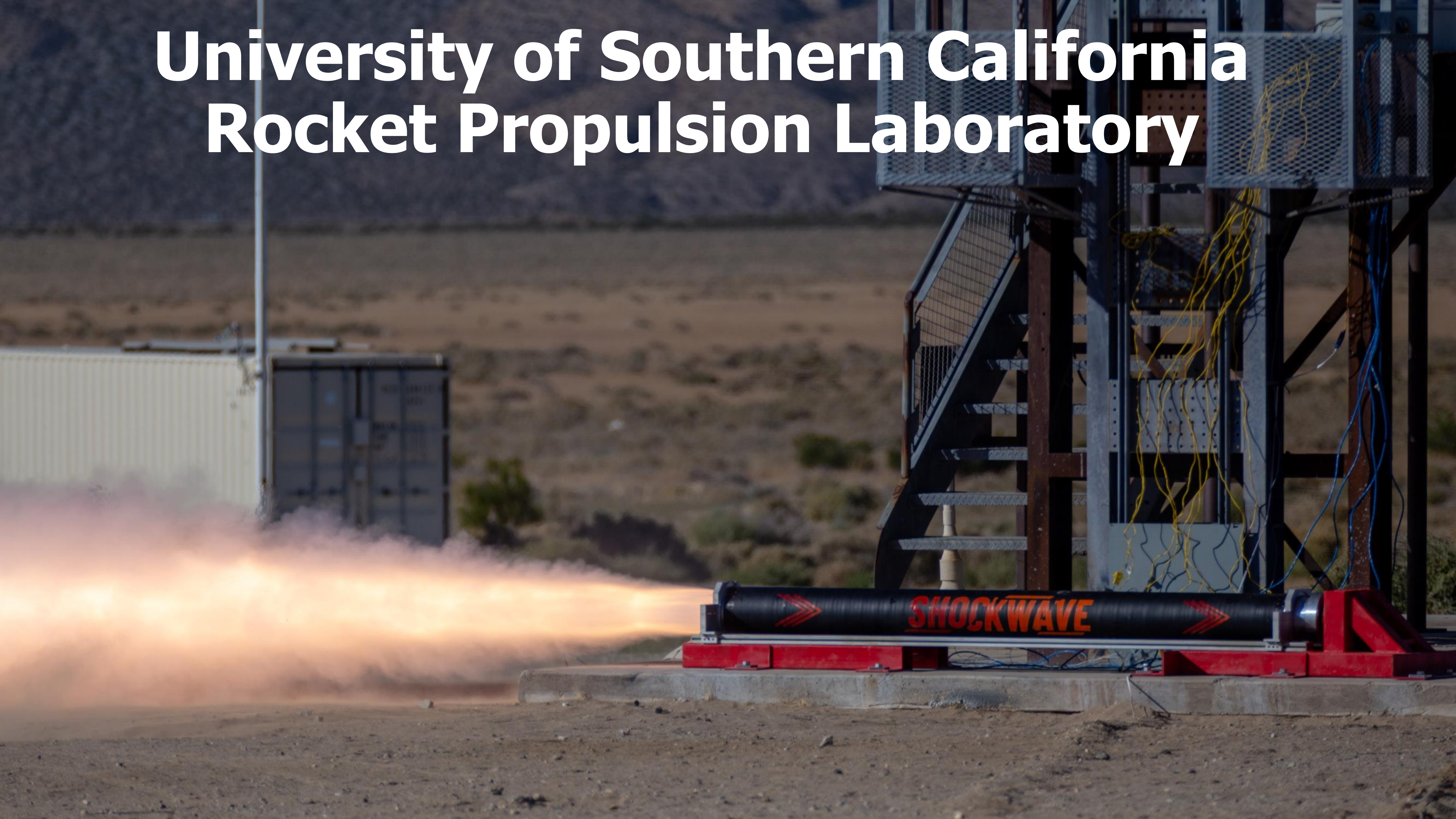
Nikitas Klapsis
Engineering Portfolio

nklapsis@usc.edu


University of Southern California
Rocket Propulsion Laboratory
SHOCKWAVE

USC Rocket Propulsion Lab Machining

Drafting

I updated and improved existing drawings for accurate tolerances and clear callouts. This included consulting the Parker O-Ring handbook to ensure our O-Ring grooves were accurately machined and could seal effectively. I further adjusted the drawings to ensure that dimensions were referenced from true datums.

Pre-Manufacture Planning

I planned the fixturing and operations needed to complete each part I was assigned. My most difficult flight critical part was the propellant liner. This was two large 4-foot tubes of linen phenolic designed to insulate the case from the burning propellant gasses. Due to the liner's large diameter and small thickness, I used a large mandrel to hold the part. I used tape around the mandrel to account for the inaccuracy of the ID of the and create a friction fit between the stock and the mandrel. I would then face it to length and turn it to the correct OD.

Machining

During machining our auto-feed was not working so I had to turn the entire 4+ ft length of the liners by hand. The inconsistency of the feed rate as well as the play between the stock and the mandrel caused ridges to form, which prevented a smooth fit into the carbon fiber case. To mitigate this, I took multiple spring passes as well as turning the liners 180 on the mandrel. Finally, I machined internal and external features to fit the liners together and finished the part.

Machining Continued

Inspection

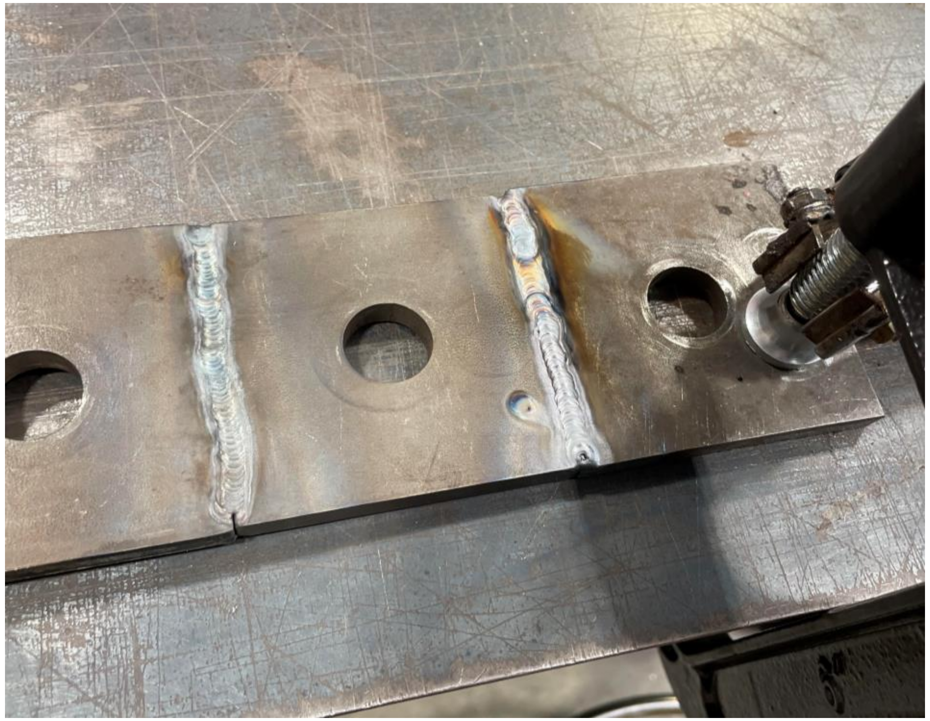
While many of our parts are machined to creep up on tolerances and test fit to achieve dimensions, inspection is still critical for many components. For more complex parts like our fin leading edges, bulkheads, and many parts of our nozzle assembly inspection is key for accurate and functioning parts. I learned how to use internal, external, depth, and blade micrometers for measuring critical dimensions. Further I learned how to use fixtures on a surface table and indicators to measure angles, profiles, and give a complete picture of a part’s deviation from design.

Takeaways

Beyond the technical skills learned, this experience also gave me more knowledge of the design to manufacturing to firing workflow. The earlier a mistake is made the more it compounds during the manufacturing process if not caught. Having multiple eyes going over each step in the process, planning for contingencies, and having the scrappiness to adapt when things go wrong are key to project completion.

Thrust Stand Manufacturing

Learning to Weld
Over the summer I learned TIG welding in preparation for refurbishing our thrust stand. I first practiced flat welds, then moved up to butt welds and fillet welds, constantly learning from my mistakes.



Machining D-clamps
I used a waterjet cutter to rough the stock, then milled the D-clamps responsible for holding the rocket onto the thrust stand.

Thrust Stand Final Assembly and Integration

Welding and Test Fit
At the beginning of the semester, we installed new anchors at the MTA pad using a water-jet grid that allowed the anchors to be precisely placed while having the high pull-out strength of pour-in anchors. We then used that same grid to place the brackets in relation to each other on the stand and tacked them together. We finished welding the anchor brackets, completed the test fit and welded in the brackets to hold the 8020 extrusions perpendicular to the thrust collector.

Final Assembly
The day before the Shockwave firing, we assembled and integrated the thrust stand to the pad in less than three hours, showcasing the success of the pour in grid anchors and refurbished thrust stand.

Shockwave Static Fire

Troubleshooting

During motor integration we realized that the aft bulkhead could not seat onto the sealing surface due to a mistake during case manufacturing. To mitigate this issue, we had to create G11 spacers to move the entire stack up a quarter inch aft. After receiving rough cut stock, we had less than an hour to machine the stock down to fit the case.

Result

We created a makeshift sander capable of finishing and rounding the stock, using the case to test fit as needed. We successfully finished machining the spacer and fired the next day, resulting in a max thrust of 3,772 lbf and a total impulse of 45,698 lbf-s.

Baum Family Makerspace Machinist

Variety of Parts, Variety of Challenges

I was responsible for making parts for a variety of USC undergraduate engineering teams including the Autonomous Underwater Vehicle team, Formula SAE, Formula SAE electric, and many other smaller projects. Each day brought new and unique challenges with their own specific requirements. Notable parts include a sonar enclosure designed to seal up to 30 meters underwater, suspension components for the formula SAE car, and hydrophone covers requiring complex fixturing and programming.

Generalized Robot Learning from One Scenario

Nikitas Klapsis, ndklapsis@gmail.com
Crescenta Valley High School, Class of 2022
USC Viterbi Department of Computer Science, SHINE 2020

USC Viterbi School of Engineering

SHINE Summer High School Intensive in Next-Generation Engineering

Introduction

A major bottleneck to effective robot learning is collecting and processing enough data to solve complex tasks. The robot must interact with example scenarios many times to solve each scenario, and must be presented with a diversity of scenarios in order to generalize. We asked the following research question:

Can a robot interacting with only **one** scenario still learn to solve complex tasks?

Methods

To solve the general task, the robot must extract as much information as possible from the single scenario. We evaluate our approach on the lunar lander domain from OpenAI Gym where the objective is to land a spacecraft safely. Each scenario differs in terrain and initial conditions of the lander. In order to generalize to all scenarios, we want our robot to explore **different** solutions to landing the lander such as impacting the ground at different velocities or landing at different positions. To explore different solutions we trained our robot with the quality diversity algorithm Covariance Matrix Adaptation MAP-Elites (CMA-ME).

Research and Results

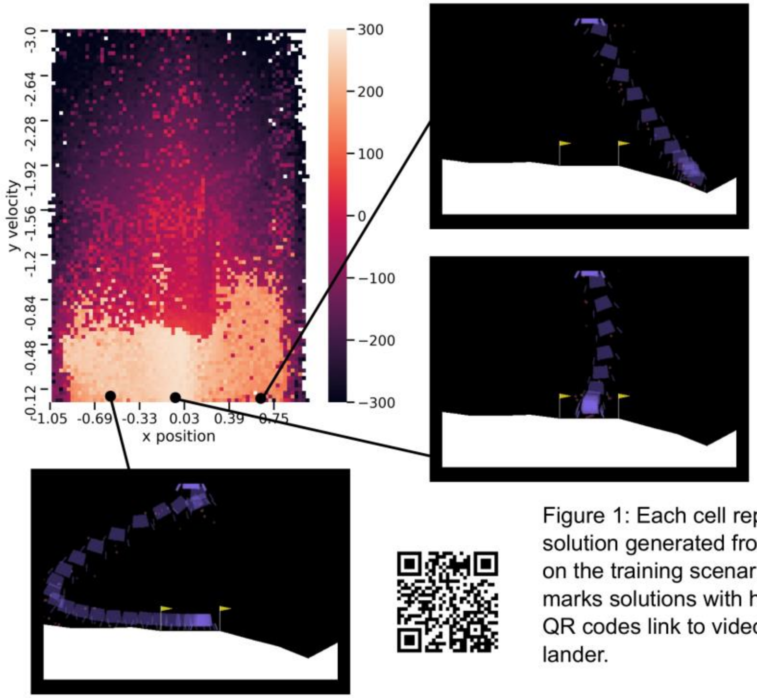


Figure 1: Each cell represents a solution generated from CMA-ME on the training scenario. Intensity marks solutions with high rewards. QR codes link to videos of the lander.

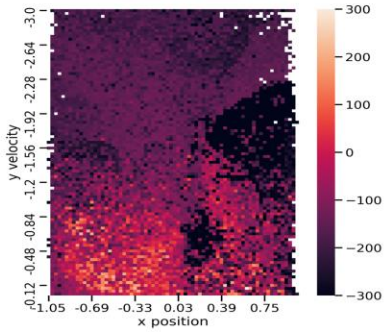


Figure 2: Each cell represents the average score from 200 different environments generated from the model made by CMA-ME for the first training environment.

Next Steps and Broader Impacts

The next steps in our project would be seeing if this method also worked in a different OpenAI Gym environment like car racing and bipedal walking. Furthermore, by implementing a neural network instead of a linear model, our method could solve more complex tasks. After demonstrating the generality of our method, we could train physical robots with fewer example scenarios.

A possible application for this method of learning is to use it where the data from an environment is extremely limited, like rovers on different planets. Diverse solutions for both design and control of rovers could lead to greater chances of mission success, and more robust exploration of planets. The applications for CMA-ME are vast and continue to grow as machine learning becomes an essential part of research and daily life.

Acknowledgements

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[Link to Full Presentation]

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