Generic Ascent Model Features

General Ascent Motion Model

Complete model for the ascent mission is a **synthesis** of all the force **models**, in the Newton's 2nd **law** for a rotating frame, as given **below.**

$$\frac{d}{dt}\left\{\vec{V}_0 + \vec{V}_b(t) + \vec{\Omega}_0 \times \vec{R}_b(t)\right\} = -\frac{\mu \hat{R}_b(t)}{R_b^2(t)} - \frac{\dot{m}(t)}{m(t)} g_0 I_{sp} \hat{u}_T - \frac{D}{m(t)} \hat{u}_D$$

As can be seen, these are **non-linear** and time varying system of **ODEs**, for which **no** known closed form **analytical** solutions exist.

Ascent Mission Design Task

Ascent mission aims to **achieve** a velocity, altitude and flight path angle for the **spacecraft**, which are generally **fixed** quantities as per the **desired** spacecraft mission.

Further, **both** launch and injection **points** are also **fixed** in the terrestrial (i.e. **geographical**) context.

Therefore, **ascent** mission design **task** is to arrive at (1) **vehicle,** and (2) **trajectory** for safe & optimal **operation.**

Ascent Mission Problem Description

It should be **noted** that while, as a design **task**, we need to solve for a **vehicle** for a given **trajectory**, it is useful to first **generate** the trajectory for a given **vehicle.**

Once we **characterize** the trajectory **nature**, we can **reformulate** the trajectory **equations** to arrive at **vehicle.**

Both these **tasks** are usually **carried** out through **simplified** models, which are later **verified** through rigorous simulations and **experiments.**

Model Simplification Strategy

Model **simplification** is carried out based on **overall** accuracy **requirements** and as a first **step**, most solutions use **idealized** scenarios to capture the **primary** effects.

Subsequently, these **primary** solutions are **corrected** for the **secondary,** tertiary and other higher order **effects**.

In this **manner**, we can obtain a fairly **accurate** solution, while limiting the computational / **numerical** effort during the conceptual**/preliminary** design process.

Summary

Generic ascent model, while **employing** simplified force models, has **sufficient** realism to capture overall **features** of the ascent trajectory in a **practical** context.

We also **note** that we can always **refine** the model to suit the **accuracy** requirements.