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Application of Reflectance Transformation Imaging Technique to Improve Automated Edge Detection in a Fossilized Oyster Reef

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The world's largest fossilized oyster reef is located in Stetten, Lower Austria excavated during field campaigns of the Natural History Museum Vienna between 2005 and 2008. It is studied in paleontology to learn about change in climate from past events. In order to support this study, a laser scanning and photogrammetric campaign was organized in 2014 for 3D documentation of the large and complex site. The 3D point clouds and high resolution images from this field campaign are visualized by photogrammetric methods in form of digital surface models (DSM, 1 mm resolution) and orthophoto (0.5 mm resolution) to help paleontological interpretation of data. Due to size of the reef, automated analysis techniques are needed to interpret all digital data obtained from the field. One of the key components in successful automation is detection of oyster shell edges.

We have tested Reflectance Transformation Imaging (RTI) to visualize the reef data sets for end-users through a cultural heritage viewing interface (RTIViewer). The implementation includes a Lambert shading method to visualize DSMs derived from terrestrial laser scanning using scientific software OPALS. In contrast to shaded RTI no devices consisting of a hardware system with LED lights, or a body to rotate the light source around the object are needed. The gray value for a given shaded pixel is related to the angle between light source and the normal at that position. Brighter values correspond to the slope surfaces facing the light source. Increasing of zenith angle results in internal shading all over the reef surface.

In total, oyster reef surface contains 81 DSMs with 3 m x 2 m each. Their surface was illuminated by moving the virtual sun every 30 degrees (12 azimuth angles from 20-350) and every 20 degrees (4 zenith angles from 20-80). This technique provides paleontologists an interactive approach to virtually inspect the oyster reef, and to interpret the shell surface by changing the light source direction. One source of light for shading does show all morphologic features needed for description. Additionally, more details such as fault lines, overlaps and characteristic edges of complex shell structures are clearly detected by simply changing the illumination on the shaded digital surface model.

In a further study, the potential of edge detection of the individual shells will be analyzed based on statistical analysis by keeping track of the local accumulative shading gradient. The results are compared to manually identified edges. In a following study phase, the detected edges will be improved by graph cut segmentation. We assume that this technique can lead to automatically extracted teaching set for object segmentation on a complex environment.

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