



Team 555
Monostable Solutions

Air Hockey Robot

UTDesign

Jack Doan ■ **Michael Lamunion** ■ **James Steenburg** ■ **Jeremiah Plauché** ■ **Sol Morris** ■ **Andrew Reetz**
Computer Engr Electrical Engr Electrical Engr Mechanical Engr Mechanical Engr Mechanical Engr



Customer: *Sci-Tech Discovery Center*
Term: Fall 2017 - Spring 2018

Background

The Sci-Tech Discovery Center is a children's museum located in Frisco, Texas that wishes to launch a new robotics themed exhibition. Team 555 was tasked with creating one of several additions to this exhibit, the air hockey playing robot. The team's addition is to be the exhibit centerpiece and will be showcased in the middle of the main floor of the museum.

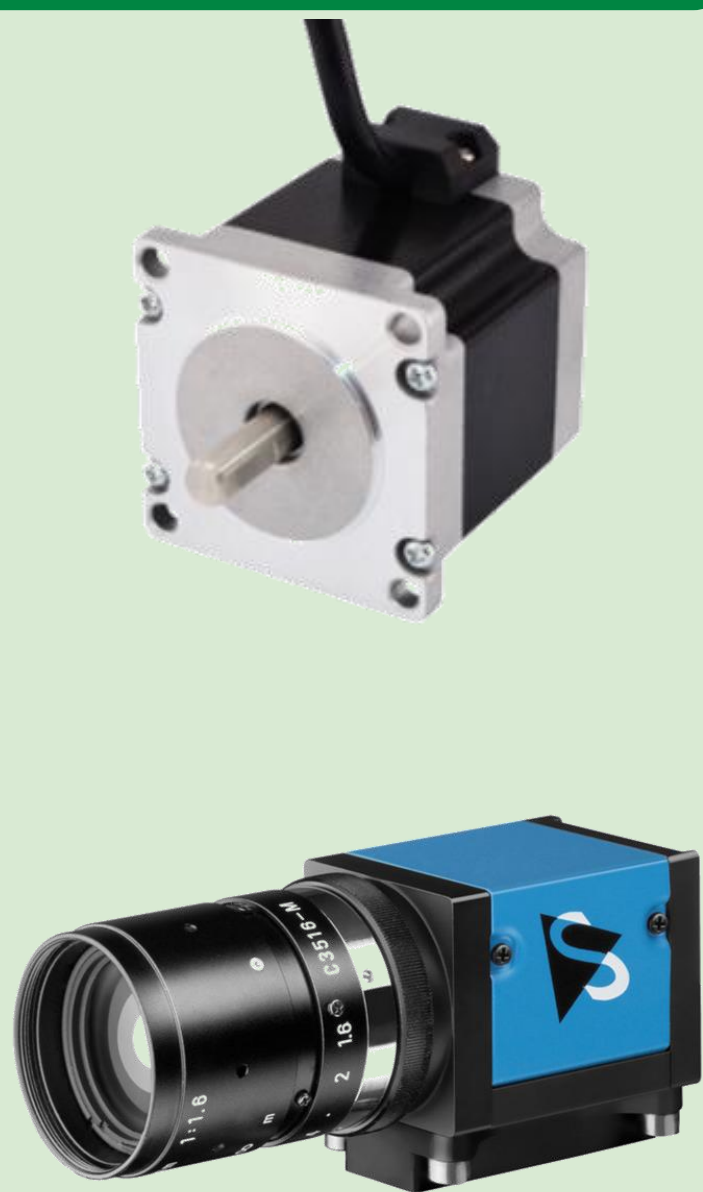
Sci-Tech's Mission

"The Sci-Tech Discovery Center provides dynamic experiences that inspire people of all ages and backgrounds to embrace discovery and innovation through the active exploration of science, math, and technology"

Requirements

- Design an exhibit for Sci-Tech Disc Center
- Play air hockey aptly against visitors
 - Variable difficulty levels
 - Minimum lifespan of 3 years
 - Relatively easy/ low maintenance
 - Be safe for children
 - Must be educational and showcase engineering concepts

Electronics

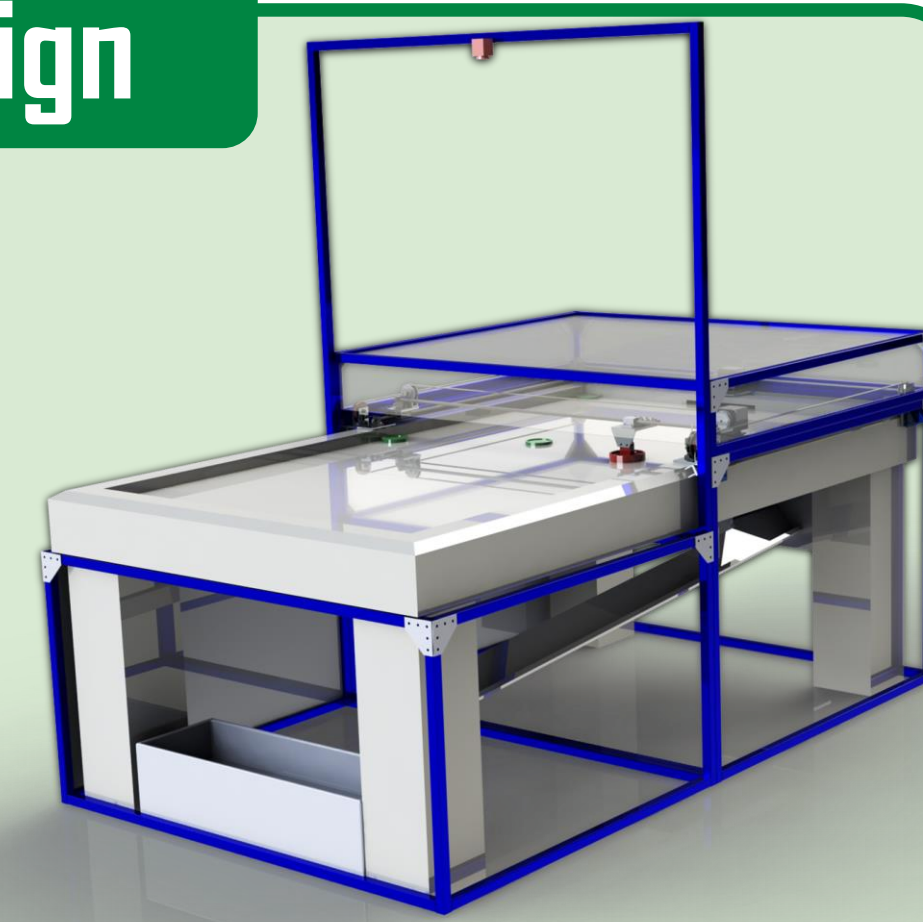


- Camera: Imaging source 60FPS, 720P, USB 3.0
- Utilizes 2 microcontrollers
- 48V stepper motors
- System power of 750W
- Processing unit specifications: AMD Ryzen 3 2200G, NVidia 1050, 8GB DDR4-2800, Intel SSD
- Linux RT provides safety, stability, and determinism

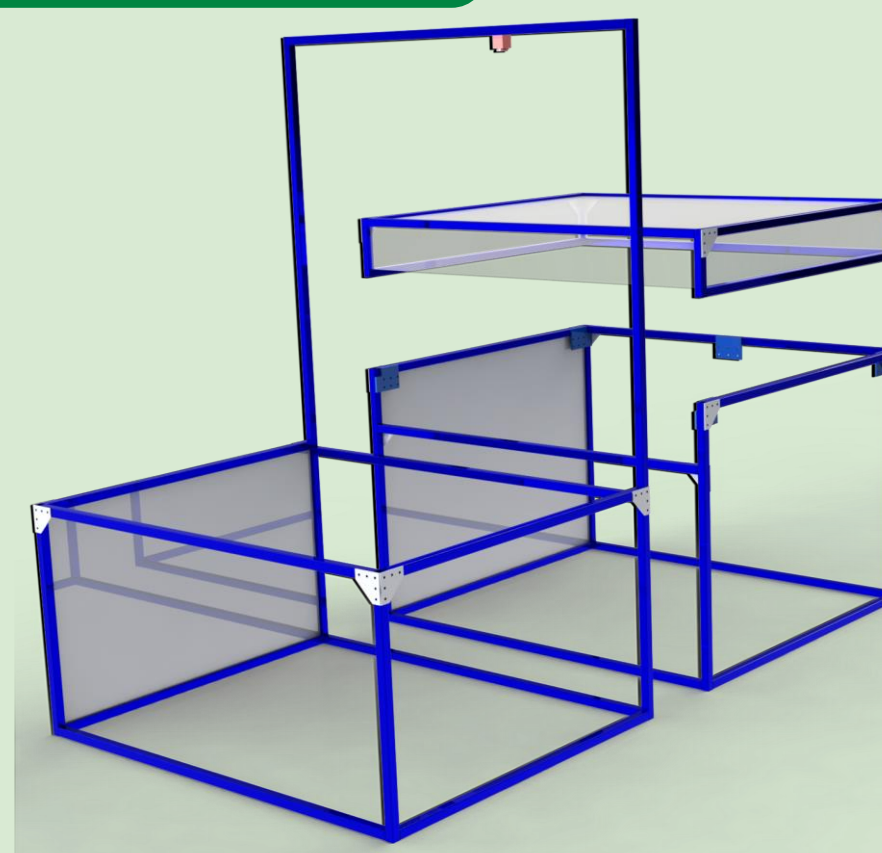
Final Design

Upper Level Sub Assemblies

- Actuator
- Puck Return
- Safety Cage

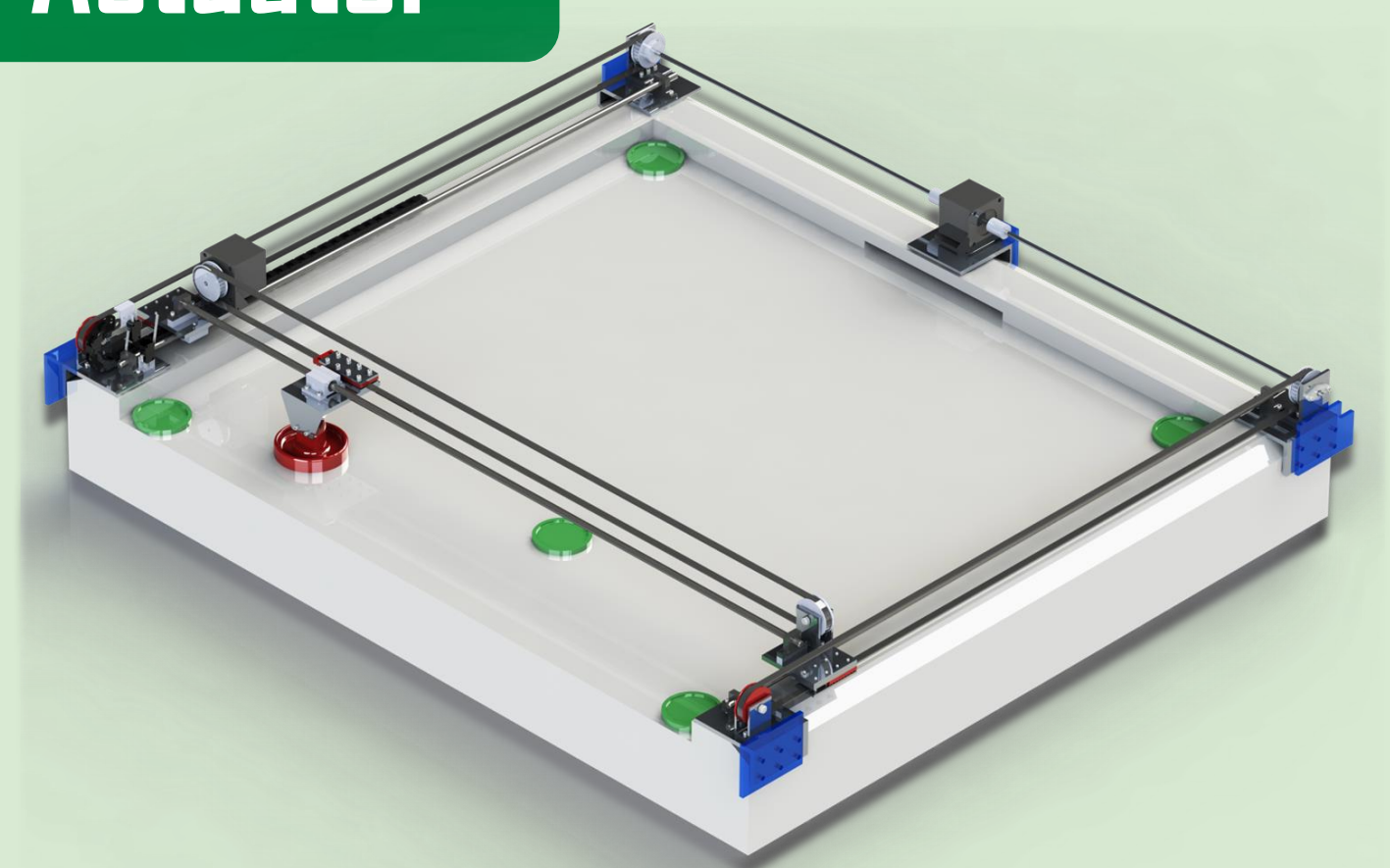


Safety Cage



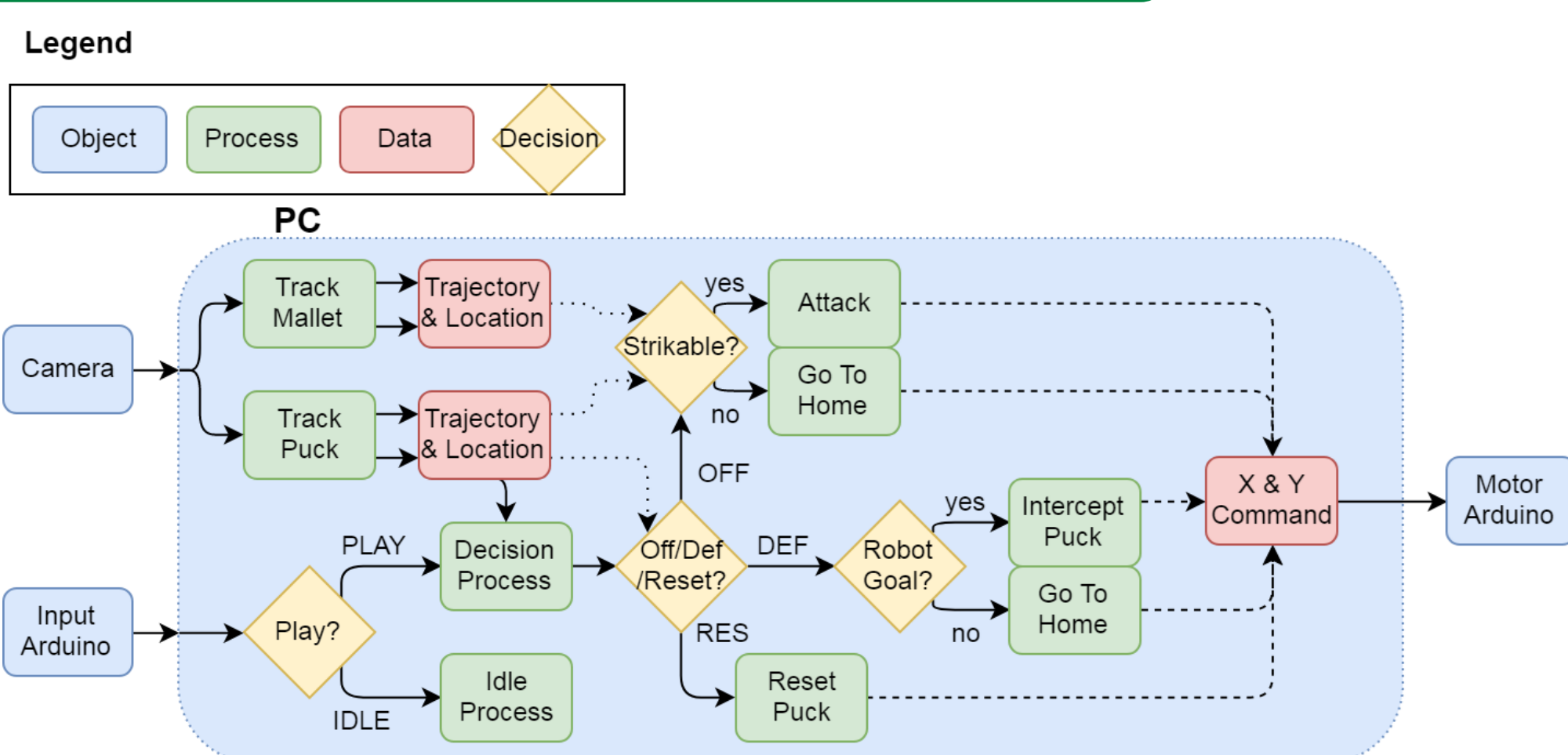
- Encompasses the entire table to prevent injuries
- Framing is made of extruder aluminum
- The clear panels are polycarbonate,
- The opaque panels are HDPE plastic
- The mesh is a thermoplastic coated steel mesh
- The cage can be broken down into 4 sub-assemblies for transportation and maintenance access
- Camera mounts to top bar

Actuator

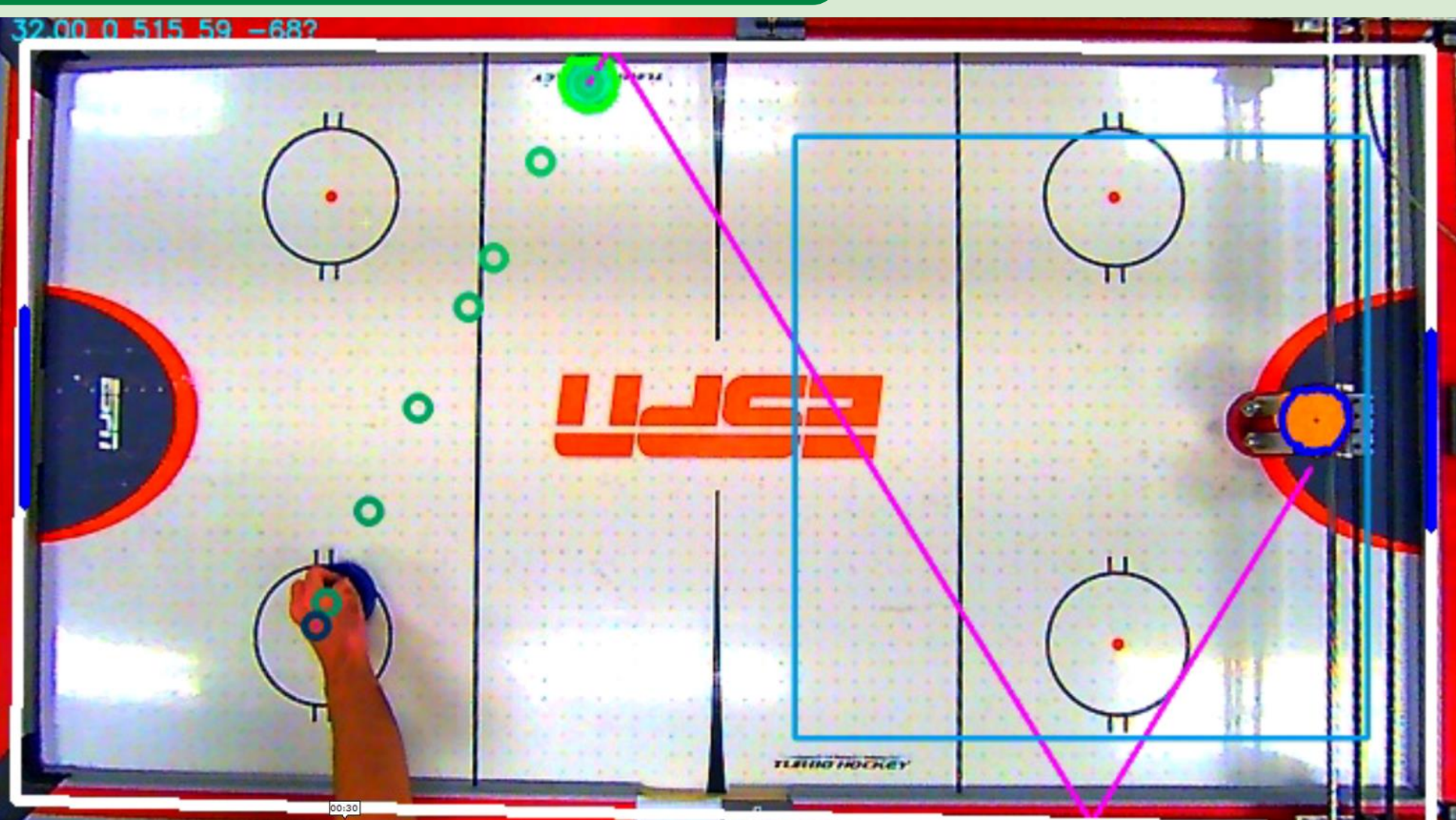


- Designed after standard H-frame gantry
- Belt driven by 2 Nema-23 stepper motors in the y-axis and 1 in the x-axis.
- Uses linear guide rails and bearings
- Mounts directly to the safety cage to allow for table replacement and stability
- Uses 3D printing for the idler pulleys, belt clamps, and long bearing housings.
- Designed belt clamps with a sliding part for tensioning.

Programming Flowchart



Computer Vision



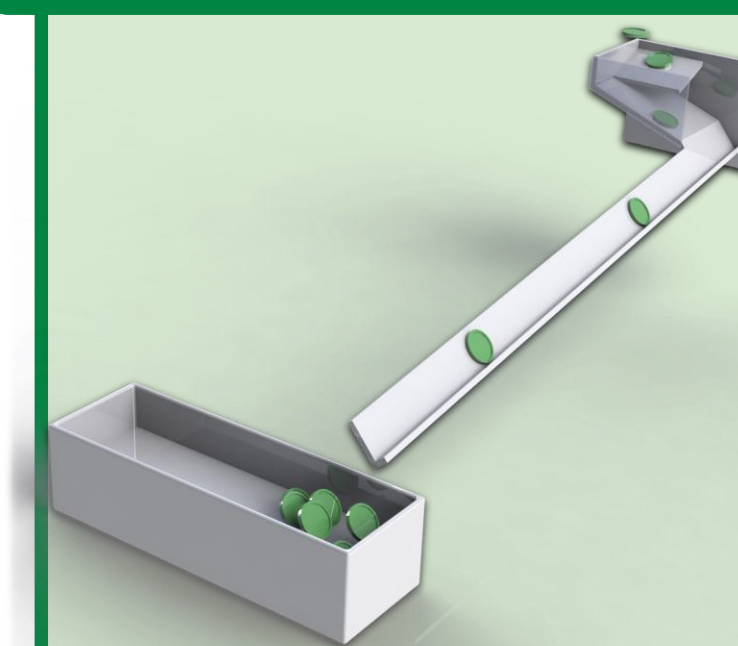
- Use of OpenCV 3.4 (C++)
- Undistort frames to make planar
- HSV thresholding
- Threaded contour search used to detect game objects
- Determine field of play from image
- Puck trajectory used to predict and anticipate goals
- Mallet location used to close the motion control loop
- Determined boundaries set motion limits and used to predict ricochets

Conclusion

Team 555 Monostable Solutions proudly presents our take at an air hockey playing robot. Our exhibit meets the requirements of playing air hockey, having variable difficulty levels, and being safe for children. In the months to come, we hope to prove that our design is durable with minimal maintenance, meeting the next two requirements.

The final requirement was to be educational and to showcase the engineering concepts that went into this project. We sincerely hope that everyone that interacts with our exhibit is inspired by the engineering and effort put into this project. Ultimately, we hope to live up to Sci-Tech's slogan of *Mind-Stretching Fun!* Enjoy!

Puck Return



- Uses a simple ramp to return player scored pucks to the player side
- Made of steel U-tube

Ethics

- An emergency stop is mounted in an easily accessible location to shut off all components immediately
- The polycarbonate casing is designed to prevent anyone from reaching into the robot during operation
- The lower panels prevent injuries under the table

Team 555: MonoStable Solutions would like to thank the UTD North Lab Machine Shop, the UTDesign Administration team, Dr Spong, Dr. Gans, & Dr. Skinner

For more details contact
Jack at jack.doan@utdallas.edu or
Jeremiah at jeremiah.plauche@utdallas.edu