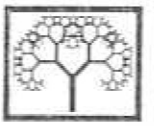

©1998, CIVIL-COMP Ltd., Edinburgh, Scotland
B.H.V. Topping, (Editor),
Advances in Engineering Computational Technology,
Civil-Comp Press, Edinburgh, 301-310

THREE DIMENSIONAL ACQUISITION AND NURBS BASED GEOMETRIC MODELLING OF NATURAL OBJECTS

E. Dimas*, E. Psarakis+, D. Briassoulis* and G. Moustakides+
*Department of Agricultural Engineering, Agricultural University of Athens, Greece
+Computer Technology Institute, Patras, Greece

Abstract

This paper presents a recently developed Image Acquisition-Geometric Modelling system for the construction of geometric models of natural objects. This construction is achieved in a two-step procedure. First, the object of interest is digitised, i.e. points on the surface of the object are computed. Then, based on the digitised 3-D points, an approximating surface, a geometric model of the object of interest, is computed. Coupled with a mesh generation package, the system presented allows for further processing and analysis of the resulting model instead of the real object itself.

1 Introduction

Recent developments in the fields of Computer Aided Design (CAD) and Finite Element (FE) technology and the emergence of modern, more powerful computers, have made possible the substitution of real models of products with computer models. This evolution has many advantages in cutting down the cost and the time for a complete design-analysis-creation cycle of a variety of products in a wide range of fields and applications.

Highly sophisticated finite element packages have been commercially available, for analysis purposes. The construction of finite element models is fairly automated once a description of the geometry of the object of interest, i.e. a geometric model, is available. In some cases such models do exist. Mechanical components, for example, are often designed in front of a computer, using advanced drawing packages which have the ability to translate the drawing into a meaningful geometric model, which can be imported to a finite element analysis software package. However, constructing such models for biological objects (e.g. fruits, human body parts etc.), is a more complicated task, since they are not the product of a design process. Thus, the description of the geometry of natural objects often requires an advanced weaponry of mathematical tools and techniques.

From this point of view the major bottleneck in the complete modelling-analysis cycle is the definition of the geometry of the object under consideration (i.e. modelling part of the cycle). However, emerging technology in image processing techniques allows for the reconstruction of scanned objects (in the form of three-dimensional points on the surface of the object) from image data (photographs, video recordings, CT, NMR etc.). These points could be automatically processed and fitted so that a geometric model of the scanned object is produced. This model could then be supplied to a finite element analysis system for further processing and analysis or be otherwise utilised.

The aim of this paper is to present an integrated computer *image-acquisition/modelling* system which allows for the automatic creation of accurate geometric models from scanned images of natural objects. This system is capable of obtaining 3D information from scanned images taken with a single camera, in 3D-point form. These points are then fitted in order to produce a geometric model (an equation) which describes the surface of the object of interest. Such a system coupled with a finite element mesh generator and analysis package can be used in applications in many fields of science and humanities such as agricultural, civil and structural engineering, archaeology, and bioengineering[1].

The advantages in terms of cost efficiency and reduction of the duration of the design/analysis cycle of products are enormous. This is especially true in cases where the objects do exist but any attempt of modelling them accurately by conventional means would be inefficient or even impossible (e.g. monuments for which plans do not exist, fruits, biological objects etc.).

An image acquisition system has been developed for the creation of three-dimensional geometric data. The corresponding "3-D object reconstruction problem" has been met with the development of a technique for the generation of normal images. The principal idea is to replace the images in two planes by images in one plane, by using the fact that any perspective projection is a projective projection. Then, as the key to a stereo system is a method for determining which point in one image corresponds to a given point in the other image, the problem of image matching had to be solved. Using the image-matching model, the parameters of the mapping functions of the model had to be determined. The differential matching method was used assuming that approximate values of the parameters are known and replacing the non-linear problem by a linear one. Then, the values of the desired parameters result from the minimisation of energy of the observation noises with respect to the parameters of the problem.

The output of the image acquisition stage is a cloud of 3D points on the surface of the object of interest. These points are then converted to a mathematically expressed geometric

[1]This work was supported by Human Capital and Mobility Research Network ERBCHRXCT930386