Surrocket User Manual

"Surrocket" is a MATLAB function which simulates an entire hybrid rocket. It accepts a vector of input parameters, and can be used for both design optimization or uncertainty analysis. When used for design optimization, all the rocket inputs that are not design variables (such as time step, launch altitude, etc.) are hard coded as values in the MATLAB code. When used for uncertainty analysis, the input vector contains all the values of the model inputs, and only the time step is hard coded.

"Surrocket" stores all of the data relevant to the simulation in a state variable of a "struct" data type that is passed into sub-functions such as "MuleSim3" and "Suborbit". This reduces the number of variables that need to be passed into and returned from each sub-function. After loading the input data -- including the CEA lookup table (“MuleSim3CEA.mat”), the N2O saturation properties table (“N2OSat.mat”), and the drag coefficients (“Cdavg.mat”) -- the function calls "MuleSim3."

When being used with "Surrocket" for design optimization or sensitivity analysis, "MuleSim3" accepts a state variable of a struct data type as input, and returns the state variable with updated values as an output. The fields of the state variable that are used for further calculations include the thrust and mass curves compatible with "Suborbit," the total propellant mass, the burn time of the liquid oxidizer flow regime, and the final fuel grain diameter. Several other parameters of interest are stored in the state variable for ease of reference and troubleshooting after the function returns.

If "MuleSim3" throws an error, the error is caught and "Surrocket" returns values of not-a-number (NaN) for all its outputs. If there is no error, "Surrocket" then calculates the minimum required diameter and the mass of the rocket. The function "Suborbit" is then called and returns the altitude, velocity, and acceleration curves of the rocket. The velocity off the rail is calculated and then the function returns the output.

"Surrocket" returns multiple output variables. The main output is the objective function (when being used for design optimization) or specific impulse. The secondary output is the state variable which contains all the relevant simulation data such as maximum altitude.