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Research Paper

An interactive photogrammetric method for assessing deer antler quality using a parametric Computer-Aided Design system (Interactive Photogrammetric Measure Method)

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In the area of deer antler evaluation for trophy homologation, as well as in the obtaining of biometric databases for later analysis in the field of Geometric Morphometrics, different linear biometric tools have traditionally been used. In this study we used two sets of antlers from 29 Iberian red deer (*Cervus elaphus hispanicus*) to develop and establish a new photogrammetric technique which creates the 3D model of the antler using a parametric 3D Computer-Aided Design (CAD). This simple and reliable method for deer hunting trophy homologation was compared with the other two more extensively used methods of antler measurement, the traditional measuring tape and the Articulated Arm Coordinate Measuring Machine (AACMM or CMA).

The advantage of this innovative photogrammetric method is the use of only two photographs to obtain both the 3D model and the dimensions required for antler evaluation. A procedure was performed to compare lengths and antler evaluation as hunting trophy. The three methods showed similar reliability, although the photogrammetric process using the 3D CAD system was much faster and more functional than both the traditional measuring tape and Articulated Arm methods. Since this method only requires two photographs per individual, it makes possible the study of a high percentage of antlers in the field.

This new photogrammetric method has been successfully used in the biometrics area, but it could become a more extensively used method in this and other fields because of its ease of operation, speed and accuracy of data collection.

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1. Introduction

From the deer hunting point of view there is a growing interest in antler assessment and in their homologation as trophies, as well as in the obtaining of biometric databases for later analysis in the field of Geometric Morphometrics. In order to accomplish this task, new tools and methodologies for facilitating and accelerating the collection and processing of geometric data are necessary. Figure 1 shows the main methods used in the field of biometrics to assess antler quality. Although most tools use both Traditional Measuring and Contact Measuring Methods, new interesting techniques such as 3D Scanner and Photogrammetry have recently been used in Biology, mainly in the field of the creation of 3D Biological models. Furthermore, 3D models can also be measured in order to obtain geometric dimensions. These latest measurement technologies applied to biological elements provide results of high accuracy.

Articulated Arms Coordinate Measuring Machines (AACMM or CMA) are the most common contact measuring instruments used in 3D biological studies for obtaining points coordinates on the surface of the measured element. These articulated arms work based on acquiring the three-dimensional location of landmarks (homologous points located in similar positions on different biological elements) with regard to a reference system. Moreover, the CMA is a highly accurate method, easy to implement in the laboratory. In the field of Geometric Morphometrics it has been used to study especially complex bones of apes and humans, such as for example temporal bones (Harvati, 2003; Lockwood, Lynch, & Kimbel, 2002), mandibles (Nicholson & Harvati, 2006), or craniofacial regions (Kimmerle, Ross, & Slice, 2008).

However, the 3D scanner is currently another technique that performs a highly efficient coordinate digitisation, which is the most accurate in collecting a huge amount of points on the surfaces of the measured elements. It has been used in studies such as biometric and geometric morphometrics (Hennessy & Stringer, 2002), surface acquisition of human body geometry (Fortin et al., 2007) and human shape studies linked to the industry for mannequin creation (Wang, 2005). In fact, industry is the area which uses these techniques more extensively, mainly in the Reverse Engineering field (Korosec, Duhovnik, & Vukasinovic, 2010; Yu & Peng, 2007; Panchetti, Pernot, & Veron, 2010; Beccari, Farella, Liverani, Morigi, & Rucci, 2010), product design and re-design (Goyal et al., 2012; Ye et al., 2008), and building installations (Brilakis et al., 2010, 2011).

Nevertheless, both Scanner 3D and CMA methods are only reproducible in terms of precision in laboratories or controlled environments. This is a drawback of these methods because deer antler studies must usually be carried out outside the laboratory, taking a short time per antler. The data is usually obtained in the field or on a hunting day, the number of specimens is usually high and the conditions are difficult. Both methods are not suitable in the field.

Another interesting method is Photogrammetry. Many studies have used photogrammetry to obtain 3D models similarly to using 3D scanners. This is achieved by generating a large number of photographs of the object, taken from different locations called "viewpoints". A ray is traced from each viewpoint to the points on the object studied. The rays obtained from different viewpoints are intersected in order to produce the three-dimensional coordinates of studied points. By means of the mathematical intersection of converging rays in the space, the precise location of points can be determined.

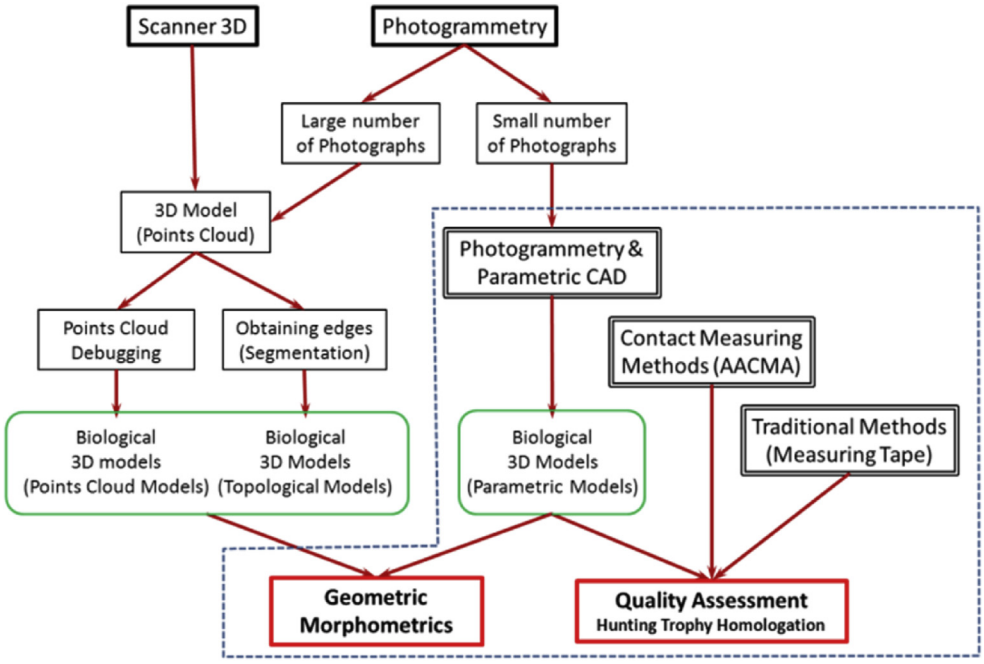

Fig. 1 – The main methods used to obtain 3D models in the field of Geometric Morphometrics and antler quality assessment. We have marked the scope and the methods used in this study.