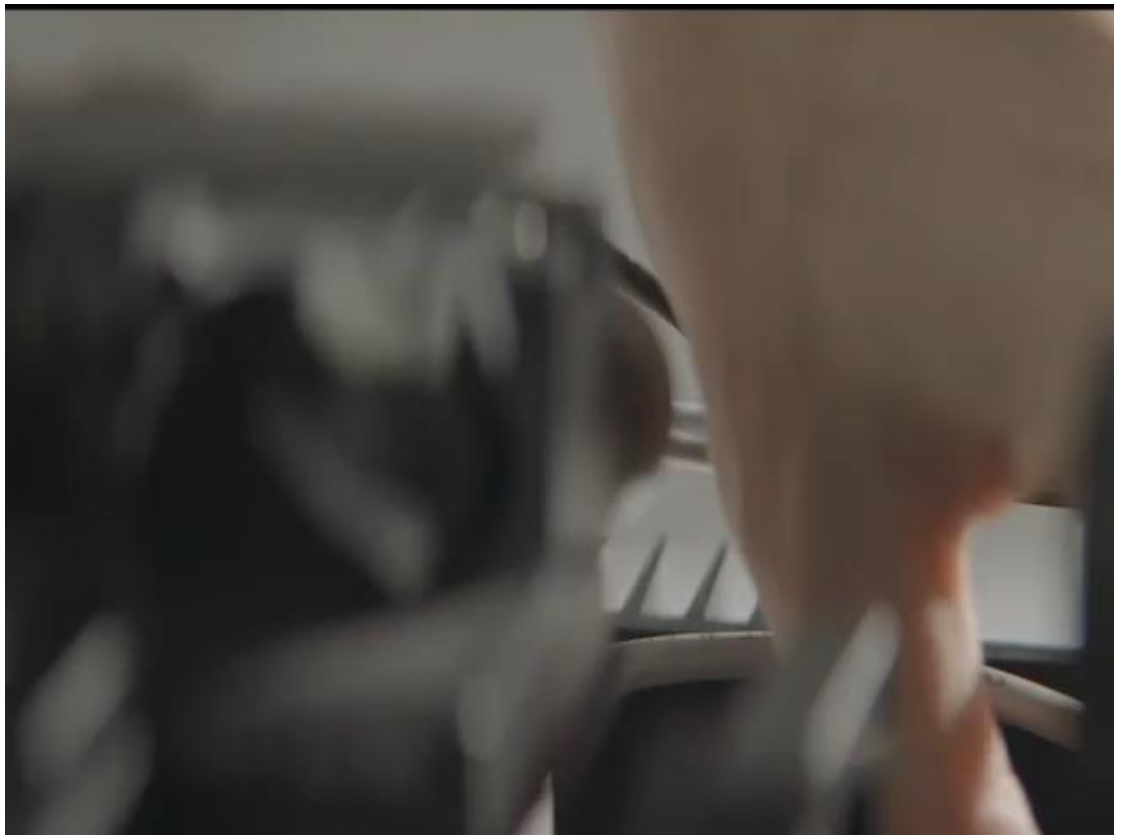


Event-based cameras

Event-based cameras as hardware retinal models

Basic idea: convert analogue visual into events

- Capture (logarithmic) **changes** in illumination
- If the change is greater than a threshold, produce an event (spike)
  - The change can be in either direction
  - Reset the threshold to the current input
- Completely **asynchronous** pixels!



Credit: Metavision®

Relevance for the space sector

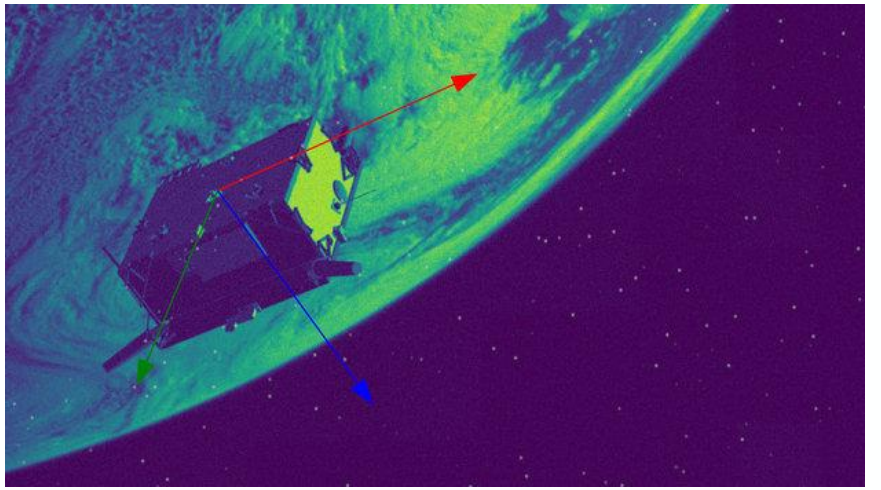
Shortcomings of classical vision-based sensors

- Limited dynamic range (edge detection)
- Limiting configurations / illumination conditions (Sun-facing, reflectors)
- **Unnecessary data acquisition and processing**
  - High data rates required for fast acquisition
  - Compromise resolution / acquisition rate

Event-based cameras

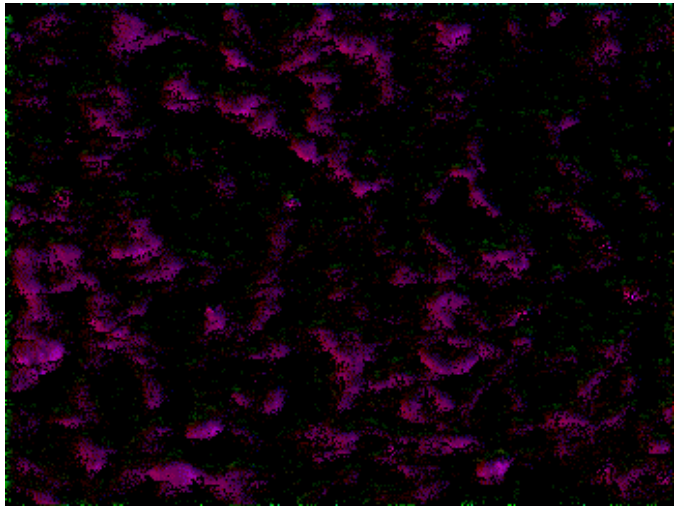
- **High dynamic range**
- **Sparse event output**
- **Low power consumption**
- **Low latency**
- **High temporal resolution**

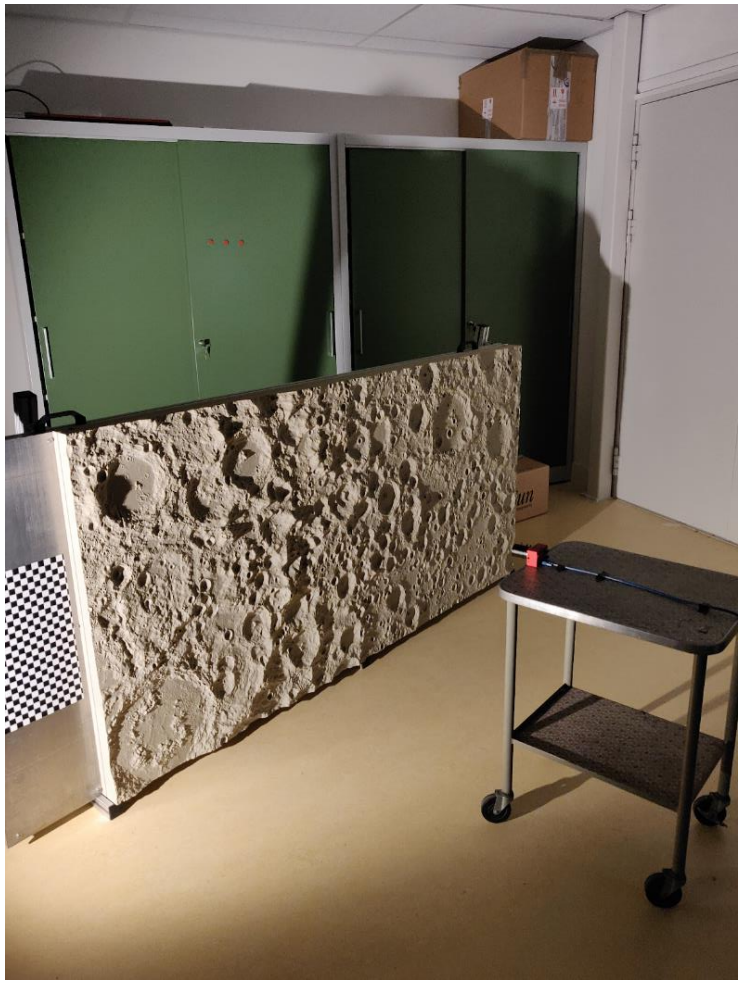
→ **Applications for Pose Estimation, Planetary Landing, RV&D**



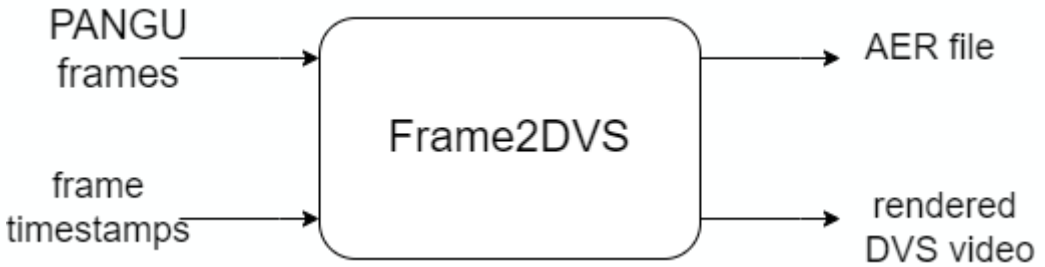
Exploratory Activities – Optical Flow Reconstruction

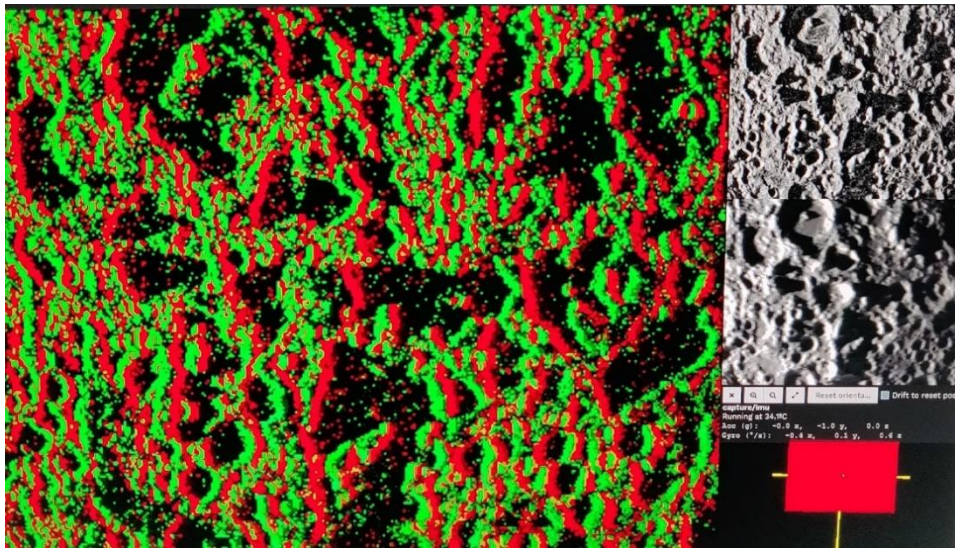
- **Collaboration with TEC-SAG** : DAVIS 346 camera
- Use of the GRALS facilities (mechanical arms)
- Reconstructing optical flow using spiking neural networks

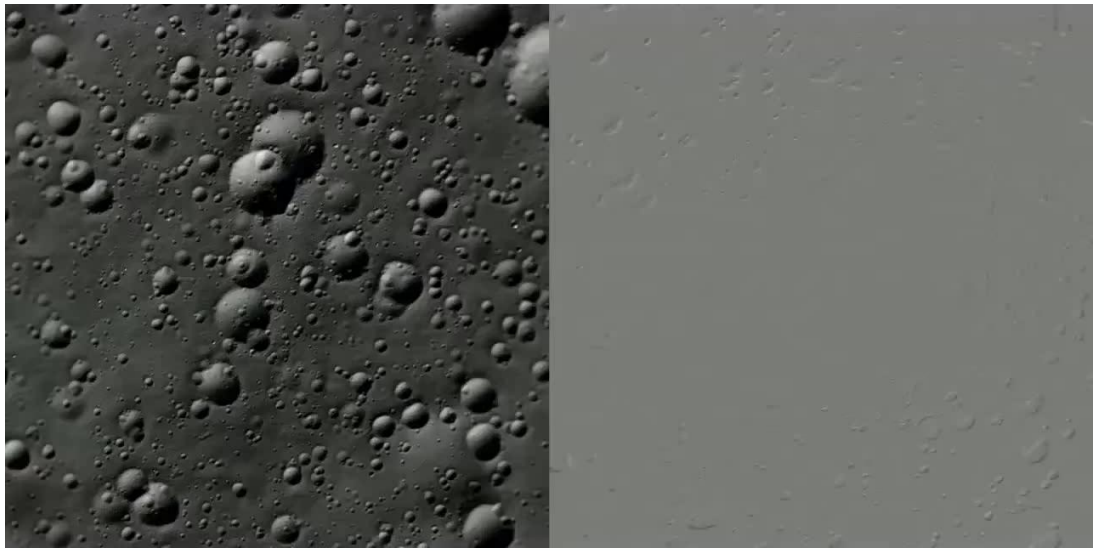




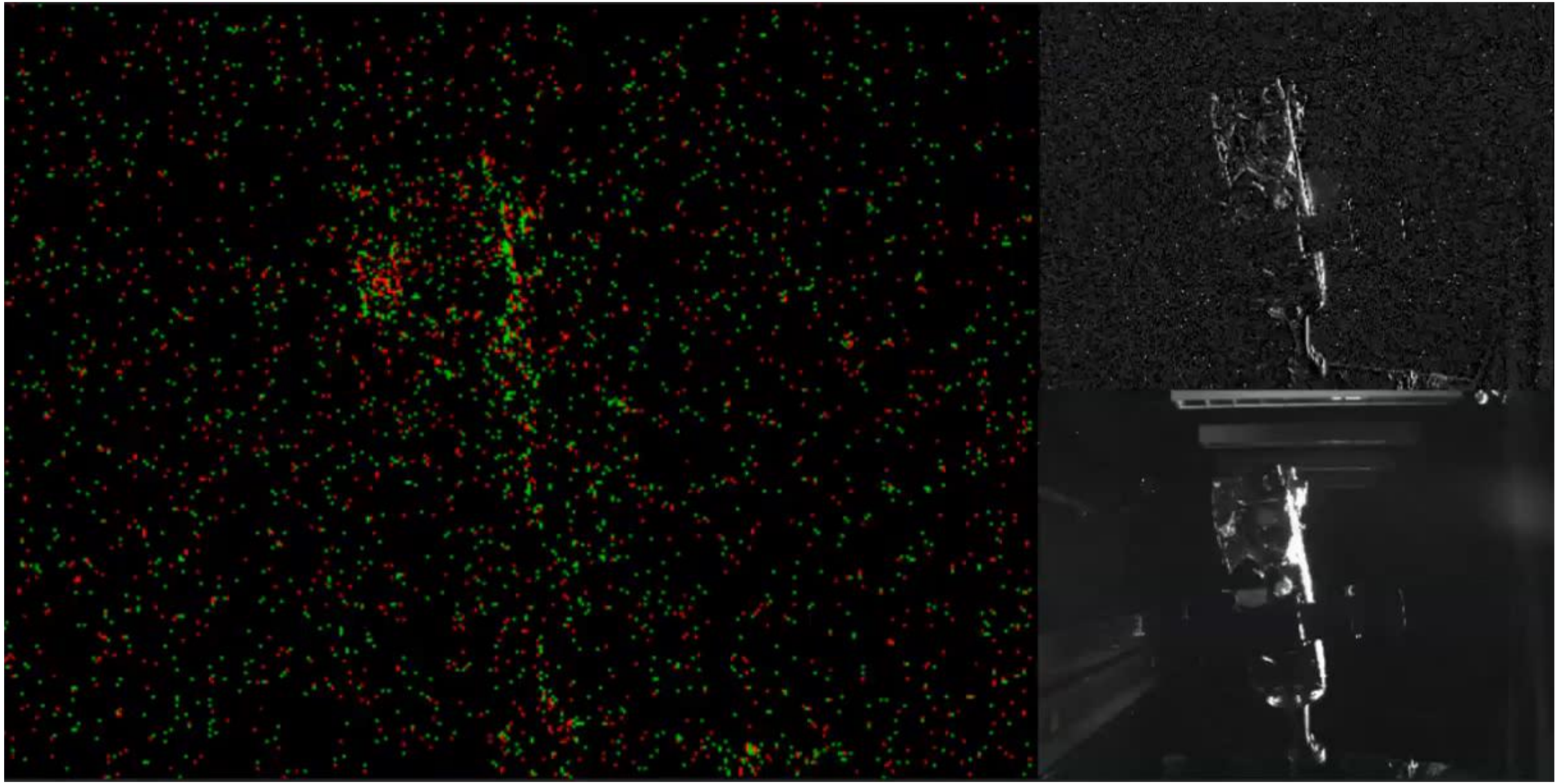
Exploratory Activities – Planetary Landing







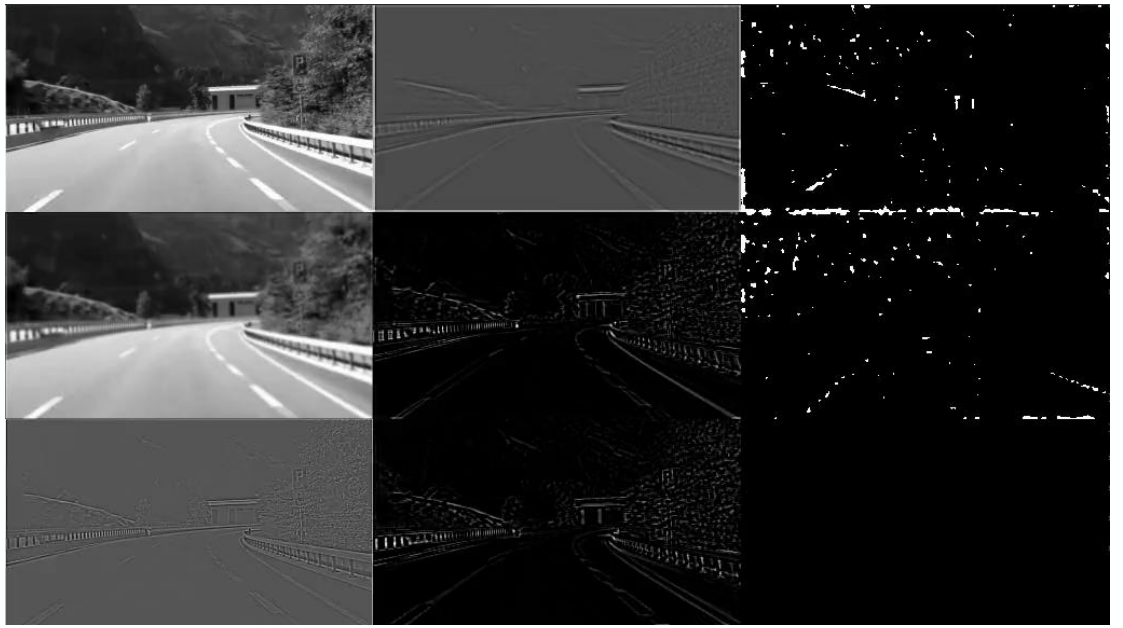
Exploratory Activities – Pose Estimation, RV&D



Exploratory Activities – Analogue sensors

More realistic retinal models

- A hierarchy of artificial sensors that mimic retinal cells
- But only in simulation for now
  - We want to implement it in hardware to make it work in real time!



Simulation of adaptive retinal model

Exploratory Activities – Analogue sensors

More realistic retinal models

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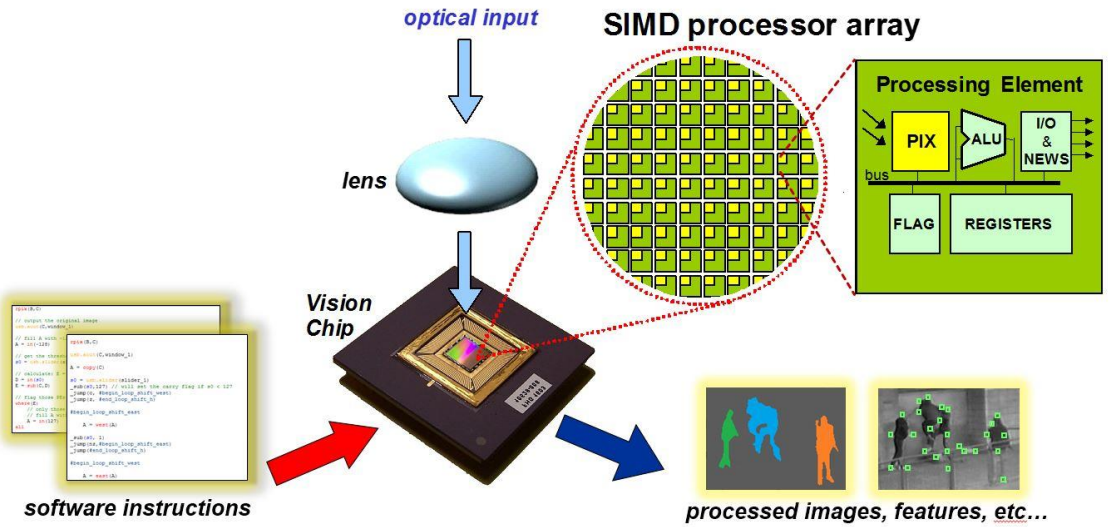
  - We want to implement it in hardware to make it work in real time!

Candidate hardware platforms

- SCAMP5 analogue sensor
  - Massively parallel architecture
  - Very low power consumption
  - Easy to implement various CV algorithms
  - Most of the advantages of current event-based cameras with less artifacts and drawbacks



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