CSE 468/568 Assignment 7
Vision Based Perception

The objective of this assignment is to perform camera calibration and generate depth map from stereo images. Create a new package called `lab7`. Download the files required for this assignment here: https://buffalo.box.com/s/p3omlj66fvnjj9oiqmbp9sss2ej82lac Extract them in your `src/lab7` folder.
In this assignment, you will have a single launch file, and two independent nodes.

1) Perform Camera Calibration (25 points)

For this section, you will calibrate your phone camera and calculate the intrinsic parameters. Print the chessboard pattern on a letter sized paper. Stick it to a wall and take a bunch of images from various angles and distances, use the images to calibrate your camera. You must submit your images along with your code. This will be one of your nodes in this assignment. Once your node spins, it needs to load the images from `src/lab7/images/` and print out the intrinsic parameters of your camera. You **ARE** allowed to use OpenCV functions (but only OpenCV) for calibration. Test to see if you can launch everything by running the command:

```
$ roslaunch lab7 lab7.launch
```

2) Read Ros bag File and Visualize Data (25 points)

Ros bag files are used to record/store ros messges, which can be "played" later. The message inside a bag file will be published on the same topics they were recorded from, as if they are being generated in real-time. Check out http://wiki.ros.org/Bags

For this portion, you will play the ros bag file shared with you and visualize the data. In the data that you should have downloaded and extracted, we have provided the ros bag files. The bag files should be in `src/lab7/data/`. The bag file contains left, right and depth video feeds from a stereo camera along with a lot of other topics, you can use `rqt_bag` to explore the bag file. Go over all of them and visualize the data in rviz. Specifically, we require left and right RGB images, as well as the depth image.
For this section, you don't need to write a rosnode, but you need to configure your launch file, to play the bag file and open rviz with your configuration. Make sure you include the rviz configuration file in your package. Test to see if you can launch everything by running the command:

```
$ roslaunch lab7 lab7.launch
```

3) Depth from Stereo (25 points)

Given a pair of calibrated stereo cameras, you can obtain a depth image from left and right RGB images. Although you have calibrated your own camera in part (1), we want everyone to use the same data/camera for this part. Once you have explored the bag file, you will use the left and right RGB images to generate a depth image. You **ARE** allowed to use OpenCV functions (but only OpenCV). To achieve this you will have to:

- Subscribe to the left and right camera RGB topics
- Use OpenCV for the computation of the depth image
- Publish the depth image to a new topic and visualize it on `rviz`

The camera used to capture data is the "StereoLabs ZED".

Video Output

Output Resolution	Side by Side 2x (2208x1242) @15fps 2x (1920x1080) @30fps 2x (1280x720) @60fps 2x (672x376) @100fps
Output Format	YUV 4:2:2
Field of View	Max. 90° (H) x 60° (V) x 100° (D)
RGB Sensor Type	1/3" 4MP CMOS
Active Array Size	2688x1520 pixels per sensor (4MP)
Focal Length	2.8mm (0.11") - f/2.0
Shutter	Electronic synchronized rolling shutter
Interface	USB 3.0 - Integrated 1.5m cable

Depth Sensing

Baseline	120 mm (4.7")
Depth Range	0.5 m to 25 m (1.6 to 82 ft)
Depth Map Resolution	Native video resolution (in Ultra mode)
Depth Accuracy	< 2% up to 3m < 4% up to 15m

Link to datasheet

Your launch file should open rviz and display left and right images along with your depth image and the control depth image (the one from the bag file).

You will need to write a new, independent rosnode, that will publish your depth image topic. Since you already load `rviz` in your launch file from part (2), you can simply update the configuration to include your depth image topic. i.e. part (3) is an extension

of part (2) and they will be graded together at once.
Test to see if you can launch everything by running the command:

```
$ roslaunch lab7 lab7.launch
```

4) PointCloud from Depth (25 points)

In this part, you will use your generated depth map and the RGB image, to generate a PointCloud. You should add a `rosparam` in your launch file. This integer parameter will be the index of a frame within the bag file. Your node from part (3) should pick this particular frame from the bag file and the corresponding depth image you produced, and associate the depth and RGB values together, and represent them in `rviz` using markers. You can pick either the left or right RGB image for this part. Remember, this should be done ONLY for a single frame, not the whole video. You should extend the `rviz` configuration file from previous part. Test to see if you can launch everything by running the command:

```
$ roslaunch lab7 lab7.launch
```

Submission Instructions

You will submit `lab7.zip`, a compressed archive file containing the lab7 package (folder). The folder should contain your calibration photos from part (1) in `src/lab7/images/` folder, your source files and scripts, your rviz configuration file, and your launch file. The folder should compile if we drop it into our catkin workspace and call `catkin_make`. Please take care to follow the instructions carefully so we can script our tests. Problems in running will result in loss of points.
Note: Remember to include your `rviz` configuration file.
Note: You must submit your calibration images within `src/lab7/images/`
Note: You must **NOT** include the bag files. Including the data folder is unnecessary (we will use a different data set), and it only increases the submission size for upload/download. Make sure you remove the data folder before your submission.

Please use UB Learns for submission.
The assignment is due Friday, April 22 before midnight.