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An open-source toolset for automated processing of historic spy photos: sPyMicMac

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First launched in 1971, the KH-9 “Hexagon” reconnaissance satellites were operational until 1986. In addition to the high-resolution main cameras, the satellites had a secondary camera system, the mapping camera, which acquired images at approximately 6-10m ground resolution. These images, declassified in 2002, provide an unparalleled ability to extend records of elevation change over areas of the world where older data, typically from aerial photogrammetry, are missing, unavailable, or unreliable, including High Mountain Asia and the Arctic. These images are not, however, free from challenges. Storage and film processing have introduced warping into the images, and the large film format means that images are scanned in halves which must be precisely re-aligned for photogrammetric processing.

Building on previous efforts, we have developed an open-source toolset, based in python, that performs several of the steps necessary for processing digital elevation models (DEMs) from the raw imagery within MicMac. These include precise re-alignment based on dense keypoint detection, automated detection of the reseau field to aid in un-warping of the images, color balancing to increase contrast in low-contrast areas, and automated detection of ground control points using modern orthorectified satellite images such as Sentinel-2 and Landsat 8, and high-resolution digital elevation models such as ArcticDEM. Each of these tools interface with the MicMac photogrammetry software package that performs each of the steps necessary for DEM extraction.

We have tested this toolset on scenes from Alaska, Iceland, and Norway. Comparison to external elevation datasets such as NASA’s Ice, Cloud and Elevation Satellite (ICESat), ArcticDEM, and national elevation products yields agreement of better than 10 m root mean square error over stable terrain, even in mountainous areas. In particular, we obtain satisfactory results in remote areas where precise ground control measurements are difficult to obtain. This toolset provides the ability to easily extend records of precise elevation change in areas where very little historic data exist. In addition, the GCP matching routine can be used to process other air photo datasets,

providing a useful tool for processing older photo archives.