Cambridge Rocketry Toolbox for Octave

Getting Started Tutorials

1 Tutorial 1

1. Open Octave

2. In order to use the Cambridge Rocketry Toolbox you must navigate to the toolbox folder from within Octave. This makes the folder active and allows you to run the toolbox functions. If the toolbox folder is saved in, for example, C:\My Documents\CambridgeRocketryToolbox then you can navigate there by typing

   ```
   cd ‘C:\My Documents\CambridgeRocketryToolbox’
   ```

   and pressing return. You can verify that you are now in the correct directory by typing

   ```
   pwd
   ```

   and pressing return. This prints the working directory which should be the directory of the toolbox folder which you just entered.

3. Type

   ```
   edit ‘Template1St.m’
   ```

   and press return. This opens another window using a text editor and displays the Template1St function file, which we will be using in this tutorial.

   Function files like this one are the building blocks of the toolbox and in these tutorials we will be making function files that describe the type of simulation we want to perform and running the functions to execute the simulations.

The first three lines in the `Template1St.m` file are comment lines, in function files any text that follows a `%` symbol is a comment and is ignored by Octave. On the fifth line is the function declaration.

```
function Template1St()
```

The name of the function "`Template1St`" should be the same as the name of the function file '`Template1St.m`', which it is in this case. We do not need to know the meaning of the brackets `()` at this stage. Any lines following this function declaration will be executed by Octave when the `Template1St` function is run.

A brief description of the meaning of the lines in the `Template1St` function follows: On lines 7 and 8 we load two data files. `'intab_CLV2s1_K660.mat'` is a data file that describes the rocket for the simulator. `'intab4_2006100809.mat'` is a data file that describes the atmospheric conditions at the launch site.

On lines 10 - 13 we declare four variables that are required by the simulator. The rocket, which is described in the data file `'intab_CLV2s1_K660.mat'`, is a dual-deploy rocket. This means that it has two parachutes; one that is deployed at apogee and a second that is deployed at a given altitude programmed by the flier. `Parachute2Alt` is the altitude at which the second parachute is deployed. `RailLength` is the length of the launching rail. `RailDeclination` is the angle of declination of the launching rail in degrees. `RailBearing` is the direction that the launching tower is pointing in degrees from true north. Both `RailDeclination` and `RailBearing` are set to `0` here meaning that the rail is pointing "straight up".

Finally on line 18 we invoke one of the toolbox's simulation functions called `rocketflight` the variables in square brackets `[]` are the outputs of the function and the variables in curved brackets `()` are the inputs to the function.

4. The `Template1St` function can be run by typing

```
Template1St();
```

in the Octave command line and pressing return. The simulation will take a few minutes to complete depending on the speed of your computer. When the simulation has run you should receive an output in the Octave window similar to the one below.

```
Cambridge Rocketry Simulator

Simulation complete at:  16-Jun-2008 10:03:53
Elapsed time is 129.418 seconds

Apogee data:
Apogee reached 24 seconds after launch
Apogee location is 60m West and 184m South of
launch location
Apogee altitude is 3539m

Landing data:
Landing occurred 179 seconds after launch
Landing location is 665m East and 859m North of
launch location
```

Also a new window should open showing a 3-D profile of the rocket's flight path like that shown in figure 1;

5. Try changing the values assigned to the variables `RailDeclination`, `RailBearing` and `Parachute2Alt` in the `Template1St` function and then run the function again to see how this affects the results.

2 Tutorial 2

1. The function file `Template1St.m` can be used as a template for your own function files. Here we will rename the `Template1St` function and hence create a new function. Edit the function declaration on line 5, changing it from

```
function Template1St()
```

to

```
function MyFunction01()
```

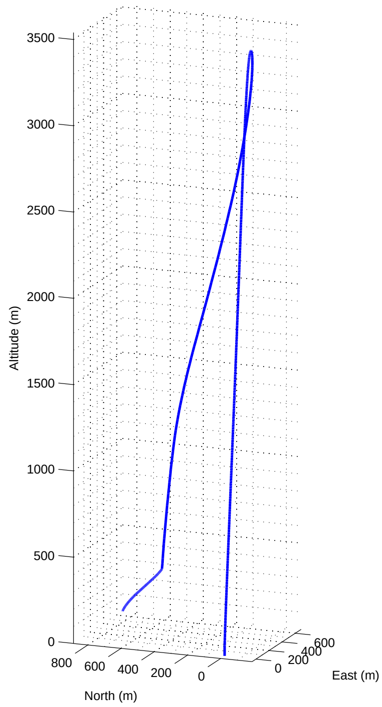

Figure 1: Example rocket flight path output from `rocketflight`

2. Next save the edited file in the toolbox folder with the new filename '`MyFunction01.m`' We have now created a new function that can be run by typing `MyFunction01();` in the command line and it will do exactly the same as the `Template1St` function.

3. Now we will make a change to our new `MyFunction01.m` file: Add the following line to the end of the function file

   ```
   [headers,RDT]=flight_variables('FlightData01',AscentData,
   INTAB,INTAB4,Parachute2Alt,RailLength,RailDeclination,RailBearing);
   ```

   Here we are invoking the `flight_variables` function. The inputs to this function are listed between the curled brackets `()` the first of these - '`FlightData01`' is a filename. This function (`flight_variables`) takes the detailed data about the position, rotation, forces and velocities of the rocket during it's ascent and writes these data to a `.csv` file called '`FlightData01`'. This file is saved in the toolbox folder.

4. Run the function by typing

```
MyFunction01();
```

in the Octave command line and pressing return.

5. Using your operating system navigate to the toolbox folder and find the file called `FlightData01.csv`. This file can be opened and viewed using spreadsheet software like Open Office Spreadsheet or Microsoft Excel.

3 Tutorial 3

In this tutorial we will learn how to use data from a UK Met Office Aviation briefing form F214 to create an atmospheric data file and then use this file in a simulation.

1. Go to the Met office aviation briefing website: http://www.metoffice.gov.uk/aviation/ga.html, register as a new user (if not already registered) and get the most recently issued F214 form. An image of part of an F214 form is shown in figure 2. The f214 form shows tables of wind speed and direction vs height data on a coarse grid covering the UK. In the centre of figure 2 you can see the data table for the grid confluence at 52° 30′ N and 2° 30′ W. The colums of the table are (left - right): altitude (thousands of feet), wind bearing (degrees), wind speed (knots) and temperature (centigrade)

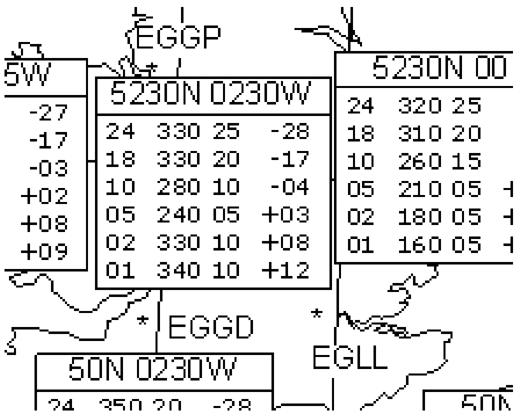

Figure 2: Section of an F214 aviation briefing form

2. Type

   ```
   edit 'TemplateF214.m'
   ```

   in the Octave command line and press return. This will open the `TemplateF214` function file for editing. To briefly explain the lines in this file: Firstly an array called `F214` is defined, an array is defined in square brackets and the rows of the array are separated by a semicolon. The data in the array are the same as the data in the central table in figure 2, except that we have added an additional line for zero altitude with zero wind speed. The wind direction and atmospheric temperature are the same as the line above. Next the `F214` array is passed to the function `f214read` which outputs the atmospheric data in a variable called `INTAB4`. This variable is accepted by the simulation functions in the toolbox. Finally the `INTAB4` variable is saved as a binary data file with the name `'intab4_5230N0230W.mat'`

3. Change the data in the F214 array to data from a table on the f214 form that you have downloaded. Then run the function by typing

   ```
   TemplateF214();
   ```

   in the Octave command line and then pressing return.

4. open up `Template1St` again, rename the function and save it as we did in tutorial 2, then edit the function file so that instead of loading the atmospheric data file called `'intab4_2006100809.mat'` it loads the file you have just saved (`'intab4_5230N0230W.mat'`). Run the new function and see how the new atmospheric data affect the rocket's flight path.

4 Tutorial 4

In this tutorial we will find out how to encode the simple rocket design shown in figure 3 into a rocket design file and then simulate a flight using this rocket design.

1. Type

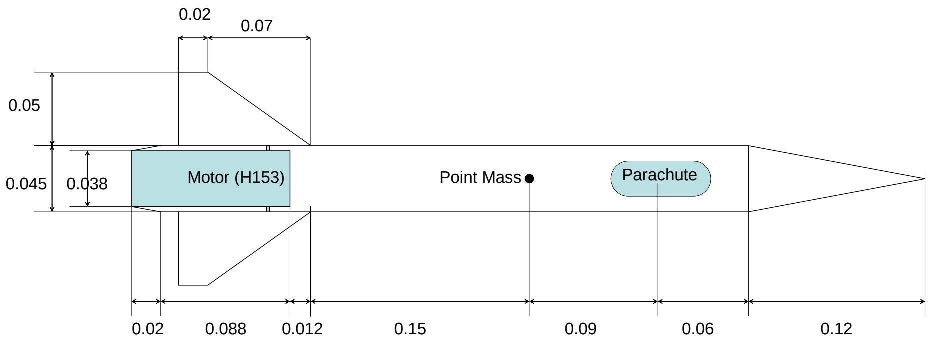

Figure 3: Sketch of rocket design

```
edit 'TemplateRocketDesign.m'
```

into the Octave command line and press return. The function file that opens contains the encoded form of the rocket design in figure 3. The rocket is broken down into several component parts: nosecone, body tube, finset, parachute etc. The `TemplateRocketDesign` function file shows the syntax for encoding data about each of these parts into a single variable (`n1, B1, F1` ...). In the final two lines of the `TemplateRocketDesign` function you can see that a function called `intab_builder` is invoked, this takes the part variables as inputs and outputs a rocket design data variable called `INTAB`. Finally this variable is saved in the same way as the `INTAB4` variable was saved in Tutorial 3, using the filename `'intab_DesignTemplate.mat'`

2. Type

```
TemplateRocketDesign();
```

into the Octave command prompt to run the function and create the rocket data file.

3. Open up the `Template1St` function file, rename the function and save it in the same way as we have done in the previous tutorials. Then edit the line in which the rocket data file is loaded so that it loads the new data file. i.e. change the line

```
load 'intab_CLV2s1_K660.mat';
```

to

```
load 'intab_DesignTemplate.mat';
```

Now run the new function to see a simulation of a flight with this rocket.

4. Finally rename and save the `TemplateRocketDesign` function file so you can use it as a template for your own rocket designs. Try changing some of aspects of the rocket design in the function file and then simulating a flight to see the effects of the changes.

5 Further Learning

1. Please see the Cambridge Rocketry Toolbox for Octave – Instruction Manual for comprehensive instructions on how to use all the available toolbox functions and learn how to:
   - Simulate two-stage rockets
   - Incorporate uncertainty into your simulations using the Monte Carlo functions
   - Optimize the launch rail configuration
   - Simulate a parachute failure
   - Create rocket design files from RockSim files.
   - Load different rocket motor files and create your own.
2. Try using some of the other templates available in the toolbox such as
   - `Template2St` – A two stage rocket simulation template
   - `Template1StMonte` – A Monte Carlo simulation template
   - `Template1StDel` – A launch rail optimization template
   - `TemplateRSim` – A template for creating a rocket design file from a RockSim file.
3. For help learning how to use Octave in general try one of the many Octave and Matlab tutorials on the web. A few examples:
   - http://www-mdp.eng.cam.ac.uk/CD/engapps/octave/octavetut.pdf

- http://volga.eng.yale.edu/sohrab/matlab_tutorial.html
- http://www-h.eng.cam.ac.uk/help/documentation/docsource/matlab_by_example.pdf