METR4202 Tutorial 7 Solutions

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

```matlab
% 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'.

```matlab
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:** $f_c = [484.06182, 488.54439] \pm [12.91434, 13.34187]$ 
- **Principal point:** $c_c = [305.03943, 277.13272] \pm [11.84356, 10.69209]$ 
- **Skew:** $\alpha_c = [0.00000, 0.00000]$ => angle of pixel axes = 90.00000 ± 0.00000 degrees 
- **Distortion:** $k_c = [0.08068, -0.21748, 0.00805, -0.01236, 0.00000]$ 
- **Pixel error:** $\epsilon = [0.32544, 0.39724]$ 

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

\[
\text{fc_error} = \frac{\text{fc}}{\text{fc}} \times 100
\]

\[
\text{ans} = \begin{bmatrix}
2.6679 \\
2.7309 \\
\end{bmatrix}
\]

Re-running the calibration with all 100 frames only reduces the error by \(\sim 1\%\).

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.