# Spacecraft Low Thrust Optimization System

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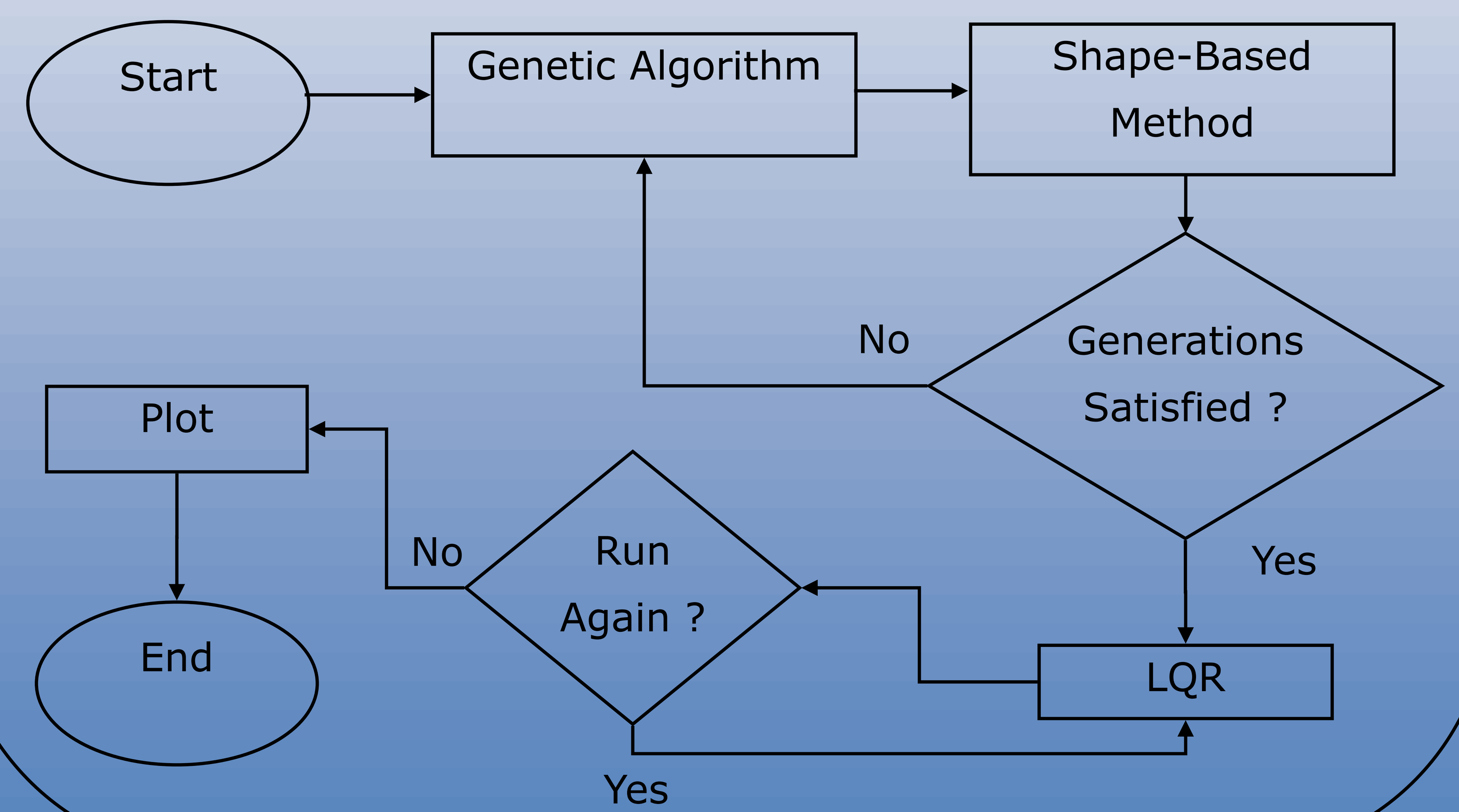
## Introduction

As we advance into a modern space-age there is a need to obtain better trajectories for spacecraft missions, in which optimization plays an integral role. The improvement of trajectories will provide a more cost efficient means of conducting space missions. Throughout this project such optimization will be discussed in terms of accomplishment and potential problems.

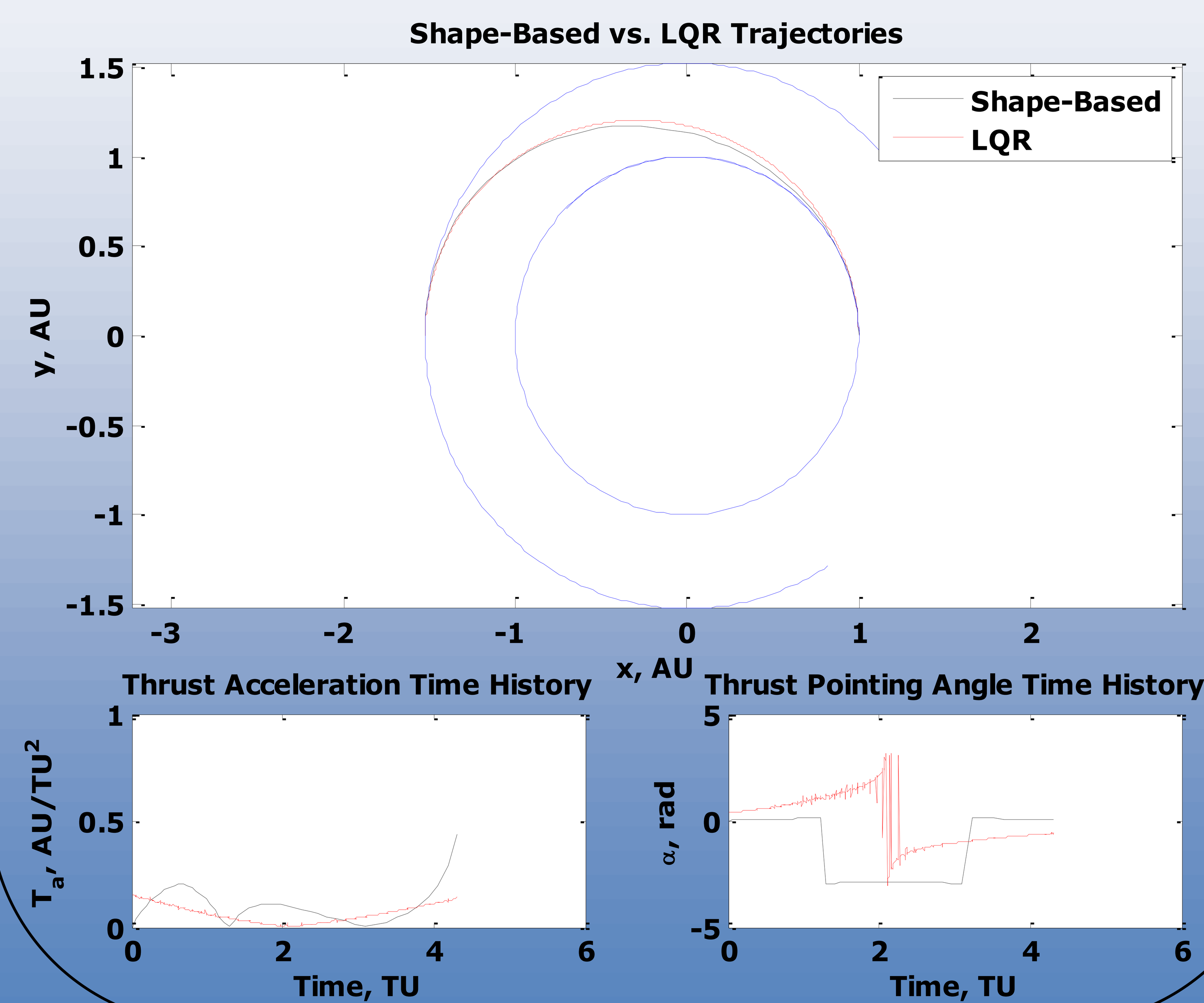
## Approach and Method

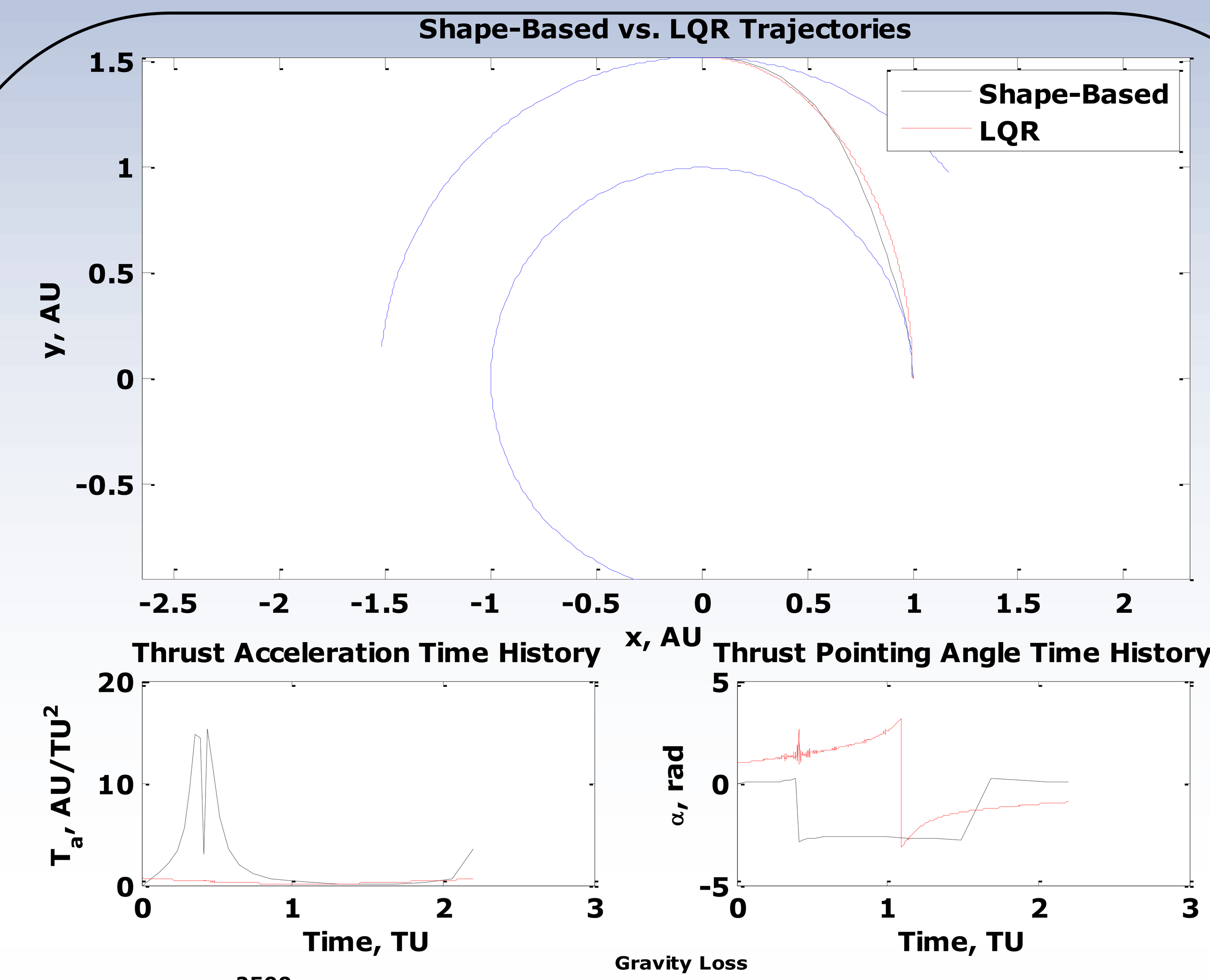
By selecting initial parameters for a space trajectory, such as initial body and targets, fuel mass of the rocket, time of flight and orbital elements for desired bodies. In order to obtain near-optimal solutions the Shape-Based method is used with the implementation of the Genetic Algorithm. The solution from the Shape-Based method is now passed on to the Linear-Quadratic Regulator optimization method. This utilizes the Matrix Ricatti Equation to find a neighboring optimal solution. By calculating the new cost the state variables of the problem are optimized giving the LQR solution. The Shape Based method is now compared to LQR solution, and along the evolution of the states through the time of flight.

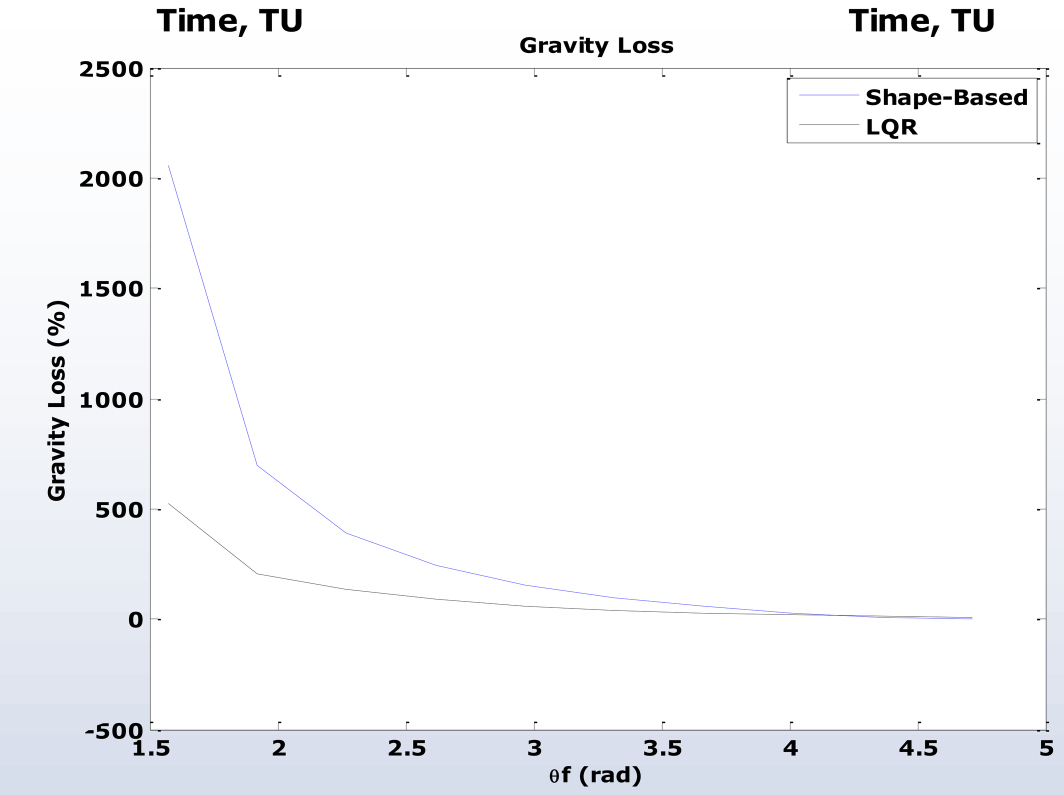



## Results

Our role in the project has been to continue the data analysis and modify the code for solving to be able to approach more difficult problems. The first step we took was to obtain a zero terminal error solution. The second step was to make the algorithm capable of approaching multi-body problems. Once we were dealing with multi-body trajectories the Shape-Based solution was better than what the LQR could optimize. Different parameters were changed such eliminating the time constraint. Unfortunately this didn't lead us to a better solution. Therefore we went back to the LQR algorithm and implemented a method to drive the terminal constraints to exactly zero. The results yielded from the previous modification gave us the desired result, unfortunately there was not enough time to implement the new modifications with a multi-body trajectory. The calculations of the gravity loss were incorporated into the algorithm, in addition to the previous actions.




## Future Directions

1. Test the modified LQR for multi-body problem.
2. Continue a more in depth research of the LQR to find the best values for the criteria matrices.
3. Advance the level of difficulty for the test cases.

## Acknowledgements

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