Initial Trials of ofxEpilog: From Real Time Operation to Dynamic Focus of Epilog Laser Cutter

Mitsuhito Ando
YCAM
ando@ycam.jp

Chisaki Murakami
YCAM
chiichan@ycam.jp

Takayuki Ito
YCAM
taka@ycam.jp

Kazuhiro Jo
YCAM / Faculty of Design, Kyushu University
jo@ycam.jp

ABSTRACT
This paper describes ofxEpilog which enable people to control a laser cutter of Epilog in real time. ofxEpilog is an addon of openFrameworks, an open source C++ toolkit for creative coding. With the addon, people could directly send their image object to a laser cutter through Ethernet. By alternating the generation and transmission of the command of cutting, the addon could sequentially control a laser cutter in real time. This paper introduces our initial trials of ofxEpilog with a real time operation (A), dynamic focus (z-axis) control with a given 3D object (B), and a scanned 3D object (C). Technical limitations and our upcoming challenges are also discussed.

Author Keywords
Laser cutter; Personal Fabrication; Open Source Toolkit

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Laser cutter is one of a core tools in personal fabrication [3]. In accordance with the rapid growth of the community, several systems explore the use of laser cutter in their unique ways beyond the standard applications (i.e. Adobe Illustrator, Corel Draw, Inkscape) and the proprietary drivers [5]. In this paper, we go step further the exploration with the flexibility of creative coding in which people try to produce something by programming at the intersection of art, media and technology. Specifically, we show our trials of ofxEpilog [1], an addon of openFrameworks (http://www.openframeworks.cc/), which enable people to control a laser cutter of Epilog (https://www.epiloglaser.com) in real time.

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BACKGROUND
The roots of the addon is cups-epilog.c, a cups driver for Epilog laser engraver by AS220 (http://mtm.cba.mit.edu/cups/cups-epilog/src/cups-epilog.c). With the driver, people could control the laser cutter through a network with a diverse range of systems such as Mac, Linux, instead of a proprietary driver just for windows. Trammell Hudson updated the driver into a command line tool (https://trmm.net/Epilog_driver) that translates the PDF files into commands for the laser cutter. The both software (and the proprietary driver, of course) generate commands based on Hewlett-Packard Graphics Language (HP-GL) [4] to control the laser cutter.

For example, a command of PD (Pen Down) starts an emission of laser till it receives PU (Pen Up) command. YP, ZS, and XR command controls the power, speed, and frequency of laser, and WD controld the height of a table of a laser cutter (Table.1).

HPGL commands	Function
PU [x, y]	Move laser cutter head with x-y coordinates
PD [x, y]	Emit and move laser cutter head with x-y coordinates
YP [power]	Set the power of vector process
ZS [speed]	Set the speed of vector process
XR [frequency]	Set the frequency of vector process
WD [z offset]	Set the height of table

Table 1. Examples of HPGL commands

By standing on the shoulders of the precursors, we have developed our software from scratch as an addon (i.e. external library) of openFrameworks, an open source C++ toolkit for creative coding. Because of the capability of openFrameworks for computational graphical programming, people could algorithmically generate a diverse range of vector graphics and send the data directly into the laser cutter.

ofxEpilog
ofxEpilog is an addon of openFrameworks that directly control a laser cutter of Epilog (e.g. Zing, Mini, Fusion).

With the addon, the coder could directly send their image object such as ofPolyline (i.e. multiple points vector data) or ofImage (i.e. pixel data) within openFrameworks through Ethernet. The x-y position and the parameter of power, speed, and frequency of a laser, as well as the height of a table (i.e. z-axis) could be controlled in the cutting process instead of the pre-configured setting of the proprietary driver. By alternating the generation and transmission of the command of cutting, the addon could sequentially control a laser cutter in real time.

INITIAL TRIALS

A. Real time operation

Previously, most of the laser cutter works with a pre-configured set of data in series. However, the latest version of Epilog laser cutter (i.e. Fusion) features a real time operation of its height of a table, position, and fire with its handy joystick. ofxEpilog expands the possibilities of real time operation by enabling the coder to connect a diverse range of input devices such as a mouse, pen, and eye-tracking with the parameters.

B. A dynamic focus (z-axis) with a structured 3D object

ofxEpilog enables to control the focus (z-axis) of a laser cutter during its operation. Therefore, when we have differences in height in a material for cutting, we could dynamically change the focus with its contour instead of dividing the data into different layers with the height with the proprietary driver. According to a given structured 3D object with a free-form surface, the addon could engrave 3D curves to the 3D object while keeping the focus (z-axis) by changing table height (Fig.1).

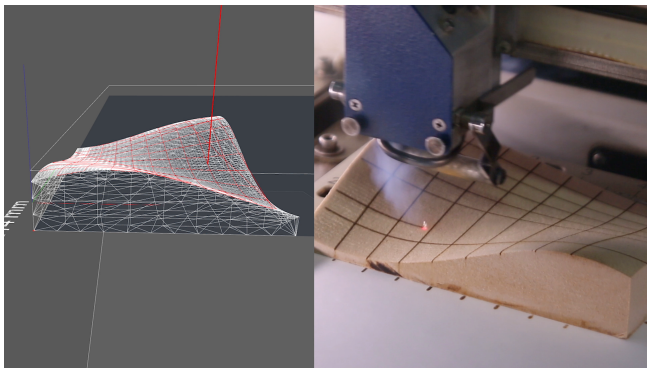

Fig 1. Processing pre structured 3D object with 3D curves.

C. A dynamic focus (z-axis) with a scanned 3D object

ofxEpilog also enable to control the focus with a scanned 3D object. Based on a 3D curve of an object from a high-resolution 3D scanner, we calculate a possible area for engraving (red in Fig.2) and dynamically control the focus with the given 3D model.

TECHNICAL LIMITATIONS

Because of the focal length (50.8mm) and the shape of laser cutter's head, we have a physical collision in a certain tool path (P1-P2- P3 in Fig.3). To avoid the collision, the path needs to have an angle of inclination less than 30 degrees while keeping the focal length.

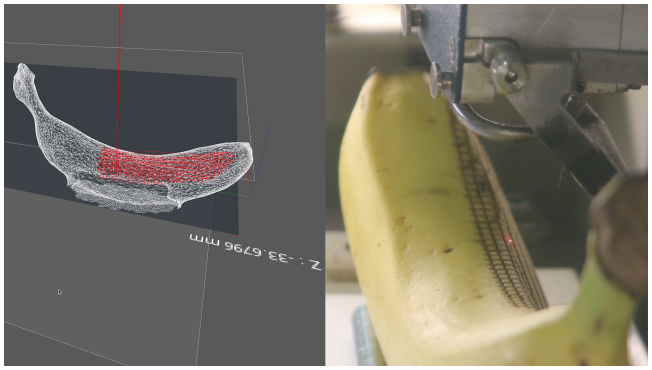

Fig 2. Processing 3D scanned object with 3D curves.

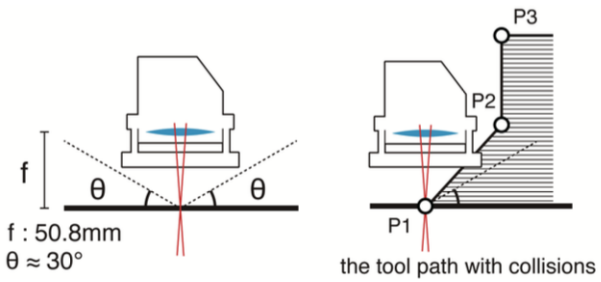

Fig 3. A physical collision in a certain tool path.

CONCLUSION

In this paper, we have explained our initial three trials of ofxEpilog, an addon for openFrameworks. Since the code is open to the public as our precursors (https://github.com/YCAMInterlab/ofxEpilog), we anticipate to have successors to expand the use of our addon in a hackable manner [2].

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