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Study on finding the Cartesian Coordinate of a Rendered Pixel with an Orthographic Projection

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Abstract

Finding the Cartesian coordinate of a rendered pixel simply requires a backwards transformation of the horizontal and vertical pixel coordinates and the depth buffer value for the pixel to the Cartesian coordinate system of the viewing volume. With an orthographic projection, the backward transformation of the pixel coordinates and depth buffer values is only a simple scaling. To compute the tool position, the tool and the surface beneath the tool shadow are rendered separately and their respective frame and depth buffers are captured. The minimum distance between the tool and the surface is computed by comparingtheirrespective depth buffers for the pixel that are shaded in both frame buffers. This minimum distance represents the distance that the tool must move along the tool axis to tangentially touch the part surface without gouging. Since the tool geometry and orientation are fixed for the single axis Lathe, the tool only needs to be rendered once and the frame and depth buffers can be stored for the use with all the tool positions.

The openGL API was used in the graphics assisted tool positioning software. Though Open GL is a software interface to the e graphics hardware, the system is not limited by the graphics hardware. If the graphics hardware does not support the functions needed, the operations are supported in software. Also, memory limitations are not a problem, as the computer will substitute RAM or virtual memory if necessary.

Keywords: Coordinate, orthographic, transformation, gouging.

INTRODUCTION

The various classes of ornamental patterns are designed and generated to make actual artefacts using different fabrication processes. The work adopts integrated product development approach which brings two different worlds of creativity , innovative designing and agile manufacturing , into contact with each other by transferring the product information from virtual representation tools to Computer Aided Manufacturing(CAM) technologies. The presented Computer Aided Design (CAD) paradigms provide the capability of designing custom engineered ornamental products in an easy to use and efficient manner, using parametric design concept. The creation of ornamental products is an ancient human endeavour. Ornamental products are adorned with different classes of patterns reflecting various styles of various styles of art and culture. Ornaments patterns are symmetric arrangement of shapes and can be implemented on products like jewellery , wooden carving , furniture, stamp block ,floor tiles, wallpapers ,doors windows screen , textile , utensils, beverage bottles etc. Ornamental products do not contribute to product's function and are mainly used only as decoration.

The research in this paper combines three topics:

- The description of a successful introduction of a computer aided design (CAD) tool in a non-industrial , non developed location. I studied how James Metcalf introduced a CAD tool in Santa Clara del Cobre, an artisan community in Michoacan, Mexico.
- The design and implementation, based on the above mentioned study, of a programmable drawing tool called Estampa (Environment for Stamping Patterns). Building on the Best Maugard technique (Adolfo Best Mauguard, 1927), Estampa provide programming constructs and commands for generating patterns of primitive motifs. The programmability of the environment allows the artisan and children to explore the design of patterns in new ways not possible existing CAD tools.
- The evaluation of Estampa through user trials with children and artisans of Santa Clara del Cobre. I then developed a set of design guidelines for the creation of specialized applications relevant for non-industrialized settings.

Computers are being introduced into developing locations by regional , national , and international agencies. To create software relevant for these locations, it is essential to have software design criteria that meet the cultural, social and economic requirements of these settings. To have a deeper understanding of these design requirements, I studied how a successful CAD/CAM application was introduced in a craft school located in the small artisan community of Santa Clara del Cobre. Based on my findings, I then created a programmable drawing tool, specifically tailored for the artisan's economic and cultural needs.

While the desire to "bridge the digital divide" has reached the agenda of many international and government agencies, there is still much discussion of what the digital divide means and how it might be diminished. Some initiatives consider it is enough to provide internet access and productivity suites, but I contend that it is not. The computer can have broader role than being just a communication and information medium; it can be used for simulation, control, sensing/acquisition or design.

The use of computer as a digital design tool might seem too sophisticated for non-industralized settings, but in Santa Clara del Cobre , CAD/CAM tools are currently being used to conceive and manufacture copper crafts . I aim to provide these artisans with an environment where they can use the computer as a programming tool. I believe that if the artisan is presented with an appropriate tool , he will use the power of computer languages to create new designs for his crafts. In the short terms, artisans could program these new designs using Estampa. Furthermore, learning program can teach debugging skills to the artisan, useful for solving daily computer problems such as configuring hardware , installing software for locating a malfunction.

REVIEW OF LITERATURE

To understand the role that the computer should play in the artisan's life, one must first understand the artisan machine relationship. The artisan started to use machines when began to appear, in the 16th century, before industry was born. Artisans have long used mechanical machines such as the ornamental turning and other tools (Rolt,1965). The ornamental lathe was designed to produce extremely intricate work, since it allowed new ways to creatively conceive a handcraft while exploring the material. The machine was not primarily used for raising productivity and lowering costs as in industry but rather to discover new creative pathways , for tools can mould matter where the hand doesn't have the shape or strength to do so. The defining characteristic if the end product was the intention of the artisan, unrestrained by fashion or price.

But in the 18th and 19th centuries, the machine became the artisan's worst enemy, in the hands of industry. The artisans couldn't compete against the efficiency of mass production powered by mechanism, steam and electricity. This decimation of artisans gave root to many movements such as the "The Arts and Crafts Movement "in England in the 1860s. some proponents such as Ruskin, argued that the machine dehumanized the worker since it detached him from the artistic process that, "all cast from the machine is bad, as work it is dishonest."(Ruskin,1853). But other proponents of the "The Arts and Crafts Movement", such as William Morris , were not totally opposed to machines , although "he was deeply critical of the consequence of machine production in a capitalist society"(Harvey Charles , 1996). William Morris understood instead that the machine did have a place in the worlds of the artisan , I would do some things by machinery which are now done by machinery: in short, we should be the masters of our machines and not their slaves, as we are now. It is jot this or that tangible steel and brass machine which we want to get rid of, but the great intangible machine of commercial tyranny, which oppresses the lives of all of us.(Morris Willam,1800)

Thus the apparent conflict between the artisan and the machine did not rise from the machine itself but from the displacement that the artisan is helpless when confronting the efficiency of mass production in the industry. Quoting Mike Cooley3

One of the most perverse things about a mechanistic view of production is the way it attempts to eliminate all uncertainty from the work process and consequently.

(Mike Cooley, 1982)

Thus for an artist to survive, he must find a product niche, which has and shall remain untouched by industry: the creation of original and unique pieces.

Just as the ornamental lathe was useful for exploring new pathways for crafting, the computer can allow the artisan to seamlessly manipulate preconceived shapes (such as motifs). Thus, the computer should not be used for its labour saving cost for easy mass production, such allowing the unskilled drawing technicians to create perfect blue prints, on the contrary, the computer should be used by the skilled artisan for experimenting with different motifs and patterns. This is the main difference between the use of the computer by an unskilled technician and by a skilled artisan- the unskilled technician uses the machine only to reach a preconceived goal , whereas the artisan can use the machine in novel ways. For instance, James Metcalf developed a technique based on the Best Mauguard Technique to use Auto CAD, to create composition using “the articulate” lines that a CAD tool offers to the user. Hopefully Estampa will add yet a new way , such as experimenting with the visualization of a pattern with different motifs and allowing for the creation of novel patterns that can only be created by programming, using the iterative power and the versatility of a computer language. Mike Cooley worked for many years in the aerospace industry as a senior design engineer and was an active trade unionist.

Educational crafting software for children

Crafting software for children is not a new idea; several projrects that have tried to involve children to create craft using digital design tools. We will start with “The Weaving Turtle” project a group of junior high school drew patterns inspired from African textiles(Mihich, 1993). They created Logo procedures to “weave” the shapes, fillings, and shading, decorating different African textile designs. Another instance of crafting combining art with mathematics can be found in the Escher’s World project that provided children with digital tools for exploring tessellations(Papert 1980, Shaffer 1995). The craft Techonologies at the University of Colorado has created several science oriented crafting techonologies to support a wide range of activites, as paper sculptures, robotics and the creation of maechanical toys group(Eisenberg , M. and Eisenberg 2000).

Professional crafting software for the craftsman. In the professional field , crafting software has existed for a long time. The morecommon software crafting such as CorelDraw or Illustrator, are intended for designers. Hoewever more specialized software does exist directed at specific craft such as quilting and stained glass. But specialized crafting applications remain scarce in non-industrial settings in the developing world, which have an important tradition in craft making. Thus , it is worthwhile to study and create computer assisted crafting applications because of their relevance in these communities.

MATERIAL AND METHOD

The viewing volume’s width and height are discretized into a rectangular array of pixels and the depth of the viewing volume is discretized by depth buffer by the graphics hardware. The depth buffer is usually used for hidden surface removal: A depth value is computed for each pixel and if the pixel’s depth is closer to the eye position, then the colour of that pixel replaces the current pixel’s colour in the frame buffer. Once the scene is rendered , the depth buffer contains the depth position of all the rendered pixels that are closet to the eye position in the viewing volume.

Finding the Cartesian coordinate of a rendered pixel simply requires a backwards transformation of the horizontal and vertical pixel coordinates and the depth buffer value for the pixel to the Cartesian coordinate system of the viewing volume. With an orthographic projections (as opposed to a projective projection), the back ward transformation of the pixel coordinates and depth buffer value is only a simple scaling. To compute the tool position , the tool and the surface beneath the tool shadow are rendered separately and their respective frame and depth buffers are captured. The minimum distance between the tool and the surface is computed by comparing their respective depth buffers for pixels that are shaded in both frame buffers. This minimum distance represents the distance that the tool must move along the tool axis to tangentially touch the part surface without gouging . Since the tool geometry and orientation are fixed for the single axis lathe, the tool only needs to be rendered once and the frame and the depth buffers can be stored for use with all the tool positions.

The OpenGL API was used in the graphics assisted tool positioning software. Though OpenGL is a software interface to the graphics hardware, the system is not limited by the graphics hardware. If the graphics hardware does not support the functions needed, the operations are supported in software. Also, memory limitations are not a problem, as the computer will substitute RAM or virtual memory if necessary. However if the card memory is exceeded or operations are performed in software, the processing speed can be significantly impaired.

CONCLUDING REMARKS

An integrative approach is proposed which automates design and manufacturing of the decorative blow- moulds and simplifies the iterative development process . The parametric feature based modelling allows faster modifications and provides tha means to design custom blow-moulds for the designer bottles. The implemented CAD system provides a manufacturing environment in the form simulated CNC machine as output.

CNC Controller section

Since ths CAD model resides within the controller, the controller can maintain Live Model simulation of the tool and part motion . This is done by mapping the physical workscape of the machine to the virtual workspace inside the controller. Gray et al.(10) demonstrated such a mapping of an offline material removal simulator to the actual machined part. Currently in our controller, only the tool and work piece motions are modelled in the simulation. The motion is simulated in the controller with the encoder providing motion feedback from the machine in real time. The real time update from the machine is the reason behind the terminology Live Model. As the tool and part positions are updated, the tool position can be computed from the graphical display of the Live Model. The tool moves along a helical footprints as the tool path and the process repeats itself until the part is completely machines. Thus, the part is automatically machined without any human intervention simply by downloading the workpiece CAD model to the machine controller.

CONCLUSION

The geometric modelling techniques used in this work are simple, yet their results are very beautiful and inspiring. This CAD paradigm has been tested by creating STL format of a model and sending it to LMT machine for rapid tooling. LMT model of bottle mould half. The CAD model of a bottle mould half is also used to generate the Cutter Location Data necessary to drive CNC machine tool to manufacture it from a rectangular block. In order to keep pace with continuous demand for novelty in ornamental patterns, the work is towards the generation of new geometrical p[patterns to apply for wood surface decoration. This paradigm provides the capability of generating a large number of variations in the traditional Zillij style pattern.

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