**Developer Notes for the Robotic Shape Sorter**

*Developer: Griff Sutton*

Physical Attributes:

* 3 Axis, 3 Joint Robot Arm
* Uses 3 180 degree Servo Motors
* 3D Printed Arms and Base Platform
* Lazy Susan Bearing for the Base
* 5V 50N Electromagnet
* Webcam and stand
* Arduino
* Recommended: Breadboard for easier wiring

Coding Attributes:

* Coding using Visual Studio and Arduino Sketch
* Bulk of the “heavy lifting” is done Visual Studio
  + Logic
  + Visual Processing
  + Calculating Servo Angles
    - Angles are calculated using law of sines
    - Comments in the code explain the process of the mathematics used
  + Shape determination and location
* Arduino Sketch takes in Servo Angles determined in Visual Studio Code
* Converts them and makes sure they are integers 0 through 9
* Writes the values for the Servo Angles to the Arduino
* Magnet is sent a signal when the Servos have reached a non home location and sent another signal when it has reached the home position to turn the magnet on and off

Prerequisites:

* User must have a PC with Visual Studio and Arduino Sketch in order to run this robot
* User will need a power supply of 7V as that is what is required for the servo motors. The 5V from the Arduino will not suffice
* User will need to mount the webcam to a stable object positioned above the paper. A basic camera stand or a homemade stand should suffice

Potential errors or bugs:

* The join at the base and arm 1 are not on a bearing, which may cause the robot to break easier if the speed of the servos is not controlled properly
* The visual process uses image warped to fit a Region of Interest to the paper the shapes are placed on. The processing may get a bit buggy if your camera is directly over top of the paper. Best practice would be to have the camera look at the paper at an angle, perhaps about 75 degrees. This should allow you to see a newly warped image that is stable
* If the threshold is not low enough, you may pick up phantom shapes. Make sure your threshold value is low enough so that the only shapes registered are the ones you intend to find. Recommended value is around 100 but this will vary depending on your lighting, webcam, and general set up.
* When the magnet turns off, the Servo Motors go back to a 90 degree 90 degree 90 degree position. As of now, the reason for this bug is unknown, but does not affect performance. User should exercise caution during this stage of the robots movement

Future Development:

* Fixing Servo Motor reset after the magnet turns off
* Fine tuning the visual processing to make the webcam work at a wider degree of angles
* Creating a more supportive arm with additional bearings and a more sturdy base
* Using stronger materials for a more durable arm, such as aluminum
* Developing a wall mount to use this concept in multiple environments