Physics-Enriched Co-Registration for Satellite On-Board Processing

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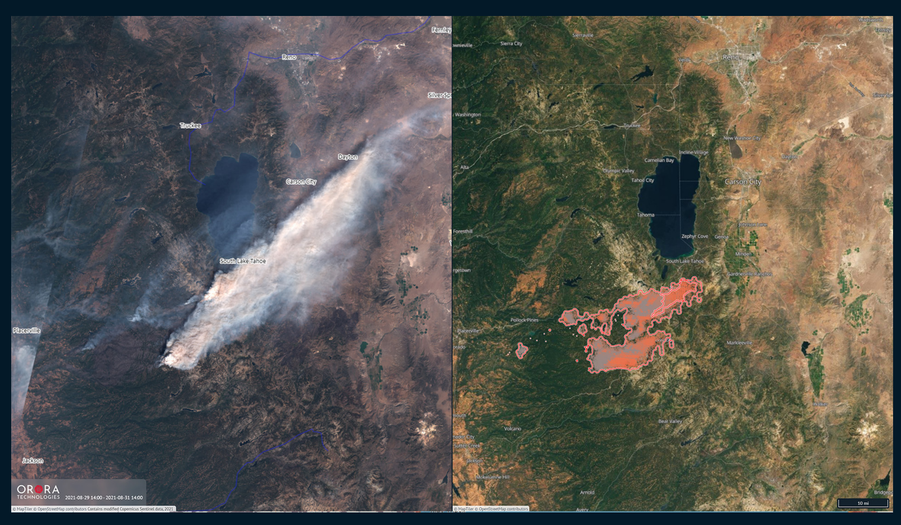
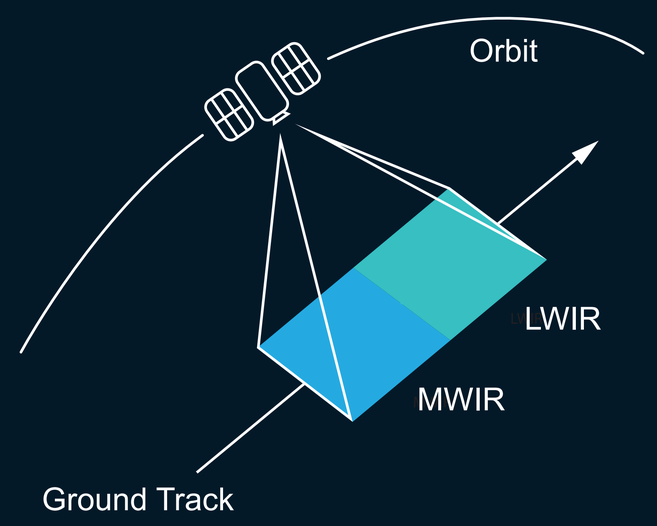


OroraTech's Mission

- Wildfires have immense impacts on people, biodiversity, economies, and CO_2 emissions.
- Need for real-time fire detection on a global scale
  - → Extend capabilities of existing IR-imaging satellites with OroraTech's CubeSat constellation
    - → IOD mission launched **01/2022**, next launch **2023**
    - → Equipped with an IR detector, sensitive to mid- and long-wave IR bands
    - → Capable of processing data on-orbit and downlinking detected fires via inter-satellite communication

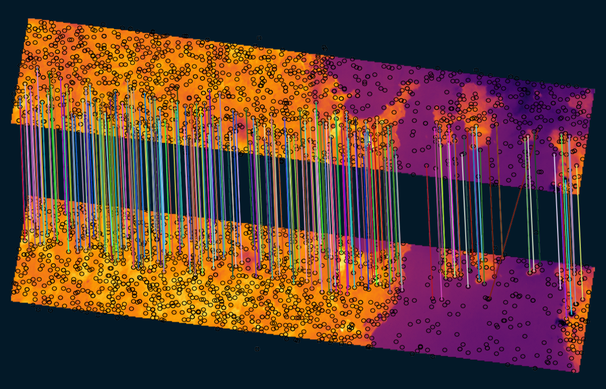
Challenge

- Fire detections needs multispectral product
- Sensor/filter assembly introduces temporal and spatial offset between bands
- ADCS has insufficient knowing accuracy for direct georeferencing of images
  - → Need for real-time image-to-image co-registration in an environment with limited compute resources



Traditional SIFT

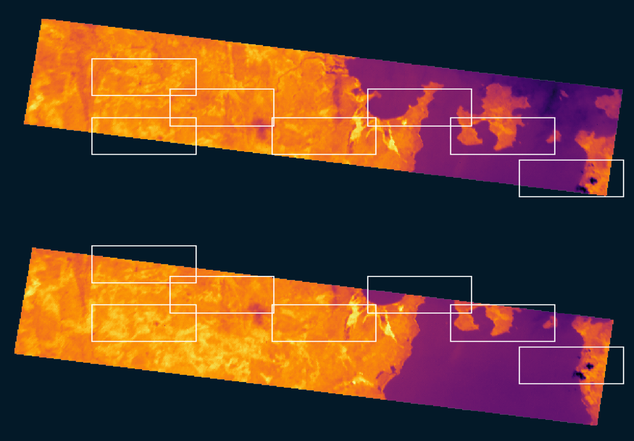
Step 1: Find match points via SIFT



- X Difficult to parallelize
- X Obvious incorrect matches possible
- X Scales with $O(n^2)$ with image size n

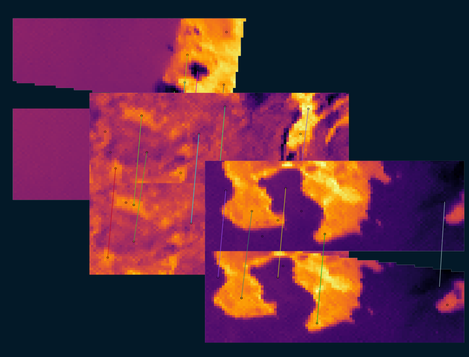
Physics-enriched SIFT NEW

Step 1: Define small windows via physical & sensor data of the satellite



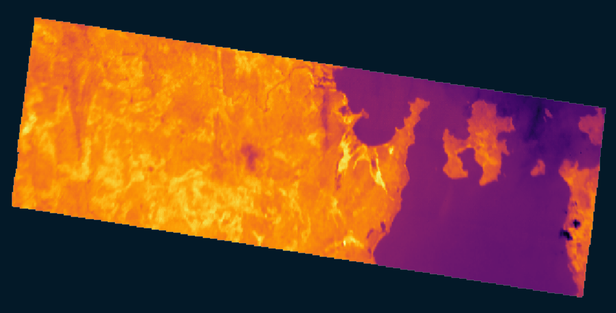
Ignore low contrast areas, e.g. oceans

Step 2: Find match points via SIFT or PhaseCrossCorrelation in small windows



- ✓ Easy parallizable
- ✓ Scales with $nb\_boxes * O(m^2)$ with box size m $(m<<n)$

Step 3: Find transformation by using all match points



Result:

High speed-up: e.g. >6x for 540x200 pixel
No loss in accuracy over landcover
Further speed-up easily archivable through paralellization

Partially funded through SERAFIM research grant by the Government of the Free State of Bavaria, Germany

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