METR4202 Tutorial 7 Solutions

1) The following code can be used to display a frame from 'calibration_dance.mat'

```
% Choose a frame to extract
frame_number = 3;

% Slice from the rgb_images matrix. We want all (:) y values, all x values,
% all rgb values, and the selected frame number.
frame = rgb_images(:, :, :, frame_number);

% Convert to uint8 for displaying
frame = uint8(frame);

imshow(frame);
```

2) The following code shows one way to implement the function 'choose_n_images'.

```
function choose_n_images(rgb_images, n)
%choose_n_images Randomly chooses N images from the given list of frames

    % Get a random permutation of the numbers from 1 to the number of
    % frames
    rand_nums = randperm(size(rgb_images, 4));

    % Choose the first n random numbers, and order them
    rand_nums = sort(rand_nums(1:n));

    for i = 1:length(rand_nums)
        % Get the ith image
        rgb = uint8(rgb_images(:, :, :, rand_nums(i)));

        % Save the image
        imwrite(rgb, strcat('rgb_', num2str(i), '.jpg'));
    end

end
```

3) The calibration results and intrinsic parameter matrix for the Kinect camera are as follows.

```
Calibration results after optimization (with uncertainties):

Focal Length:          fc = [ 484.06182    488.54439 ] ± [ 12.91434
13.34187 ]
Principal point:       cc = [ 305.03943    277.13272 ] ± [ 11.84356
10.69209 ]
Skew:             alpha_c = [ 0.00000 ] ± [ 0.00000  ]   => angle of pixel
axes = 90.00000 ± 0.00000 degrees
Distortion:            kc = [ 0.08068    -0.21748    0.00805    -0.01236
0.00000 ] ± [ 0.07163   0.33082   0.00746   0.00754   0.00000 ]
Pixel error:          err = [ 0.32544    0.39724 ]

Note: The numerical errors are approximately three times the standard
deviations (for reference).
```

$$KK = \begin{bmatrix} 484.0618 & 0 & 305.0394 \\ 0 & 488.5444 & 277.1327 \\ 0 & 0 & 1.0000 \end{bmatrix}$$

The % error of the focal length in x and y can be found by

```
>> fc_error ./ fc * 100
ans =
    2.6679
    2.7309
```

Re-running the calibration with all 100 frames only reduces the error by ~1%.

4) As can be seen in the below images (a map of the distortions, and one undistorted frame), the Kinect camera lens causes a slight pincushion distortion on the lower and left hand sides of the frame.

Complete Distortion Model

Pixel error   = [0.3254, 0.3972]
Focal Length   = (484.062, 488.544)   +/- [12.91, 13.34]
Principal Point   = (305.039, 277.133)   +/- [11.84, 10.69]
Skew   = 0   +/- 0
Radial coefficients   = (0.08068, -0.2175, 0)   +/- [0.07163, 0.3308, 0]
Tangential coefficients = (0.008053, -0.01236)   +/- [0.00746, 0.007542]