CS 223b: Introduction to Computer Vision
Assignment #3 Solutions

1 Correlation based stereo

(a) The minimum number of design decisions we expected from you were:

1. similarity measure
2. window size
3. disparity range

Here's an example solution:

```
% Compute disparity from the normalized versions of two images.
% The maximum disparity is bounded by max_d.
% The radius of the matching window is rad.
function [d] = corr_stereo(corrL, corrR)

max_d = 15;
rad = 2;

% get image and window size
[rows cols] = size(corrL);
imL = zeros(rows+(2*rad),cols+(2*rad));
imR = zeros(rows+(2*rad),cols+(2*rad));
imL(rad+1:rad+rows,rad+1:rad+cols) = corrL;
imR(rad+1:rad+rows,rad+1:rad+cols) = corrR;

% initialize disparity matrix
d = zeros(size(imL));

% compute disparity
disp('Computing Disparity');
for u = rad+1:rows+rad
    disp(['Line ' num2str(u)]);
```

```
    for v=max_d+rad+1:cols+rad
        smL = imL(u-rad:u+rad,v-rad:v+rad);
        vals = 9e99*ones(1,cols+2*rad);
        for mv=v-max_d+1:v
            smR = imR(u-rad:u+rad,mv-rad:mv+rad);
            vals(mv) = sum(sum( (smL-smR).^2 ));
        end
        [mn, dp] = min(vals);
        d(u,v) = v-dp;
    end
end

d = d(rad+1:rad+rows, rad+1:rad+cols);
```

(b) There are a variety of answers here, depending on the assumptions you made. After all of the clarifications, what we were essentially looking for was to notice that, given the focal length f_x of the cameras and the extrinsic parameters T_1, R_1 and T_2, R_2, the baseline B can be calculated as the euclidean distance between T_1 and T_2. Given that, the range map is a simple application of equation 7.2 from the text:

$$Z = f_x \frac{B}{d}$$

2 Short Answer:

1. Correlation-based stereo advantages:

    - returns a dense disparity map
    - easy to implement

    Correlation-based stereo disadvantages:

    - poor results in untextured regions
    - can be computationally expensive

    Feature-bases stereo advantages:

    - faster than correlation-based techniques
    - insensitive to illumination changes and specularities

    Feature-based stereo disadvantages:

    - returns sparse disparity maps

2. Given a point in space and two cameras, the epipolar plane of the point is defined as the plane through the point and the two camera centers. The intersections of an epipolar plane with the image planes are called epipolar lines, and the two epipolar lines produced by the same epipolar plane are said to correspond to one another. The epipolar constraint states that corresponding image points must be on corresponding epipolar lines. This constraint speeds up the correspondence problem because it reduces search for a matching image point from the entire image to one line.

3.
    - (a) No. Corresponding rays will never intersect.
    - (b) No. The baseline is 0, making triangulation impossible.