# The Microphotogrammetry as a Portable Diagnostic Tool for Monumental Surface Monitoring

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This paper shows the application of a portable microphotogrammetry tool to analyze surface pattern (colour and geometry) with 50μm accuracy. 3D reconstruction is not the main target of the system that is oriented to perform high precision measurements on plane surfaces.

## 1 Introduction

The digital micro-photogrammetry is a development of the common image-based 3D rendering technology currently in use in the field of the conservation and documentation of monumental buildings, architectural surfaces, historical objects and archaeological sites. We present a new portable tool whose main application is not 3D reconstruction. The system, provided by Menci Software, is composed by software and hardware elements and allows to analyze surfaces' geometry and colour by generating 3D point clouds with high accuracy on small objects (e.g. 6x6 cm).

## 2 Hardware and software

Hardware is made up by a high precision motorized slide bar and a calibrated digital camera (Canon EOS 400) (Fig. 1). The camera and the bar are controlled by software by USB connection. Software is divided in three parts: Z-Scan Micro for acquiring a the images of the object to analyze, Z-Scan for generating 3D RGB models and Z-Map Laser for editing surfaces, building orthophoto, merging 3D models, orienting and drawing on images. The 3D model is reconstructed by a set of three photographs.

## 3 Accuracy

Three certified reference blocks (Fig. 1), 2mm, 1.5mm and 1mm thick, are used to verify the accuracy of the system. The system is sensitive to noise due to light reflection. This phenomenon is stressed for smooth metal surfaces, thus two grazing light rays are preferred to set up the measurement (Fig. 2). The reference plane is chosen on the 2mm block and the differences in height between the blocks a) 2mm-1mm and b) 2mm-1.5mm are calculated.

The results show that, chosen a distance of the CCD sensor in the range 260mm – 300mm, the maximum error, $Err_{max}$, is 50μm for case a) and 100μm for case b).

## 4 Results

The whole system has been used to analyze a zone of the back right arm of Ercole in the statue "Ercole E Caco" by Baccio Bandinelli, Piazza della Signoria, Florence, 1534. Figure 4 shows the first acquisition, A, with a hole in the statue. Figure 5 shows the same zone after three months, B, and the hole filled with marble and resin. Figure 6 and 7 show the digital elevation models, DEMs, of A and B represented with colour gradients and scales of z-quotes. The reference plane is the same for A and B. Figures 8 and 9 show the frequency distributions of the z-quotes of A and B. Z-Map Laser returned the depth of the hole equal to 0.72mm. The variation of colours is estimated in 44.6% for the red channel, 32.1% for the green channel and 23.2% for the blue channel.

## 5 Figures

***Fig. 1*** *Hardware*

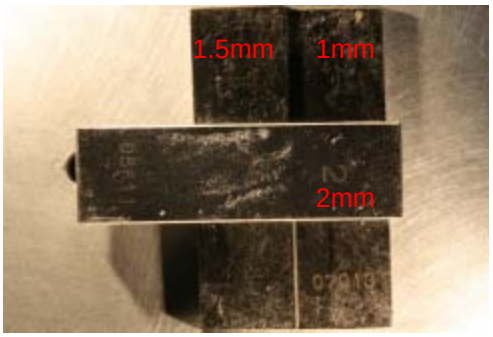


***Fig. 2*** *Reference blocks for accuracy test.*

***Fig. 3*** *Grazing light rays for uniform illumination.*

***Fig. 4*** *A:right back arm of Ercole.*

***Fig. 5*** *B:right back arm of Ercole after 3 months.*

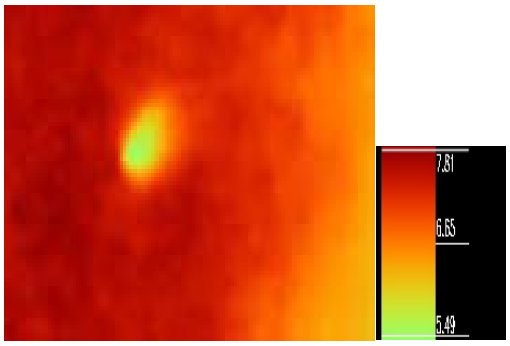


***Fig. 6*** *A:DEM with scale of z-quotes in mm.*

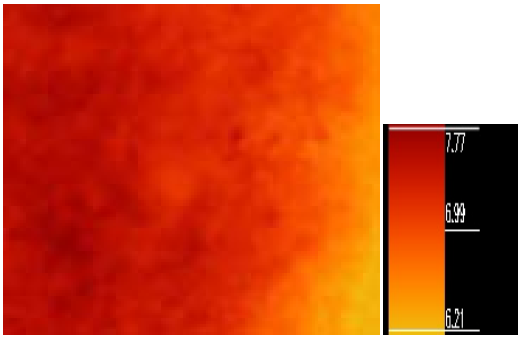


***Fig. 7*** *B:DEM with scale of z-quotes in mm.*

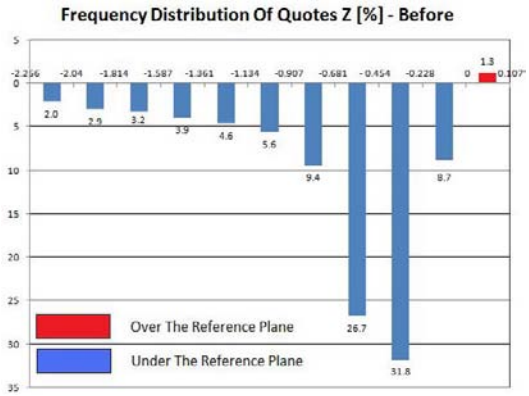


***Fig. 8*** *A:frequency distribution of z-quotes.*

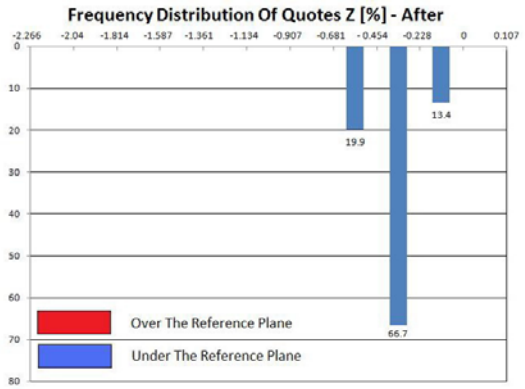


***Fig. 9*** *B:frequency distribution of z-quotes.*