Mural Painting Robot

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Abstract

On average, it takes a person about 40 hours to paint a full color, 10’x10’ mural. The process is time consuming and expensive, as you have to pay the artist for their time. High costs associated with murals make them unrealistic for most places. By automating the process of painting, we can drastically cut the cost of large scale, full color murals, making them more attainable for the average building. The goal for this project was to make a robot capable of painting an 8 color mural on a vertical wall, without human intervention. Our end product is able to decode any image and paint it in a given size.

Background

The current methods for painting large scale murals are to use painting robots or having a human paint one by hand, a tedious and potentially dangerous process depending on the location. The average time to complete a 10-foot by 10-foot mural by hand is around 1-2 weeks depending on the complexity. A human cannot precisely replicate an image on a very large canvas either. Having a robot do this job instead can allow for savings in cost and time, relieve a human from a hazardous situation, and allow for superior precision.

There is currently one robot in the world that can paint large scale murals called the Albert Robot Muralist that accomplishes what we set out to create: a fully autonomous large scale mural painting robot.

Robot Capabilities

Max Test Mural Size: 8’ wide x 5’ tall (can be easily expanded by adding rail and raising mount height.)
Run time: Not reliant on battery life, can paint till the cans run out. Did not reach a time limit in testing
Colors: 8 at any given time. Can have multiple of the same color to extend amount of paint coverage
Power: 12V 60A AC/DC power supply
Wall Mount Style: Anchored direct to wall via screws, concrete/drywall anchors
Combined System Weight: ~80lbs

Robot Components

The robot relies on the combination of several simple mechanisms to accomplish its goals.
X traversal: A wheel pressed on the unistrut rail driven by a motor with a worm screw gearbox. TFM-Plus TOF sensor fused with quad encoder on rail.
Y traversal: 72:1 gearbox driving a 40:1 worm screw winch. Quad encoder on input motor.
Paint changing: Custom 3d printed geneva mechanism driven by a Vex 393. Quad encoder on input motor.
Paint Spraying: Custom 3d printed rack and pinion driven by a Vex Mini Cim motor. Touch sensor on backside of rack.

Software Framework

The software framework was designed around having separate mechanisms for canvas traversal and painting. To optimize our two part system, a separate state machine was created for each the artist and the brush. The artist state machine was at the top of our software hierarchy and was responsible for interpreting the mural CSV, maneuvering the robot, and providing accurate data to the brush. The brush’s state machine was responsible for paint color selection and paint application.

Finally, a few other software features

- Sensor fusion of encoder and ToF LIDAR to provide absolute displacement
- PID closed loop control to accurately place pixels
- Custom MATLAB script to decode real images

Possibilities for Future Work

- The ability to work in suboptimal weather
- The ability to paint a 16 color mural with two passes
- Sensor provided color accuracy checking
- Improvements to speed, resolution, and consistency

Results

In spite of being developed completely remotely, Bot Ross saw many successes as it reached all of the project's goals. Currently, this robot is able to fully autonomously paint a complex mural. The mural can be composed of up to eight different colors and can be planned from any image that is appropriate resolution. The robot paints with a resolution of 6 dots per foot and can recreate an image on a 4x8 canvas in under 2 hours. Use of sensors such as encoders and Time of Flight(ToF) rangefinders provide accuracy and repeatability.

Overall, Bot Ross is able to consistently apply legible large-scale murals to a variety of canvases. It’s scalability and strong first-iteration output create considerable potential for improvements with future WPI MQP projects.

The Robot