Drawn To Customisation: The Machine As Artist

James I. Novak

Queensland College of Art
Griffith University
Gold Coast, QLD Australia
j.novak@griffith.edu.au

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Abstract

This paper accompanies a demonstration at ACM SIGCHI – ‘Designing Interactive Systems’ 2016 in Brisbane, Australia, of a 3D printer that has been hacked to automatically create and draw 2D portraits of its environment using a pen. The paper and practical work calls attention to the novel process of using 3D Computer-Aided Design (CAD) algorithms to mimic the artistic practice of drawing abstract imagery of a live scene, displaying the growth of line-work in real-time to the viewer and allowing them to control the quality of the abstraction by the length of time the computer is allowed to view the scene through a webcam. Ultimately the artist/designer is responsible for creating a system whereby infinite drawings are possible, rather than drawing a singular image themselves, challenging the role of traditional designers and artists as technology allows for ever more intuitive and interactive methods of creative expression.

Author Keywords

3D print; algorithm; art; computer-aided design (CAD); customisation; drawing; hack; human-computer interaction; parametric; prosumer; workflow

ACM Classification Keywords

D.1.7. Software: Visual Programming; H.5.2. Information Interfaces and Presentation (e.g., HCI):

User Interfaces; I.2.10. Artificial Intelligence: Vision and Scene Understanding; I.3.5. Computer Graphics: Computational Geometry and Object Modeling; J.5. Arts and Humanities; J.6. Computer-Aided Engineering

Introduction

With design software and Graphical User Interfaces (GUI's) becoming increasingly interactive and accessible to the public, *consumers* are rapidly shifting to *prosumers* "by cocreating goods and services rather than simply consuming the end product" (Tapscott and Williams 2006, 1). This represents a broader shift towards mass customisation, threatening the traditional mass production paradigm, and is enabled by technologies like 3D printing, 3D scanning and the availability of affordable computing (Tseng, Jiao, and Wang 2010, Hu 2013).

By hacking into a desktop 3D printer and converting it into a machine capable of drawing 2D line-work with a pen, this notion of mass customisation and interaction is explored. However before exploring the process in more detail, it must be acknowledged that neither hacking into a 3D printer and repurposing it, nor creating custom 2D drawings using code are by themselves unique. For example, online tutorials are widely available describing how to turn your 3D printer into a 2D drawing machine (Kraft 2014, Smeekes 2015), allowing you to turn 2D images and photographs into drawings similar to a plotting machine. The limitation of such conversions is that the software driving the printer is only capable of converting a static digital JPEG image into a physical representation, much like a traditional inkjet printer. By comparison the demonstration for this conference uses

a webcam to 'see' a scene in real time, with algorithms used to expressively interpret the scene using abstract line-work in similar fashion to a human artist.

Algorithms and 2D plotting have also been utilised in the work of Miguel Nóbrega (2015), who rather than plotting JPEG images, uses coding to generatively create abstract geometry which is different with each iteration of the same code. This geometry is then drawn in 2D by a plotting machine, in very similar fashion to a 3D printer which has been converted to only operate in two dimensions. However, as with the previous example, the drawing machine is simply translating an image, which in this case is generated completely within the algorithm, into a 2D drawing. The machine is not capable of looking at the physical world and translating this into digital code, nor is it interacting with the user.

Kyle McDonald and Matt Mets have managed such a real-world connection with their 'Blind Self Portrait' machine (2012). As a user sits in front of the camera, they sit their arm on a custom-made machine which guides them to draw a single-line portrait of themselves; something described as "machine-aided drawing" (McDonald 2012). Such a system demonstrates the capacity for mass customisation, with each portrait unique, and real-time interaction with the user in the physical world. The differences between this work and that produced for the conference demonstration will be highlighted throughout the following section.

Figure 1 This screen capture from Rhinoceros shows the streaming webcam image within the Grasshopper plugin on the right, and the 2D line work progressively drawn in Rhinoceros. Screen capture by the artist.

Process

The novelty of this particular work is in the unique workflow to translate between the digital and physical worlds, extending the significant work already produced by aforementioned practitioners. Firstly, the computer is capable of observing its' environment through the use of a standard webcam, similar to McDonald and Mets' machine. However 3D CAD software is implemented in the form of Rhinoceros with the plugins Grasshopper and Firefly, to convert the live-streaming webcam video into an evolving series of abstract lines as shown in figure 1. These lines gradually grow and shift on screen for the viewer to see, much like a drawing created by a human evolves over time. The user can choose to stop the drawing algorithm at any

time, resulting in more or less detail and allowing them to intervene in the aesthetic outcome. The power of the workflow is the algorithm used to turn live imagery into an abstract interpretation over time; often an image or video may simply be distorted by applying a filter or effect, however this algorithm works in 3D CAD space to evolve the line-work over time, human-like in its logic and capacity to draw within a 3D environment. The 3D environment controls the final size of the artwork, and may be scaled without loss of quality to suit any 3D printer or plotting system.

Once the user is satisfied with the drawing preview, the line-work is automatically translated into G-Code, the language used to control various automated machines

Figure 2: 3D printed pen holder mounted to the extrusion head of a Solidoodle Press 3D printer. Photo by the artist.

Figure 3: The final drawing produced by the modified Solidoodle Press of the line work created in figure 1. Photo by the artist.

including 3D printers. This G-Code is essentially a collection of X and Y coordinates describing the path for the 3D print head to follow as it traces the lines generated in Rhinoceros. Still within this same software, the G-Code is sent directly to a modified 3D printer (in this case a Solidoodle Press, however most printers could be used) which no longer has an extrusion nozzle to 3D print plastics, but has a 3D printed attachment to hold a pen as shown in figure 2. Figure 3 shows the final drawn image from figure 1. Unlike McDonald and Mets' machine, the user is removed from the final drawing process, allowing them to watch the 3D printer draw as one would observe an artist, resulting in an accurate reproduction of the lines similar to the machine-drawn work of Miguel Nóbrega.

The process described is currently experimental and requires someone to manually toggle some of the events within the software to enhance the speed of the process due to computer processing limitations. Paper must also be manually loaded onto the print surface of the 3D printer since it is not set up for such a purpose. However it is not difficult to imagine the opportunities for such a system to be completely automated and scaled up in size, either within the home or as a genuine method of creating custom artwork within a gallery or business setting.

Conclusion

As consumers become ever more engaged in the creative process through digital fabrication technologies, new tools are required that provide rewarding interactive experiences between humans and machines. The significance of this system produced for ACM SIGCHI 2016 is in its' engagement with the user, allowing for the mass customisation of drawn artworks

without the need for the user to be skilled in software or physical drawing techniques themselves.

Video Link

<https://youtu.be/2PfltrDhVNO>

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