

IE 423 Quality Engineering

Project Part 3, due December 30th, 2019

Instructions: Please solve the following exercises using R (<http://www.r-project.org/>) or Python (<https://www.python.org/>) as a group of at most 5 members. You are expected to use GitHub Classroom and present your work as an html file (i.e. web page) on your progress journals. There are alternative ways to generate an html page for you work:

- A Jupyter Notebook including your codes and comments. This works for R and Python, to enable using R scripts in notebooks, please check:
 - <https://docs.anaconda.com/anaconda/navigator/tutorials/r-lang/>
 - <https://medium.com/@kyleake/how-to-install-r-in-jupyter-with-irkernel-in-3-steps-917519326e41>

Things are little easier if you install Anaconda (<https://www.anaconda.com/>). Please export your work to an html file. Please provide your *.ipynb file in your repository and a link to this file in your html report will help us a lot.

- A Markdown html document. This can be created using RMarkdown for R and Python-Markdown for Python

Note that html pages are just to describe how you approach to the exercises in the homework. They should include your codes. You are also required to provide your R/Python codes separately in the repository so that anybody can run it with minimal change in the code. This can be presented as the script file itself or your notebook file (the one with *.ipynb file extension).

The last and the most important thing to mention is that academic integrity is expected! Do not share your code (except the one in your progress journals). You are always free to discuss about tasks but your work must be implemented by yourself. As a fundamental principle for any educational institution, academic integrity is highly valued and seriously regarded at Boğaziçi University.

Quality Control on Images

You are a group of Quality Engineers in a linen manufacturer. “Linen is a textile made from the fibers of the flax plant. Linen is laborious to manufacture, but the fiber is very absorbent and garments made of linen are valued for their exceptional coolness and freshness in hot weather” (Source: Wikipedia).

“Automation of the visual inspection for quality control in production of materials with textures (tiles, textile, leather, etc.) is not widely implemented. A sophisticated system for image acquisition, as well as a fast and efficient procedure for texture analysis is needed for this purpose” (Source: Rimac-Drlje, Snježana, Drago Žagar, and Slavko Rupčić. "Adaptive Image Processing Technique for Quality Control in Ceramic Tile Production." *Strojarstvo* 52.2 (2010): 205-215.). Suppose you already have the image acquisition system and you are able to obtain pictures of linen (with a resolution of 512x512) as in Figure 1.

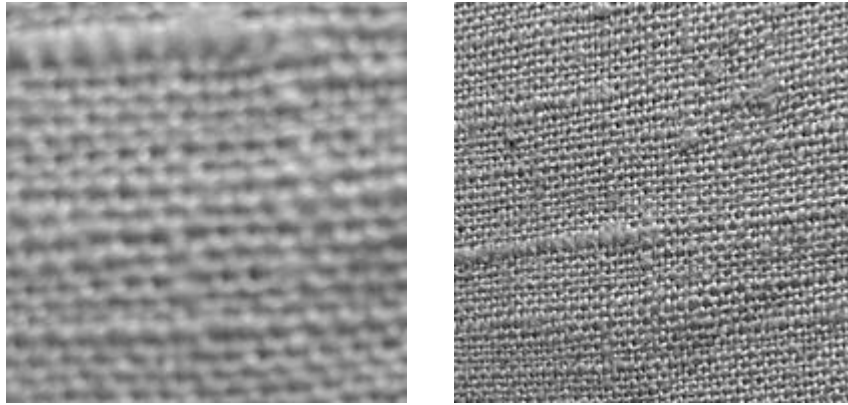


Figure 1: Sample linen images

In regular control charts you observe a sequence of measurements (i.e. time series which is 1D). However, images are from a class of spatial data where you observe the data in 2D. You are expected to devise a control procedure to identify the regions of the image that might be problematic using statistical process control. In other words, you need to come up with a statistic that you think it can identify the irregularities in each image. As in all control charts, you are required to formulate an upper and lower control limit depending on the distribution of the statistic you monitor. As you may remember from the lectures, sometimes we tend to use multiple control charts and rules to identify the out of control points. In a complex monitoring like this one, use of multiple charts can help.

Using the developed procedure, you are asked to run your approach on 20 images uploaded to Moodle. You can transform the images to greyscale before applying your method/s. You are expected to provide your code and a detailed explanation of your approach with relevant references. Your report should also have your control charts for each image dataset and out of control points labeled on each image. Your approach should consider the nature of the problem, which is to say, you should be considering the dynamics of linen manufacturing process. What are related problems with linens? What makes a linen defective? Note that the proposals introduced in Part 2 do not really consider the nature of the problem (i.e. identification of textures and etc.). You are free to perform any preprocessing to your images. There are several filters that allows for identification of patterns in the image. Therefore an important part of this project is to go over some related literature.

Your report should have the following format:

1. *Introduction:* What is linen? Why is it important to monitor processing of linens? What are the motivations regarding the use of images and identification of defects in linen manufacturing
2. *Background information:* What has been done in the literature regarding the process monitoring on linen?
3. *Approach:* Explain your approach to this problem.
4. *Results:* Provide your results and discussion.
5. *Conclusions and Future Work:* Summarize your findings and comments regarding your approach. What are possible extensions to have a better approach?