Acquisition and assessment of geometric rock mass features by true 3D images

Andreas Gaich, 3G Software & Measurement GmbH, Austria

Markus Pötsch, Wulf Schubert, Graz University of Technology, Austria

The contribution presents a data acquisition and analysis system for the easy and quick recording and measurement of the visible geometric features of rock faces. An off-the-shelf SLR camera is calibrated and used to take at least two pictures of an arbitrary rock mass region (stereoscopic image pair). During imaging the camera can be posed freely without any prior or posterior knowledge on the camera locations. This becomes possible by observing a vertically established range pole somewhere in the image area and a strong camera calibration, as well as using Computer Vision principles.

From the stereoscopic image pair a metric 3D surface model is automatically computed and aligned with one of the pictures leading to a *true 3D image.* A true 3D image therefore consists of a real photograph combined with three-dimensional information.

In contrast to traditional photogrammetry no surveying or reference points are required in advance to generate the metric 3D image. Reference points are used only if a relationship to an exterior co-ordinate system shall be established.

Larger areas can be acquired by joining several 3D images together by image matching in overlapping regions.

Once a 3D image is ready geometric measurements can be extracted. A purpose built 3D software allows assigning visible rock mass features directly on the 3D image. Discontinuity orientations given by dip and dip direction can be measured without any physical contact, i.e. there are no restrictions due to time, access or weather conditions. The software allows geological mapping providing a virtual tape measure and a virtual compass-clinometre device.

Interactive mapping of the visible rock structures is supported by several automatisms. Following a discontinuity trace is enhanced by automatic image processing. Morphological analyses, such as automatic determination of discontinuity extension or discrimination between joint sets, are possible. Furthermore, joint orientations are visualised in stereographic projections with the according statistics, such as cone of confidence or Fisher constant. Another feature determines automatically the joint normal spacing, the joint frequency, and the trace length distribution.

Direct exports into CAD or standard spreadsheet applications ensure linking the results to existing frameworks.

Accuracy of the final surface measurements depends besides the camera calibration and the automatic detection of corresponding features also from the quality of the range pole establishment (measurement in local co-ordinates) or the quality of reference points (measurement in global co-ordinates).

The system was applied in different field of rock engineering, tunnelling, mining, as well as in blasting.

The advantages of using this 3D imaging technology are several: (i) fast and easy-to-use system for determining the geometry of a rock face leading to a permanent documentation, (ii) wide operational range from below 1 m to above 1.500 m, (iii) optimal cost/performance ratio due to relatively cheap hardware components, (iv) ability to analyse even large portions of rock masses thoroughly including inaccessible parts, (v) ability to identify features that are otherwise not apparent when working too close to a rock face.

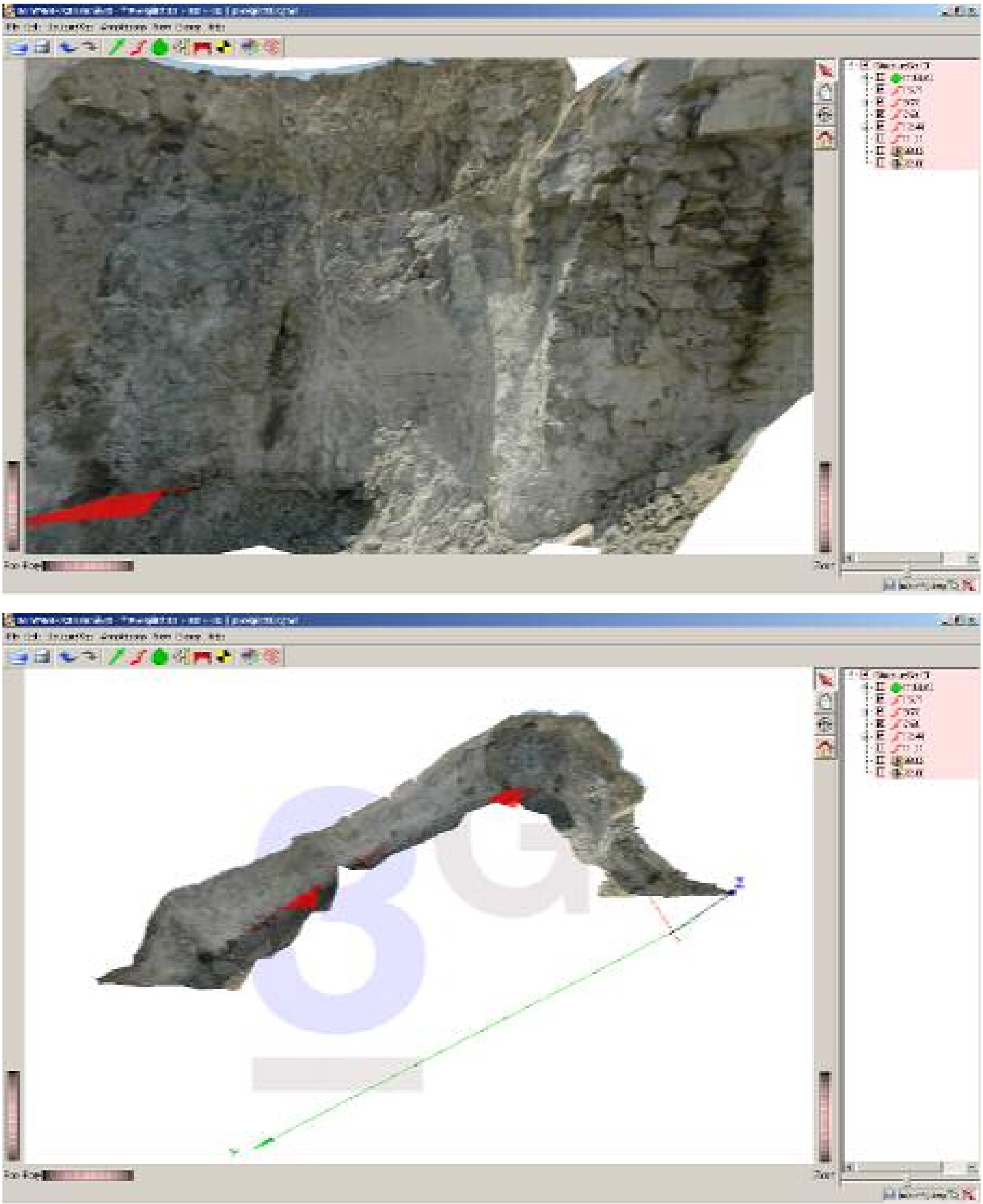

Figure 1: Snapshots of the software assessing a 3D image. The 3D image was composed from three parts taken in a Platinum mine in South Africa showing an area of about 25 m by 150 m at a resolution of about 1cm per pixel.

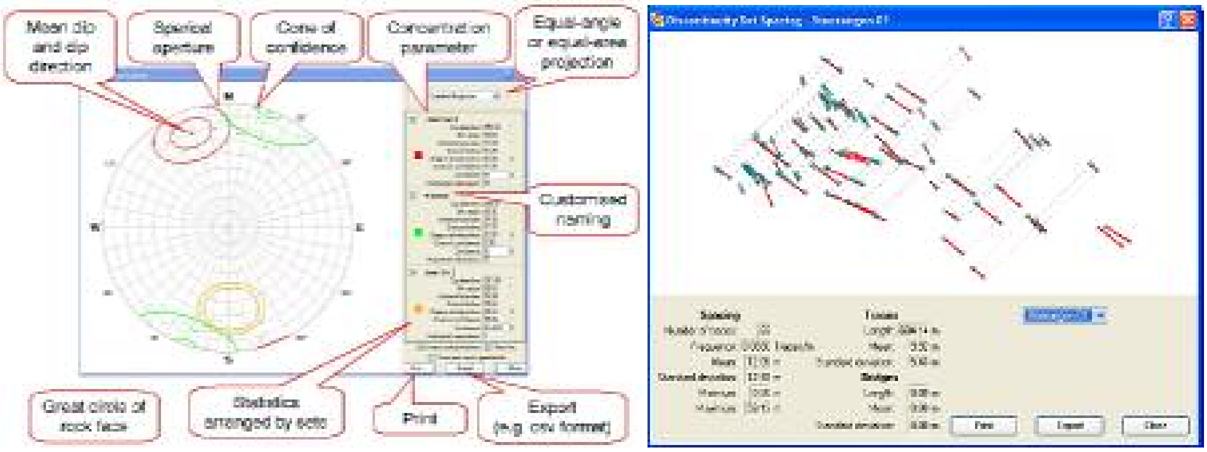

Figure 2: Snaphots of the 3D assessment software showing an automatically generated stereographic projection and a sketch for the determination of joint normal spacing.

Key words: 3D image, photogrammetry, automatic feature detection, spacing, rock mass characterisation, tunnelling, mining, blasting.