Mathematical and Computer Modelling 54 (2011) 1753–1759

Contents lists available at ScienceDirect

Mathematical and Computer Modelling

journal homepage: www.elsevier.com/locate/mcm

Mathematical morphology for design and manufacturing

Antonio Jimeno-Morenilla [a], Rafael Molina-Carmona [b], Jose-Luis Sanchez-Romero [a,*]

[a] Department of Computing Technology and Data processing, University of Alicante, Spain

[b] Department of Computing Sciences and Artificial Intelligence, University of Alicante, Spain

ARTICLE INFO

Article history:
Received 15 October 2010
Received in revised form 30 November 2010
Accepted 1 December 2010

Keywords:
Mathematical morphology
Design
Machining

ABSTRACT

In general geometric models, the design of objects is usually separated from the manufacture. Some advanced models give solutions to some of the derived problems but lack a related model of representation. The proposed model addresses the process of designing objects by assimilation of the machining process. It is based on set theory and mathematical morphology and no operation between solids or surfaces is done. Mathematical morphology describes geometric shapes from simpler ones. Sets represent object shapes in a *n*-dimensional space and morphological operations represent geometric relationships between the points in the sets. An analogy between the design and the machining processes can be established: in the machining, the geometry of an object (piece) is also described by the geometry of another object (tool). Specifically, the specification of pieces and tools can be achieved through the use of new operations describing geometric processes of cutting and reconstruction (erosion and dilation respectively, in morphological terms). For manufacturing purposes, the new morphologic operations must be restricted to support an order that will represent the tool trajectory. As a result, the model is generic (as it can be extended to any other tool shape), robust (the set theory avoids special cases or incorrect solutions) and directly displayable.

1. Introduction

A geometric model is a set of information, data structures, operations and tools oriented to the design of geometric objects. The features of a CAD/CAM system are largely determined by the underlying geometric model, since it is responsible for representing the objects and performing the basic manipulation. At present, there are essentially two general types of representations in solid modelling: boundary representations (B-REP) and constructive solid geometry (CSG). Both models of representation have interesting features, but they also have some major drawbacks. The design of complex objects is usually complicated due to their limited number of primitives (CSG) or the difficult modification and adjustment of the surfaces (B-REP). Moreover, additional superficial models are usually needed to display the objects, so the problem of triangulation arises. In general, the existing models completely separate the design process from the manufacturing one. This option facilitates the object design to users who are unfamiliar with the manufacturing processes. However, the consequence is that, after the design phase, a subsequent set of complex operations is needed to obtain the machining paths, including offset calculation, machining strategies and so on [1–3]. In these cases, the quality of the manufactured pieces is usually affected because the strategies for the trajectory generation may not be suitable for the designed objects. Mathematical Morphology has its origin in the requirements of industrial processes such as the study of the characteristics of certain minerals [4]. Nevertheless, it was not until in [5] when the morphological framework was related for first time with the

* Corresponding author.
E-mail addresses: jimeno@dtic.ua.es (A. Jimeno-Morenilla), rmolina@dccia.ua.es (R. Molina-Carmona), sanchez@dtic.ua.es (J.-L. Sanchez-Romero).

0895-7177/$ – see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.mcm.2010.12.002