

PyExpress - A pipeline for fast and reliable UAV image processing in vineyards

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Introduction

Increasing drought presents a major challenge to viticulture, affecting grape yield and quality. Unmanned aerial vehicles (UAVs) offer a promising solution by enabling high-resolution, non-invasive detection of drought stress through infrared, multispectral, or visible imaging sensors. UAV-derived data closely correlate with ground-based drought measurements and support plot-specific management and model validation. Despite growing use, there is still a lack of fast and robust image processing tools, especially for complex vineyard terrain. This study addresses this gap by developing software for automated photogrammetric analysis to support decision-making in grapevine production.



Material and methods: The PyExpress package

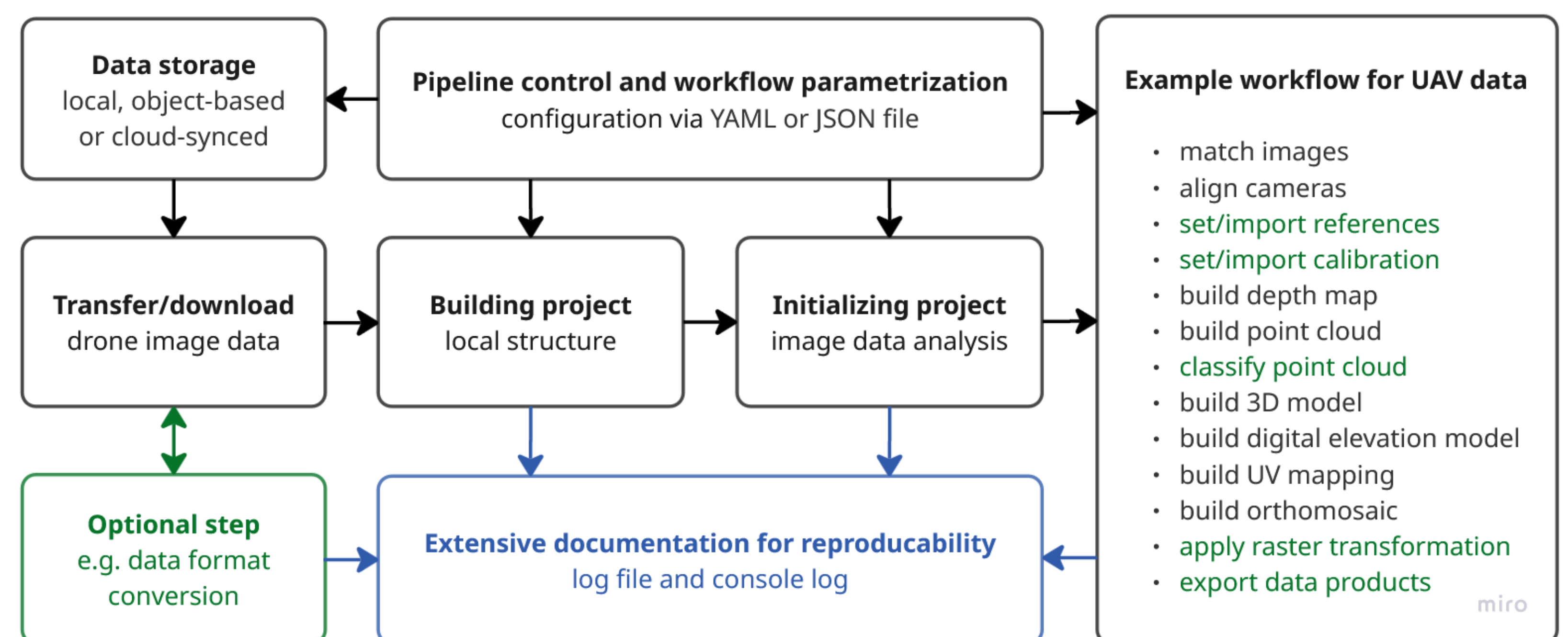
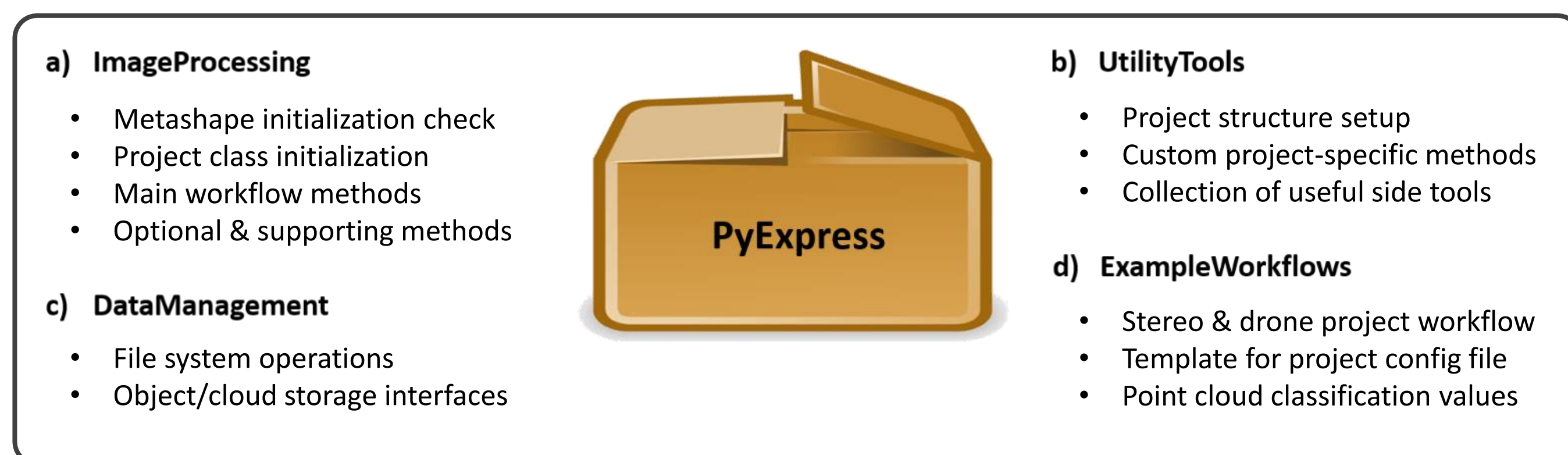


Figure 1: Left – Overview of the photogrammetric analysis package PyExpress, version 1.0 (Kobe et al., 2025), developed in the context of the EXPRESS project (Express, 2025). The included packages and modules are continuously being developed and expanded. Right – Schematic overview of a fully automated and customizable workflow for photogrammetric drone data analysis from raw imagery to 3D data products using PyExpress. Optional steps are shown in green; recommended core steps from both PyExpress and Metashape, ensuring robust performance, are shown in black; extensive workflow documentation is highlighted in blue.

Results and discussion

PyExpress enables robust, high-quality analysis of UAV-based infrared, multispectral, and RGB datasets under diverse conditions, including drought stress in vineyards. In a case study conducted in Seußlitz, Germany, PyExpress accurately extracted canopy temperature and calculated the Crop Water Stress Index (CWSI) using automated, customizable workflows. The software supports rapid and reliable photogrammetric image analysis and is currently applied to time-series from four years of UAV monitoring in Seußlitz to support data-driven decision-making in agriculture.



Figure 2: Example data products generated by PyExpress software using automated data pipelines based on the analysis of UAV IR and RGB imagery acquired in a vineyard in Seußlitz, Saxony. (a) Orthophoto of the experimental area. Management zones (blue) and microclimatic stations (red) for further research are shown. (b) Surface temperature map obtained from the example workflow shown in Fig.1. (c) Crop Water Stress Index (CWSI) calculated from grapevine canopy temperature data, filtered using point cloud classification to exclude surrounding soil (Boedeker et al., 2024). Additional outputs generated by PyExpress include point clouds, 3D models, precision maps, and workflow documentation to support advanced agricultural analysis.

References

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Contact, Partners, Funding

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