



ArtBot Project 2017

Introduction:

The Dallas Personal Robotics Group's main interest is autonomous robots. The club does have a history of robotic art projects, mostly kinetic pieces, either for demonstration or auction at local charities. The robot art contest held by robotart.org provided an interesting challenge to team members. Could we make an art generating robot in the time allowed? Could we generate art? The team believes the answer is yes to both these questions. This is the story of our efforts.

The Art:

The elegance and calming nature of the Sumi-e art style appealed to the team. This style originated in China during the Tang Dynasty (618-907) and over time spread to Japan and Korea. In its traditional form, the style reached its heyday during the 1400's in Japan. Many of the most famous Sumi-e artists were Zen Buddhist monks.

Sumi-e uses four tools: black (or colored) ink, brushes, a special ink well (discussed later), and rice paper. These four tools were named the "Four Treasures of the Scholar" (Bunbou Shishou) by traditional artists. Beginning artists were taught four forms called the "Four Honorable Knights" (Shikunshi). The forms are the wild orchid, bamboo, the flowering plum, and the chrysanthemum. Mastering these four natural forms were considered necessary to learn Sumi-e.

Sumi-e paintings are not about painting items such as plants or birds, but rather a journey of the spirit. The team believes this is why they have such impact.

The Robot:

Two approaches were taken to create a robot that could generate art using brushes and a palette. Time was of the essence. The team had about two months to get results. One approach was to modify a 3d printer that was being decommissioned. The other approach was a completely new robot. Both approaches were pursued, but the adage, "It always takes longer than you think." came into play. The focus of this article is the modified 3d printer. The 3d printer is an original Printrbot with a Wades style extruder. The controller is a RAMPS 1.4 shield on an Arduino Mega. The firmware used is Marlin.

The first modification was to remove the hot end of the extruder and exchange the large gear of the Wade extruder with one that incorporated a bracket that would act as an interface for the brush holder. Next, a brush holder was designed. The brush was then fitted with a ball to complete the fixture. A modified bull clip with its center removed to allow fitting of the brush ball was used to hold the brush in place. This arrangement allowed modification of the brush holder, easy changing of the brush, and

the ability to adjust the brush's attack angle. A turret brush holder was developed to cover the possibility of using brushes of different widths and shapes.

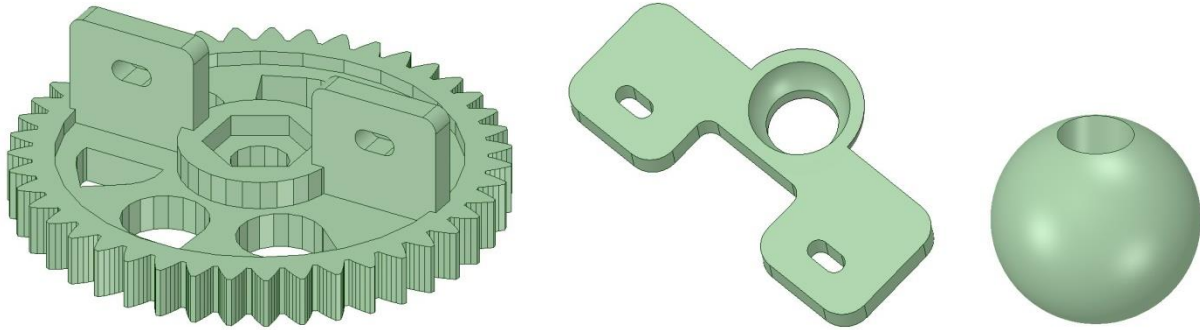


Figure 1: Modified gear, brush holder, and brush ball.

A paint palette was designed to include 12 paint/water wells, a water well for cleaning the brush between color changes, and a painting area of 6" x 6". The finished palette was spray painted with white paint to improve the water tightness of the wells. A cutoff plastic bottle was used to deepen the brush cleaning well. In application, two adjacent wells are used for each color, one for water and one for paint. This configuration speeds up the painting process.

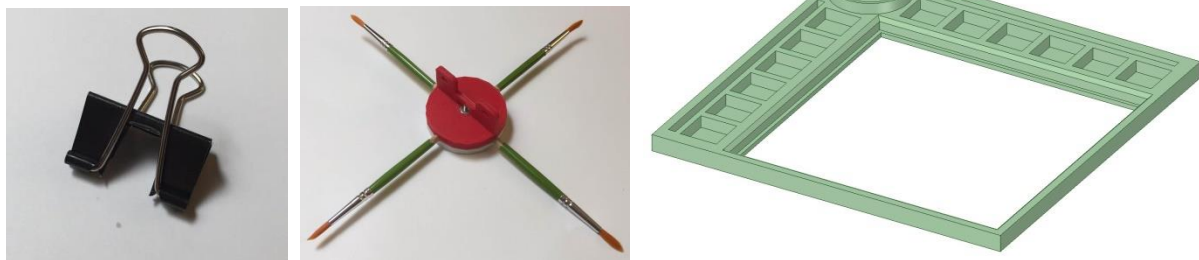


Figure 2: Modified bull clip, brush turret, and palette

A frame for the palette was designed and laser cut to index the palette and maintain established coordinates. Additionally, a resistor was placed in the extruder's thermistor circuit to prevent the firmware from alarming.

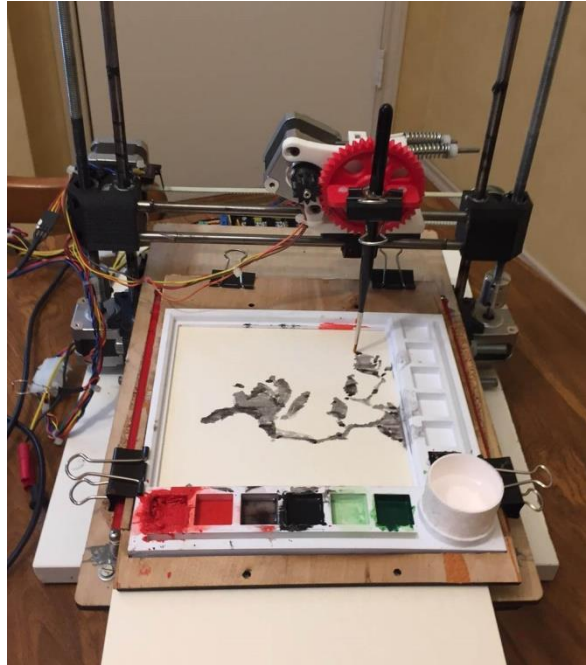


Figure 3: ArtBot

The Software:

Initially a raster approach was taken to make the paintings. Two programs were developed one using a c program with a c array generated from the image using Dot Factory, and a more sophisticated approach using a Perl script and Image Magik. The team came to the conclusion that these paths were a dead end. The results were not pleasing, and the time taken to paint a picture was excessive.

What was needed was a vector driven approach that also had the ability to modulate the Z axis so that different stroke widths could be achieved. An open source project, F-engrave, was found that almost fit these criteria. F-engrave outputs vector paths and uses Z axis modulation in its V bit mode. It also has a fill function, but no contouring. Initially, plans were to modify the available Python code of F-engrave to incorporate the necessary routines needed by ArtBot and improve the output. The deadline of the contest prevented this approach and the decision was to add a post-processor program that modified F-engrave's gcode output. The post-processor program handled getting water, paint, cleaning the brush, and restoring the Z axis position after a new paint routine. It also refined how Z axis offset was handled.

All software and CAD files except the packages Dot Factory, Image Magik, and F-engrave are available on DPRG's github (<https://github.com/dprg>). The three packages above can readily be found with a web search.

The Paint:

Acrylic paint was explored, but it had a tendency to glob up the brush as the painting proceeded and the output seemed dull. The decision to use watercolor paints was made fairly quickly in the process. Watercolor paint is magical and gives very interesting results.

Next Steps:

Using a post-processed version of F-engrave, we can paint with some limited Z axis modulation on the outlines of features and create fills for pre-separated color values. In our approach using Perl and Image Magik we had the ability to process images so that values could be separated. The team sees the next steps being to create a custom version of F-engrave, embedding Image Magik. This new software would improve our ability to create different color tones and would incorporate ArtBot's mechanical requirements. Another alteration being explored is modification of the palette to include paint wells similar to the ink well used in a traditional inkstone, or suzuri. A suzuri has a ramped ink well with an elevated part called the "oka" (hill) and a deep end called the "umi" (ocean). This shape might allow selection of different color values within the same paint well. Value selection would be a matter of coordinate selection.

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