The Intro to Computer Vision labs will be run in Google Colaboratory, a Jupyter notebook environment that runs entirely in the cloud, you don't need to download anything. To run these labs, you must have a Google account.

Step 1: click on the assignment invite link -> **Accept this assignment**. Refresh page -> individual repo for the specific assignment is created automatically

Project 2: 2 weeks

https://classroom.github.com/a/h6t_Ovtn

Step 2: Navigate to http://colab.research.google.com/github -> Click the **Include Private Repos** checkbox -> **select the correct repo** (SistemeDeVedereArtificiala/assignment_name-student_name) -> Click on the jupyter notebook of the current assignment

Step 3: [GitHub sign-in window] In the popup window, sign-in to your Github account and authorize Colab to read the private files.

Step 4: [in colab] **File** -> **Save a copy to GitHub**. Select the correct repository for the SPECIFIC assignment -> Click the **Include Colab Link** -> Click **OK**

Step 5: [in colab] Navigate to the **Runtime** tab --> **Change runtime type**, under **Hardware accelerator** select **GPU/TPU** (tensor processing unit) according to your needs.

Read the suggestions and accomplish all tasks marked with **#TODO**.

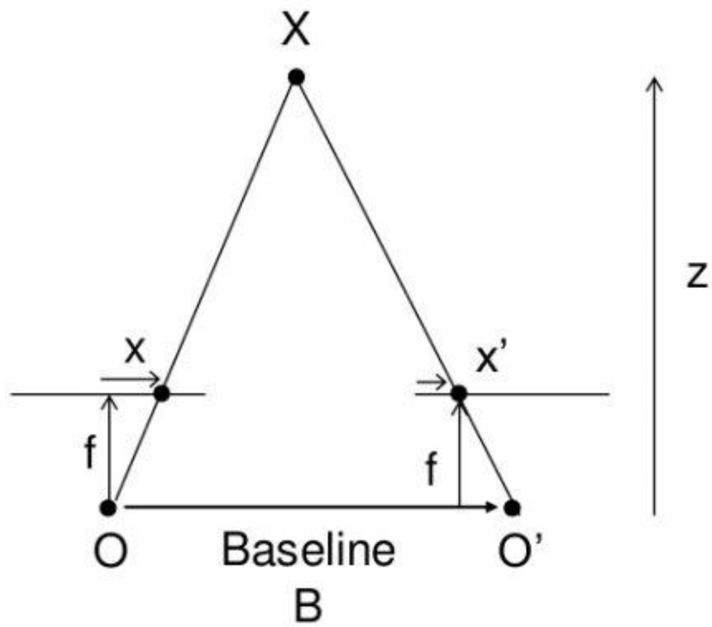
!!! At the end of each laboratory **REPEAT step 4 in order to SAVE** the answers to your private repository (individual for each assignment)

Project 4: Obstacle detection based on disparity maps

Week 2: Obstacle and ground detection based on disparity maps

A brief recap before moving on

We saw that if we have two images of the same scene, we can get depth information from that in an intuitive way. Below is an image and some simple mathematical formulas which proves that intuition.



The above diagram contains equivalent triangles. Writing their equivalent equations will yield us following result:

$$disparity = x - x' = \frac{B*f}{Z},$$

x and x' are the distance between points in the image plane corresponding to the scene point 3D and their camera center. B is the distance between two cameras (which we know) and f is the focal length of the camera (already known). So in short, the above equation says that the depth of a point in a scene is inversely proportional to the difference in distance of corresponding image points and their camera centers. So with this information, we can derive the depth of all pixels in an image. [text source: docs.opencv.org/4.2.0/]

UV-disparity space

After the disparity map is computed, we have to compute the UV-disparity space.
U-disparity space is a column based matrix which stores the same disparity values for every column from the disparity map.

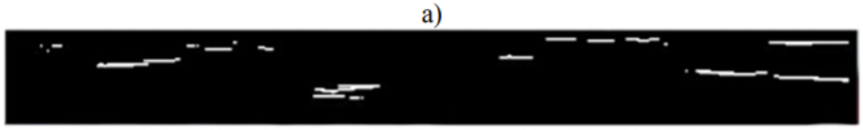
$$u_{id} = \sum_{j=0}^{rows} \delta_{ij}, \delta_{ij} = \begin{cases} 1, disp_{ij} = d \\ 0, otherwise \end{cases},$$

where $\mathbf{u_{id}}$ represents the value from U-disparity space which cumulates the number of pixels with disparity **d** from column **i** in the disparity map.
Same as U-disparity space, V-disparity space is a row based matrix which stores the disparity values for every column from the disparity map.

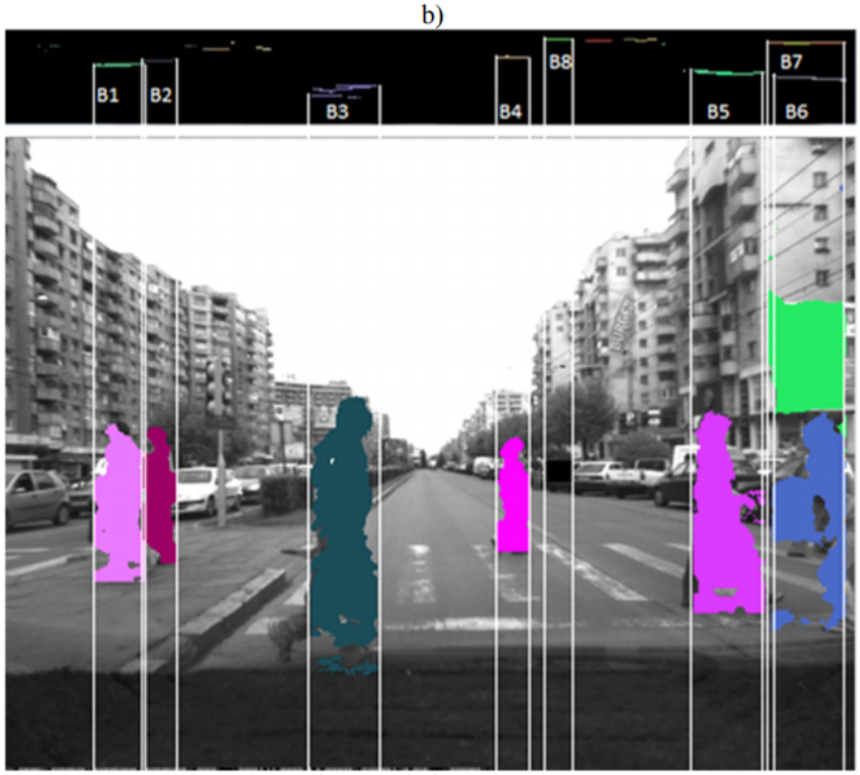
$$v_{dj} = \sum_{i=0}^{cols} \delta_{ij}, \delta_{ij} = \begin{cases} 1, disp_{ij} = d \\ 0, otherwise \end{cases},$$

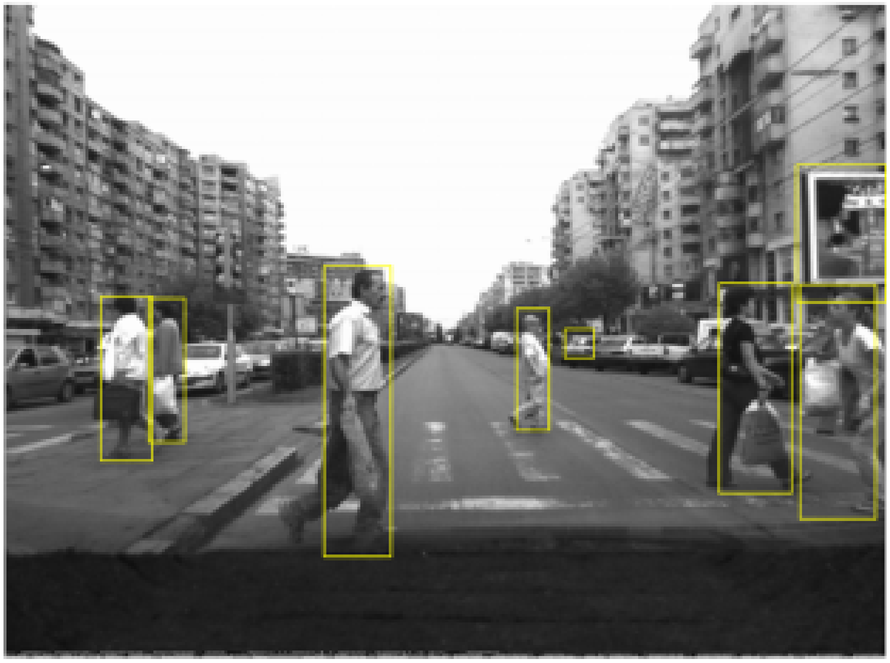
where $\mathbf{v_{dj}}$ represents the value from V-disparity space which cumulates the number of pixels with disparity **d** from row **j** in the disparity map.

a)



b)





Further study at:

1. Depth Map from Stereo Images
2. Chapter 11 - Stereo correspondence from Algorithms and Applications, 1nd Edition, Richard Szeliski
3. Chapter 12 - Depth estimation from Algorithms and Applications, 2nd Edition, Richard Szeliski
4. UV disparity based obstacle detection and pedestrian classification in urban traffic scenarios - A. Iloie, I. Giosan, S. Nedevschi, Computer Science Department, Technical University of Cluj-Napoca, Romania