ToolBox 1
Introduction au Traitement D'Image

Mini-Project

LEFDALI Rida

Contents

1 Introduction

The project is the application of image processing techniques in the field of hydraulic. The goal of this project is about to compute the height of each slug moving from left to right in function of time using videos and detect them. The following image represent how look like the expected results of this work:

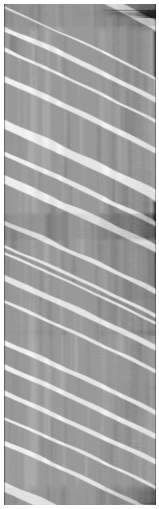

Figure 1: desired result

The abscissas represent the height of the slug and the ordinates are the time.

2 The followed method

At first, we will work on one frame, after extracting them from the videos, to know how to deal with this problem.

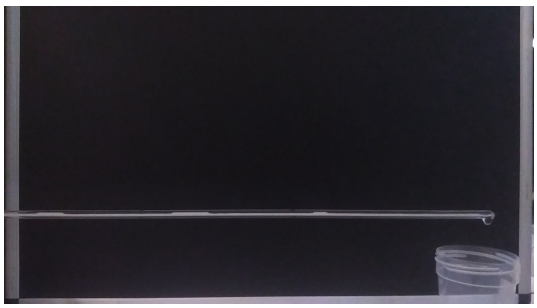

Figure 2: A frame taken from the first video

by looking at this frame, the method chosen to work with is the following steps:

- Cropping : first we crop the image and take only the region of interest which is the tube.
- Segmentation: applying one of the segmentation methods to isolate the slugs.
- Erosion and dilatation: we apply also the morphological operator opening to remove some noise resulting after the segmentation step.
- Computing the sum of gray levels of each column of the image after applying all the three first steps.

Cropping: The aim of this step is to take only the region of interest which is the tube and not to work on the whole image which is not necessary and could lead to bad results. This step is done by taking the indexes of the region of interest. The determination of this indexes has been done manually, just by looking at the frame.

```
B = I[700:800,70:1730,:]
```

Figure 3: The code of cropping

After cropping the image, we convert it to the gray scale space.

Figure 4: The cropped image

Segmentation: To determine the suitable method of segmentation, we plot firstly the grey levels histogram of the cropped image.

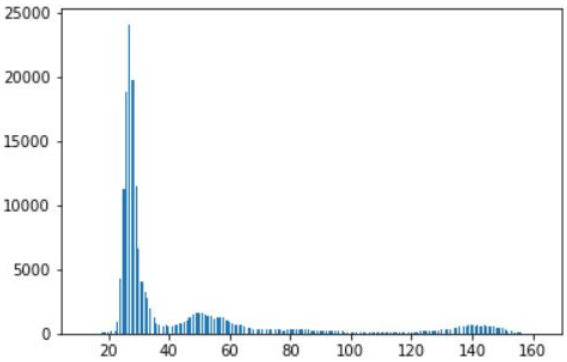

Figure 5: gray levels histogram of the cropped image

The histogram shows that there are two peaks, thus, the segmentation can be done only by thresholding globally the image.To get the best value of the threshold, we will use *Otsu* threshold.

```
T_otsu = filters.threshold_otsu(B)
B = B>=T_otsu
```

Figure 6: the code of segmentation

The result of segmentation on three random frames seems to be satisfying, but we see there are some traces of the tube and this makes the slugs unclear in the image.

Figure 7: the first segmented image

Figure 8: the second segmented image

Figure 9: the third segmented image

Opening: The applying of the opening operation consists of removing the traces of the tube remained in the binary image after the step of segmentation. For this operation we use a disk as structural element. The result of opening has improved the quality of the segmentation, this means that it has removed the traces of the tube and the slugs are noticeably clear.

Figure 10: the third segmented image

After applying the opening operation, we superpose the binary image and the original image.

```
X = I[700:800,70:1730,:]
X = cv2.cvtColor(X, cv2.COLOR_BGR2GRAY)
A = np.multiply(X,np.uint(B_opening))
plt.imshow(A,plt.cm.gray)
plt.show()
```

Figure 11: The superposition code

Then we compute the sum of the gray levels of each column and scale it by dividing by the max and multiplying by 255.

Figure 12: The superposed image

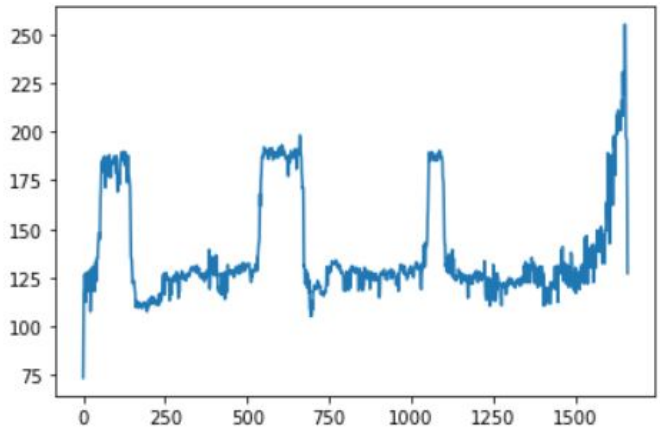

Figure 13: The sum of the gray levels of each column

3 Working with all the frames

Now we will apply the previous steps on all frame to get the spatiotemporal image of the slugs.

We define then a function *get_ spatiotemporal(I)* which take as parameter a frame. In this function, we crop the frame to get only the region of interest which is the tube and segment the cropped image by the mean of *Otsu* method, and after that we apply the morphological operation opening on the segmented image to make the slug clear and remove the remained traces of the tube. After that we superpose binary image and the original one.

Finally, we compute the sum of the gray levels of each column and scale this sum to make it between 0 and 255.

Thus, the function returns an array of size (1590,1) and each raw i contains the sum of the column i computed previously.

We apply then on each frame the function *get_ spatiotemporal(I)* and concatenate the arrays returned by this function to get the spatiotemporal image of the slugs. This is the job of the function $main(path)$, which take as parameter the path of the video. So, to test the code on any other video, you have just to execute the cell of the following sections : "Importing libraries", "Extracting all the Frames", "Generalizing the method for any video" and "Testing on the two videos".

4 Results

For the two given videos the results obtained are as follow :

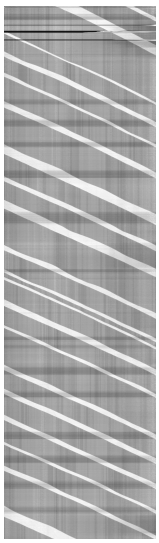

Figure 14: The result of the first video

The results seem to be satisfying and remarkably close to the desired spatiotemporal image in the introduction. Even there are some black lines as shadow in the image of the first video, but this does not affect the result globally. Maybe the problem is caused by the step of cropping or the segmentation method, because as shown previously in the histogram of the cropped image's gray levels, there are in fact three peaks and not two as it was mentioned previously but because the third peak is very weak then we have neglected it, but it can affect our result.

For the second video you find the result with the other files in the zip file.

5 Conclusion

We have seen that going through the steps mentioned previously stating by taking the region of interest which is the tube, then segment the image and finally compute the sum of the gray levels of each column, has given good results that are incredibly close to desired results.

The most important step is the segmentation of the image, we have chosen global segmentation because the histogram of the cropped frame gray levels has nearly two peaks. So, this step has been done by the mean of *Otsu* method. Thus, the segmentation should be done carefully, and a bad segmentation we lead obviously to bad results. Actually, alongside the classical method, the segmentation could be done by the mean of deep learning by using the neural

Network U-net which gives a good segmentation even the training data was not well segmented.