How does the “kick off” angle of gravity turn affects the vehicle’s final altitude and velocity?

Rocket Trajectories Using Gravity Turn and Numerical Integration

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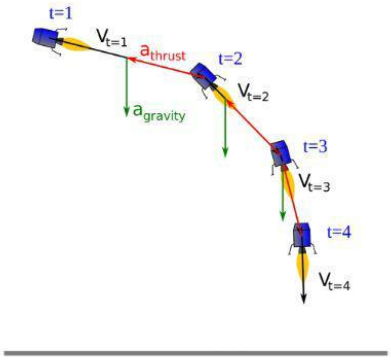
Introduction:

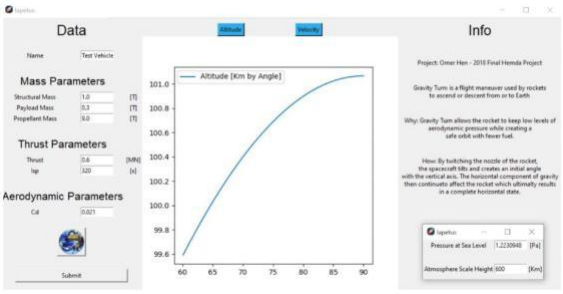


Throughout history the human race has always been fascinated by the night sky, whether it’s due to the beautiful stars, the compelling void or the curiosity of what lies beyond our planet. As time progressed, so did our understanding of the universe, and we have been able to build, using our profound knowledge, new devices to explore the alluring night sky. One such device is a rocket, which allowed humanity to break the barrier of gravity and execute space missions sending resources and people far away from Earth.However, rockets have difficulties launching and descending back to celestial bodies. One solution in addressing this issue is termed “Gravity Turn”

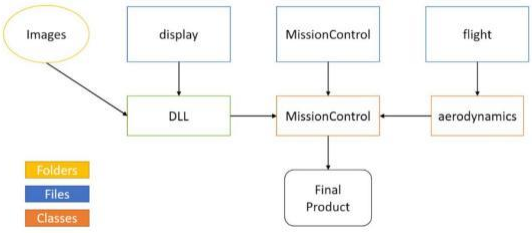
- a maneuver allowing the rocket to change its horizontal angle in order to create a stable orbit around Earth with less aerodynamic stress and decreased fuel consumption.

Computer Model experiment:

The computer model contains several different parameters which help manage the rocket’s trajectory in a more efficient way. That said, during the experiment the main variable was the initial angle of the gravity turn maneuver, which was chosen in order to get a better understanding of how the initial angle affects the vehicle’s final altitude and velocity.



Computer Model:



The computer program devised to simulate "gravity turn" for this research was written in Python 3. Though the mathematics behind the maneuver could be covered in a single module, in order to encompass all variables and produce a reliable, readable algorithm - this program consists of three independent libraries that jointly create a suitable simulation. That said, the main program is: “MissionControl”.

Results:

According to the model, a relationship between the initial angle and the final stats of the rocket can be found. The altitude and velocity increase at higher initial angles , up until a maximum of 90 degrees.

Future Research:

To reach even more accurate results and to obtain a more realistic model, I suggest adding a multistage rocket system to simulate various engines en route to orbit.