Chapter 14
Agent Based Systems to Implement Natural Interfaces for CAD Applications

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ABSTRACT
Currently, important advances are being carried out in CAD (Computer Aided Design) applications; however, these advances have not yet taken place for CAS (Computer Aided Sketching) applications. These applications are intended to replace complex menus with natural interfaces that support sketching for commands and drawing, but the recognition process is very complex and doesn’t allow its application yet. So, although natural interfaces for CAD applications have not yet been solved, works based on sketching devices have been explored to some extent. In this work, the authors propose a solution for the problem of recognition of sketches using an agent-based architecture, which distributes the agents hierarchically to achieve the best decision possible and to avoid reliance on the drawing sequence.

INTRODUCTION
Two recent studies (Barr, 2004; Rose, 2005) concluded that within the field of graphic communication, the “ability to create solid 3D models on a computer” and the “ability to produce free-hand sketches of engineering objects” are the two most highly valued skills that engineering students should be competent in. Other authors (Plimmer & Apperley, 2002; Tversky, 2002) have analysed the important role played by the use of sketches during the process of developing new industrial products, concluding that the main advantages of using sketches are the low cost of materials

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involved, the simplicity of the interface tool and the ease of editing.

The arrival of CAD (Computer Aided Design) had a deep effect on several phases of the product design process but had a poor impact on the conceptual design phase (the initial stage), where ideas are expressed and sketches with pencil and paper are still used. The main reason for this is the lack of the CAS (Computer Aided Sketching) tools provided with CAD applications, where recognisers have limited capabilities (as for instance the strictness in the drawing sequence order or the low success recognition ratio) and, therefore, they do not improve the traditional sketching carried out on paper.

Multiple techniques are used in sketch recognition to detect symbols, diagrams, geometric shapes and other user command gestures. With a classic linear discriminator, Rubine (1991) calculates features in order to classify single-stroke sketches as digits, letters and basic commands. Also based on similar features Apte, Vo, and Kimura (1993) distinguish five simple geometric shapes basing their classification on thresholds to the ratio filters established, and Paulson and Hammond (2008) implement the PaleoSketch recognizer which classify between eight primitive forms. Gross (1994) describes a prototype for the recognition of glyphs, but his algorithm requires sketching in a strict order. Other features that remain invariant with rotation, such as convex hull, perimeter and area scalar ratios, were studied by Fonseca and Jorge (2000), who use ratio values in fuzzy sets to recognize some shapes. Methods based on Fourier descriptors achieve better results than methods based on shape descriptors as presented above. In this field, Zhang and Lu (2002) use Fourier descriptors to retrieve images from databases. Fourier descriptors were also used by Harding and Ellis (2004) for recognizing hand gesture movements. Other examples of applications that use Fourier descriptors are the detection of users’ hand movement in a system to achieve an augmented reality tool (Licsar & Sziranyi, 2004).

Park and Park (2005) use Fourier transform to describe fingerprints that are classified by means of non-linear discriminant analysis.

Hence, the challenge of replacing conventional pencil and paper sketches with a digital sketching environment exists. This new environment must be designed in such a way that it favours a “natural” process that does not hinder the user and permits producing an output that can be reused in the remaining phases of the design process. These kinds of environments are known as natural or calligraphic interfaces.

Attending the classification of the different types of sketches that engineers/designers use in the course of creating a product, the one proposed by Ferguson (1994) has been followed. Thus, we distinguish between “thinking sketches,” which are used to focus and guide non-verbal thought; “talking sketches,” which provide a support for the considerations about the design that take place between colleagues; and “prescriptive sketches,” which convey instructions to the draughts person, who is responsible for producing the final version of the engineering drawings. This work is focused on the thinking sketches. The field of Sketch-Based Interfaces and Modelling (SBIM) is an emerging area of research. Proof of this is the fact that, in Europe, the forum specialized in this field was only set up 6 years ago. We are referring to the SBIM workshop, whose current objectives are still changing wide-ranging, the creation of 3D models from thinking sketches being one of the most active areas of work.

There are two approaches to the problem of transforming a thinking sketch into a 3D model within the context of the development of industrial products, namely, those based on geometric reconstruction techniques (that remains out of this paper’s scope) and the so-called gesture-based modelling methods based on interaction with the user through gestures that are recognized as commands to generate solids from 2D sections, such as the GIDeS (Pereira, Jorge, Branco, & Nunes, 2000), TEDDY (Igarashi, Matsuoka, &