CS268: MACHINE PERCEPTION

Homework 2: Landing on Mars

Fall 2012

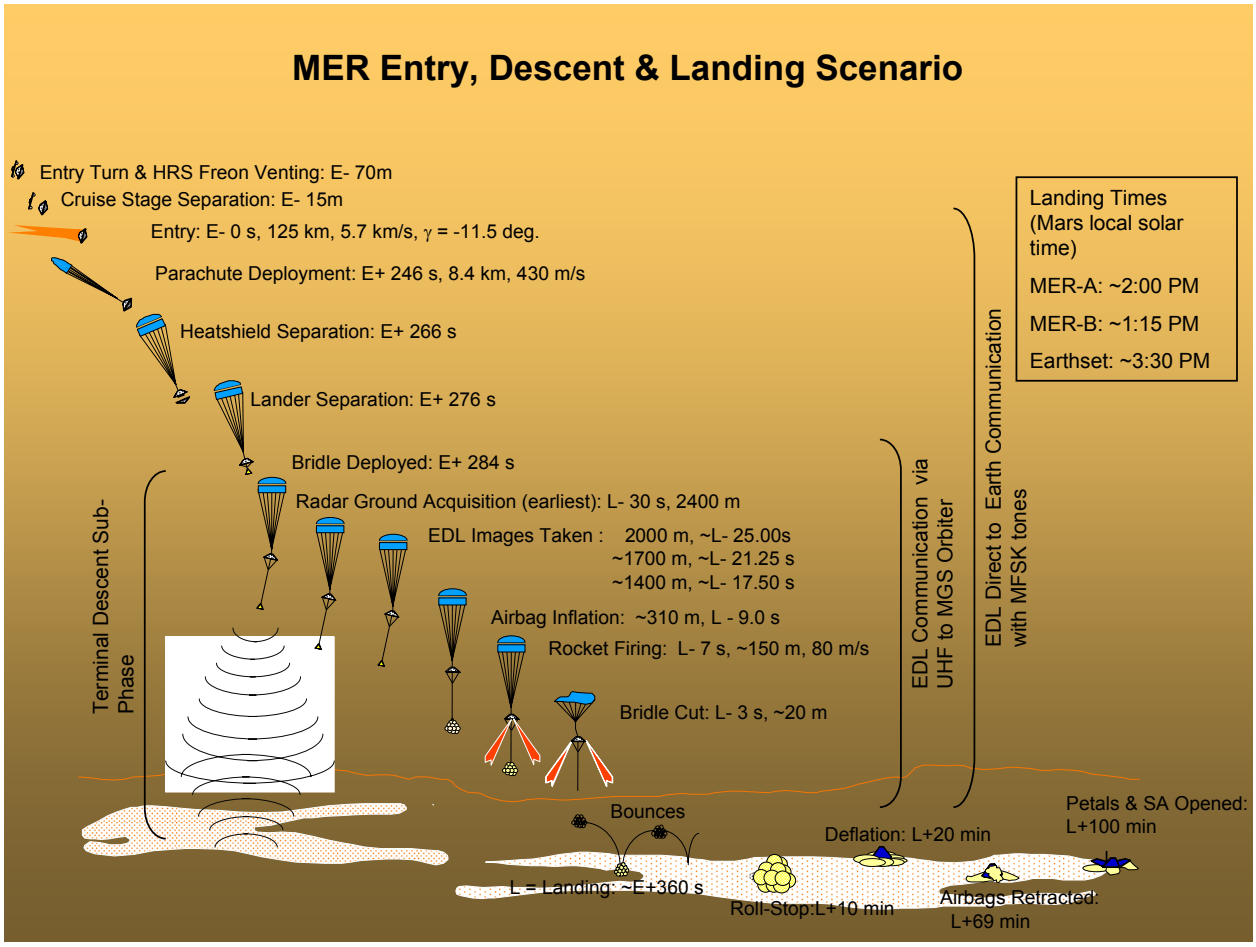

Figure 1: *MER Dimes Landing concept (courtesy of L. Matthies, JPL-NASA).*

The first Mars polar lander missions failed in part because the airbags responsible for stopping the vertical descent were rated for a maximum vertical speed but did not take into account horizontal speed due to surface winds.

In subsequent missions, starting with MER 2003, the DIMES program (descent image motion estimation system) put in place a vision system to estimate horizontal component and, if the overall velocity was higher than that allowed by the airbags, to fire a rocket to slow (ideally anihilate) horizontal velocity. The system is widely regarded as critical to the success of subsequent missions.

In this homework, you will write your own version of the DIMES algorithm. You will be given 3 images obtained during descent towards Mars, and you will be given the time stamp difference between the instants in which the images were captured. You will also be given the approximate altitude at which the images were captured.

Part I: Determining Image Transformation

In the first part of this homework you will be estimating the transformation undergone by the *images* of the ground terrain during descent. In Part II you will relate this trasnformation to the motion of the craft.

You are given:

1. Image `spirit1983.PNG`, an image captured at time $t_0 = -25$s from impact, from an altitude of 1983m.
2. Image `spirit1706.PNG`, an image captured at time $t_1 = -21.25$s from impact, from an altitude of 1706m.
3. Image `spirit1433.PNG`, an image captured at time $t_2 = -17.5$s from impact, from an altitude of 1433m.

You also know that the maximum rating of the airbags is 80m/s.

You are also given, for convenience, the coordinates of a few corresponding points in the three images:

```
x1 =
  237.5127  326.5565  345.6509  321.5818  204.2800
  640.3289  543.0804  534.0132  440.8991   34.5351

x2 =
  772.1164  744.4182  750.3491  643.2800  197.6509
  525.1886  376.1477  350.1009  305.0132  137.9196

x3 =
  604.9090  448.6071  425.7200  319.0219
  524.3289  465.9664  445.9196  520.8523
```

You are asked to determine the transformation (Euclidean? Affine? Projective?) that brings a subset of these points *approximately* into correspondence.