Design of 3D geometry field acquisition workflow: adopting photogrammetry and cross-dimensional mapping techniques

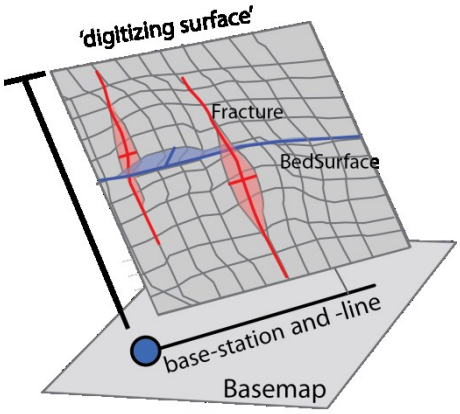
Research context: Textured surfaces descriptions from LiDAR or photogrammetry form rich dataset and backdrop for building 3D geometric models of not only buildings but also of geologic structures like rock layering and faults. DigiFract is a TUDelft in-house developed geologic field acquisition software dedicated to the description of fracture-fault geometries from the field (Hardebol and Bertotti, 2013). Currently geometries are acquired as 2D geometries on a planar outcrop surface that is placed in a 3D cartesian world. Our ambition is to capture 3D geometries from textured surfaces immediately in the field as input for geological models and for numerical simulations.

Research outline: We designed new algorithms for describing 3D geometries on textured surfaces and achieve on-the-fly cross-mapping between 2D and 3D coordinate spaces. This code is wrapped to Python (a Matlab-ish scripting language).
Your task will be to perform benchmark experiments with this new library for a specific controlled 'field' environment. The foreseen steps of the project will involve:

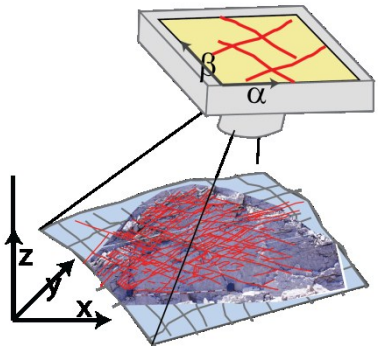
(1) Arrange a test environment in our rock deformation lab of a deformed ft^3 rock sample in an established 3D coord. system
(2) Design with a 3D CAD the ft^3 rock cube (your 'true world').
(3) Take photos of the ft^3 rock sample under arbitrary, yet known view parameters and map it as texture on the 3D CAD object.
(4) Repeat step (3) but this time the view parameters are unknown and determined from control points on both photo and object.
(5) A final test of the newly designed algorithms is to capture 2D geometry description of fractures in the ft^3 rock sample that you digitize on 2D photos and (on-the-fly) map them into 3D space.

The task will re-use commonplace photogrammetry techniques (e.g. find M for collinearity equation using control points) for the cross-mapping of complex geometries. The study will provide an important benchmark of new algorithms that are being designed and implemented in our DigiFract software. This is new and greatly relevant a new generation of geologic field studies in which complex fracture-fault networks are captured.

(a) capturing 3D geometries



(b) cross-mapping between 2D & 3D space



Supervision: The work will be performed at the Faculty of Civil Engineering in cooperation with the section of Applied Geology (Dept. of Geosciences and Engineering). You will receive daily supervision from Roderik Lindenbergh and Ben Gorte concerning the geometics and Nico Hardebol concerning the geological application and DigiFract geometry modelling environment. This project will also give you good opportunity to work in a team with C++ developers who welcome benchmark results for further code refinement. This topic is suitable for BSc students in Civil Engineering, Applied Earth Sciences and Geomatics. The project can be partly tuned to fit the interested student.

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Hardebol, N.J. and Bertotti, G., 2013. DigiFract: a software and data model implementation for flexible acquisition and processing of fracture data from outcrops. Computer and Geoscience. 10.1016/j.cageo.2012.10.021.