Advances in Computational Sciences and Technology
ISSN 0973-6107 Volume 9, Number 1 (2016) pp. 41-49

http://www.ripublication.com

Role of CAD in Ornamental Pattern for Providing Variable Shapes to the Objects

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Abstract

The ornamental pattern is bent into toroidal (revolved)shape of bottle mould half cavity. This bending feature rotates each of the parallel planes around the intersection of the neutral plane and the end surfaces of the pattern by an angle specified. The neutral plane defines the theoretical plane of zero deformation (elongation or compression) along the sectional thickness of the bent pattern.

Keywords: ornamental pattern, neutral plane, sectional bend profile, sketching plane

INTRODUCTION

Some of the features of ornamental products are identified and adopted as guidelines. The vast majority of ornamental products exhibit symmetry. This reason must in part be tied to the practicalities of fabricating ornaments. Every ornament reflects a particular style of art and culture. Thus, traditional patterns are generated with some new interpretations and implemented into ornamental products. Ornaments are the aesthetics products which involve artistic imagination. So, this work is directed towards incorporating the aesthetics into ornamental products through the design tools that can be used by persons having minimal artistic skills. Ornamental product generation is a specialized and time consuming endeavour. Therefore, the design paradigms capitalize the advantages of computer over hand by freeing from repetitive tasks and considerably reducing the effort and time required for designing and creating the ornamental products.

Actual CAD systems are still monolithic and are based on complex geometrical models. Our aim is to implement a new mathematical approach based on fractal geometry integrating the advantage of web technology and providing a novice end-user with an easy to use system. In order to get the same performances as a local system, it is necessary to provide our system with adequate data representation aid architecture. This paper presents a framework of web based system to generate the patterns for ornamental objects. The emphasis of this paper is to outline of methodology and architecture to develop the system, which depends on classifying the elements influenced in the conceptual design stage. The proposed system provide as tool for customer to generate design alternatives according to designer's preferences. Thus the customer can directly explore more alternatives and generate designs with her/his style from predefined images in the data base of system. Accordingly, to the requirement of customer, the whole system regenerates the designs using the power of macro programming. This whole system will use the power of web technology and macro programming to generalize the designs. Fractal geometry is like all other forms of geometry, the Mathematics of size, shape and special relationships. The point where it differs from Euclidean geometry is that it deals with shapes that are infinitely irregular. As Euclidean geometry is the natural way of representing manmade objects, fractal geometry is the natural way of representing objects that occur in nature. In addition, many products in jewellery industries have similar natural design. Computer Aided Design (CAD) is at the heart of the present industrial revolution. The design capabilities of contemporary CAD systems are either based on the solid modelling method or on the surface modelling method. The surface modelling method gives a precise and a convenient way to sculpture free form surfaces, while the solid modeling method provides an unambiguous and information complete solution to define a three dimensional object [2].On the hand, rapid prototyping(RP) technology is used with CAD to make available the physical generation of a solid object. Natural objects, such as mountains, clouds and trees have irregular or fragmented featured with self-similarity. These natural objects can be realistically described by fractal geometry while Euclidean geometry is mainly used to represent manmade objects such as squares, circles and triangles. It is thus valuable to develop a method that can manufacture self-similar designed objects. Here, fractal geometry is used in the representation since it has the important geometric property of self similarity. Fractal geometry can also provide a simple way to represent jewellery design which needs to be aesthetically appealing to humans. However, no commercial CAD systems are to the efficient manipulation of fractal geometry. For example, the non-uniform rational B-spline (NURBS) method in surface modeling cannot be used to model a fractal curve due to fragmentation. Further, the constructive solid geometry (CSG) method in solid modeling will represent an object hierarchically, but it cannot model the self similarity in the fractal object.[3] Therefore, it is valuable to apply fractal geometry integrating with web technology for customized pattern designs for aesthetic objects.

REVIEW OF LITERATURE

The artisan, in the relationship that he establishes between the master and the apprentice, learns by working and it is through this activity of conceiving and doing that he broadens his capacities enriching permanently his craft. (Ana Pellicer & James Metcalf, 1997)

We shall consider what we are unconsciously striving for: the materials and suggestions, which will make us utilize our creative energies but placing us in the proper environment. By giving us the general principles we shall find the most direct route self expression through own experience, thus eliminating unnecessary waste of effort and time. The most salient features of this system are the simplicity and rapidly with which results are obtained. (Adolfo Best Maugard, 1927)

This learning philosophy and technique are very akin to the constructionist framework developed by Seymour Papert based on the constructivist learning theory of Jean Piaget. Papert refers to constructionist learning as :

Learning happens felicitously in a context where learners are consciously engaged in constructing a public entity.(Seymour Papert, 1980)

The congruence of constructionism and apprenticeship stems from the emphasis on using authentic tasks for knowledge building. However, constructionism appreciates the tool more for its educational qualities while apprenticeship values the tool for its creative properties. These are not mutually exclusive learning methods, but they strive for different goals. While apprenticeship focuses on attaining the perfection of the end product, constructionism focuses on the learning of abstract ideas during the process of designing/ building concrete artefacts

One of the most difficult challenges of this thesis was creating an environment that was appropriate for both of these learning philosophies-a tool that focused on the learning of abstract ideas in the domains of geometry and programming while supporting the creative composition of an aesthetic authentic Mexican design.

Fieldwork

Computers and software never evolved in non- industrial environments in developing countries, they just materialized. In developed countries, the creation of crafting software has been following the advent of digital technologies. This is illustrated by the variety of crafting software and hardware that is available in the USA to create traditional crafts such as quilting, embroidery and stained glass. However, in non industrialized settings, computers are appearing without any previous history. Consequently, no software has specifically been developed for these environments and even less with them. If the computer is to find its place in a non-industrial society in non-developed locations, it is important to developed applications that are specifically suited for their culture and infrastructure.

In order to create adequate tools for the intended audience, the programmer must go, on site, to understand the design criteria. The involvement of potential end user for the design of a system stretches across a wide range of perspectives, backgrounds and areas of concern but is formalized in several design approaches. Participatory design in particular, encourages the designers to work with users to better understand the implications of prototypes and scenarios for new designs (Greenbaum & Kyng, 1991).

MATERIAL AND METHOD

This CAD paradigm is implemented under the ActiveX and Visual Basic Applications (VBA) programming environment using AutoCAD. The combination of the powerful ActiveX Automation object model in AutoCAD and VBA presents a compiling framework for customizing the AutoCAD software program.

The design algorithm begins with mathematical description of the geometrical patterns using ubiquitous polygonal technique. Then, CAD programming interfaces are used to turn the mathematical descriptions of patterns into computer program. These programs render the patterns on the computer screen. The CAD data of these patterns can be transferred to a variety of computer controlled machines.

The CNC machine with laser cutting tool is used for carving rendered geometrical patterns into wood. The laser uses a beam of light as the carving tool. The depth of cut produced by laser cutting depends greatly on the power of the light being focused through the laser lens.

The Ornamental pattern is bent into torodial (revolved) shape of bottle mould half cavity. This bending feature rotates each of the parallel planes around the intersection of the neutral plane and the end surfaces of the pattern by an angle specified. The neutral plane defines the theoretical plane of zero deformation (elongation or compression) along the sectional thickness of the bent pattern.

The following steps are carried out for bending of pattern into the shape bottle mould half cavity.

Step 1: The references shown in figure 1 are generated which include a user coordinate system coordinate system at the centeroid of the pattern, a sketching plane (SP) in X-Z plane passing through the centroid of the pattern to sketch the sectional bend profile, a reference plane (RP) perpendicular to the sketching plane, a neutral plane (NP) perpendicular to end planes passing through the centeroid of the pattern and two end planes (EP) parallel to the sketching plane at end surfaces of the pattern to define the radius of the toroid.

Step 2: The bend profile which defines the shape of the cross section of the toroid is created from a chain of entities (spline, arc, line, etc.). A 3-point arc is selected as bend profile shown in Figure 5. Two end points of the arc are fixed on extreme surfaces of the pattern and lie in the sketching plane. The third point lie in the Z-axis and defines the radius and centre of bending curvature. The pattern is first bent along the bend profile about the bending axis passing through the center of curvature as shown in Figure 2.

Step 3: The two end planes are used to bend toward each other at an angle equal to 180 degrees to generate the shape of bottle mould half cavity. These planes pull the bent pattern toward each other and all geometry will be toroidally bent.

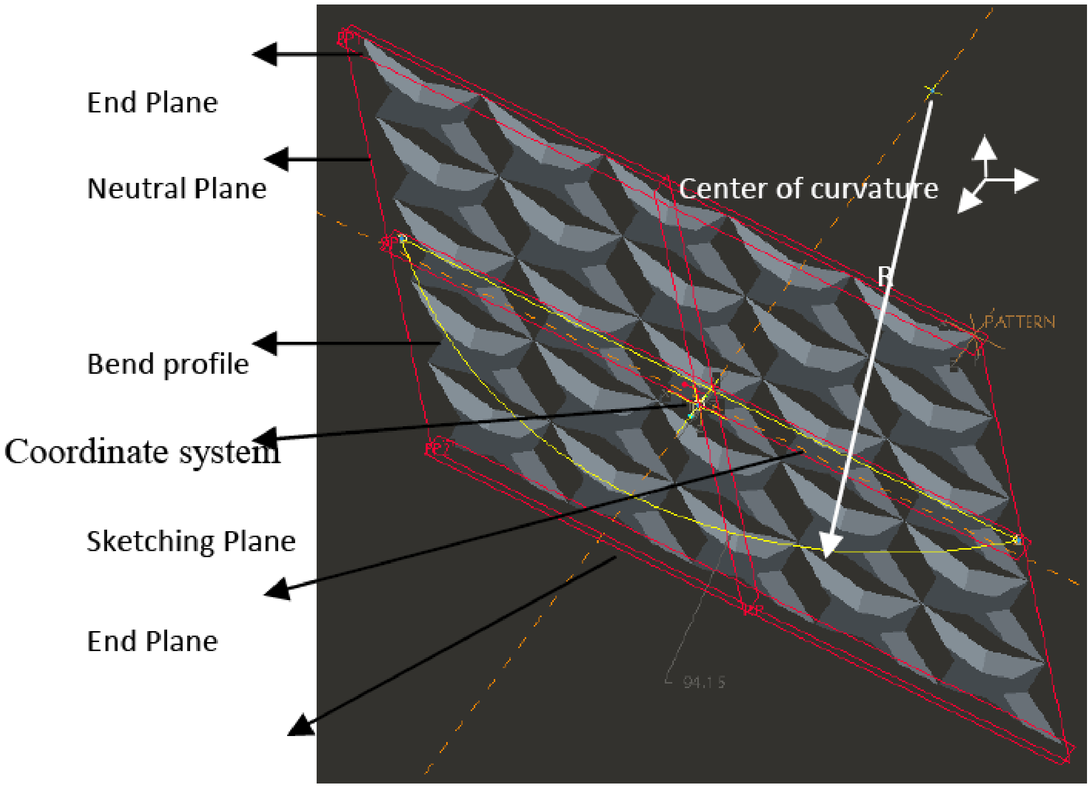

Figure 1

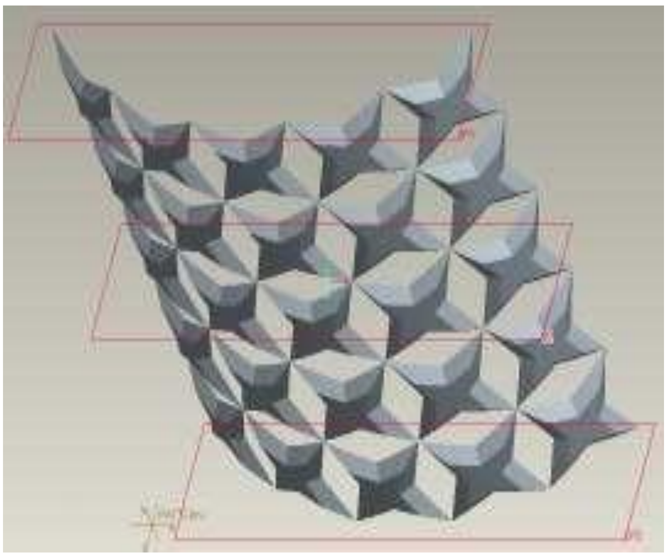

Figure 2

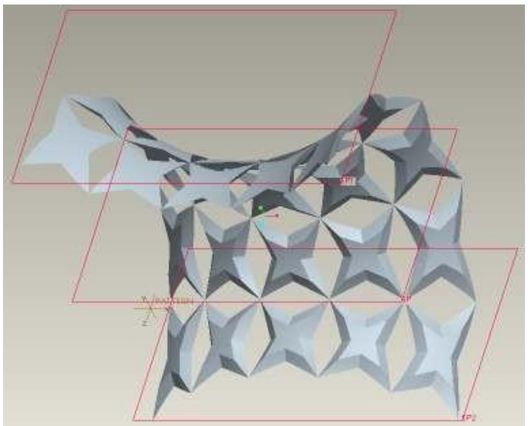

Figure 3. Toroidal bending at 180 degrees

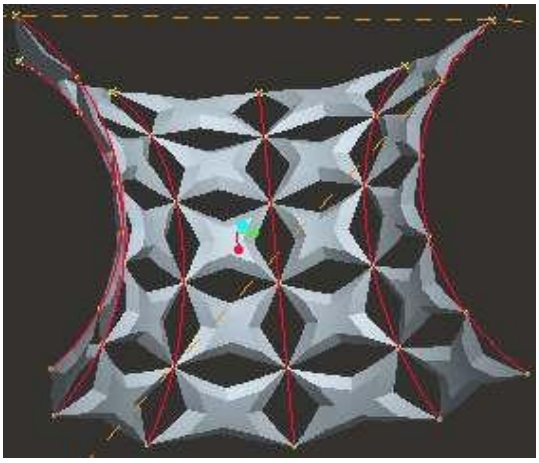

Figure 4. Generation of trajectories

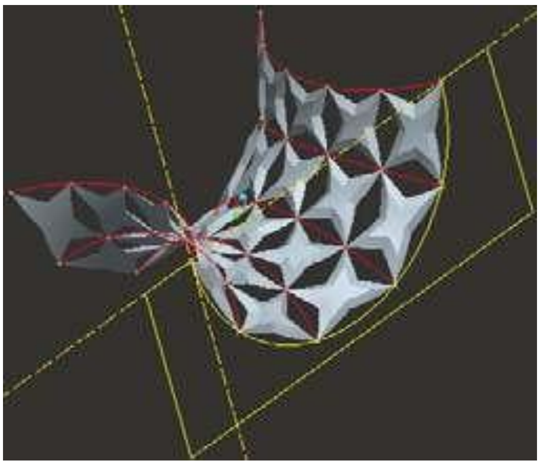

Figure 5. Creation of Cross Section of the Stock-Solid

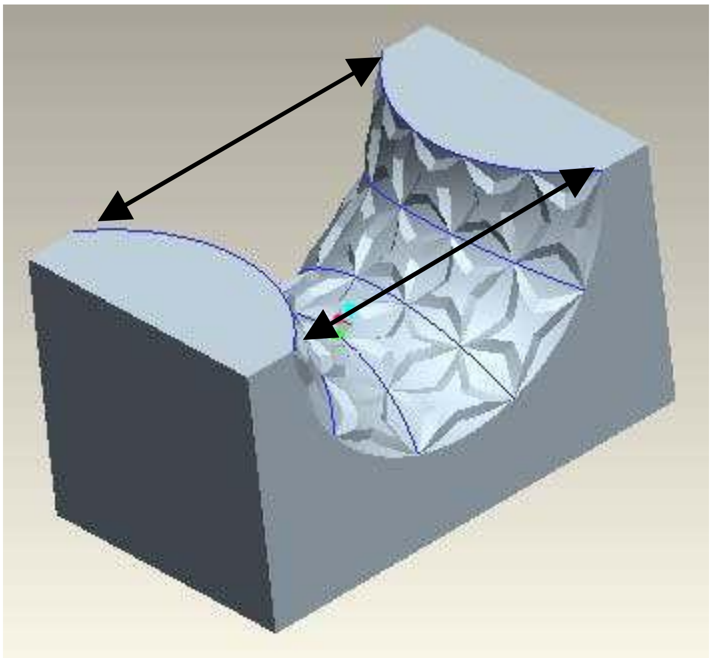

Figure 6. CAD model of middle section of the mottle mould half

MODELING OF THE DECORATED BOTTLE MOULD

The stock material is added to the toroidally bent pattern using the Variable Section Sweep feature to produce the decorated middle section of bottle mould half. The section trajectories are generated longitudinally across the variable cross sections of toroidally bent pattern to produce the mould cavity as shown in Figure 4. The cross section of stock solid is created and swept along the selected trajectories. The sketch of cross section does not change its shape as its being swept along the trajectories. The CAD model of the decorated middle section of bottle mould is rendered as shown in Figure 7 and used for post processing (generation of cutter location file). The top and bottom sections of the mould half cavities take the shape of top portion of bottle dome and base of bottle each. These sections are created using the sketching approach. These sections are generated with two-dimensional entities to sketch a sweep base followed by rotational sweep about an axis to an angle of 180 degrees. The dimensions and profiles of the sweep bases to create top and bottom mould sections are taken according to the dimensions ‘R1’ - and ‘a’ of the middle section of mould shown in Figure 7. The radius R2 in the profile of top section is taken equal to the radius of threaded portion of bottle. The three sections are aligned using and joined into the shape of decorated bottle mould half using the 'mate’ constraint of CAD system as. The profile of middle section can be changed by altering the curvature of bend profile of bottle mould halves decorated with same pattern but generated with different bend radius of a 3-point arc used as bend profile: Top section, Bottom Section and axis of revolution.

CONCLUSION

The work in this thesis outlines our initial developments towards a more generalized system for direct model-to-part manufacturing to machine industrial components autonomously. The system was demonstrated on the Single Axis Lathe, which has a fixed helical tool path trajectory. Although this system demonstrates the concept, it is understood that it is an initial implementation and that the system must be applied to a machining platform with more degrees of freedom for industrial implementation. We are currently constructing a new 4-Axis Router CNC Machine which the direct model-to-part system will be adapted to control using a similar control architecture as the Single Axis Lathe; the CAD model will reside inside the controller, and the controller will autonomously determine the tool path.

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