

Mandatory project exercise part II of II

INF 4300 Fall 2009

Segmentation and recognition of symbols

During this semester you are going to design and implement an algorithm for recognition of symbols (numbers) in images. The algorithm should be based on a combination of programs and routines available in image analysis program systems we have at IFI, and your own programs/routines.

The exercise is divided in two parts with two deadlines:

Part I: Classification (completed)

Part II: Segmentation and preprocessing to find objects.

Time table

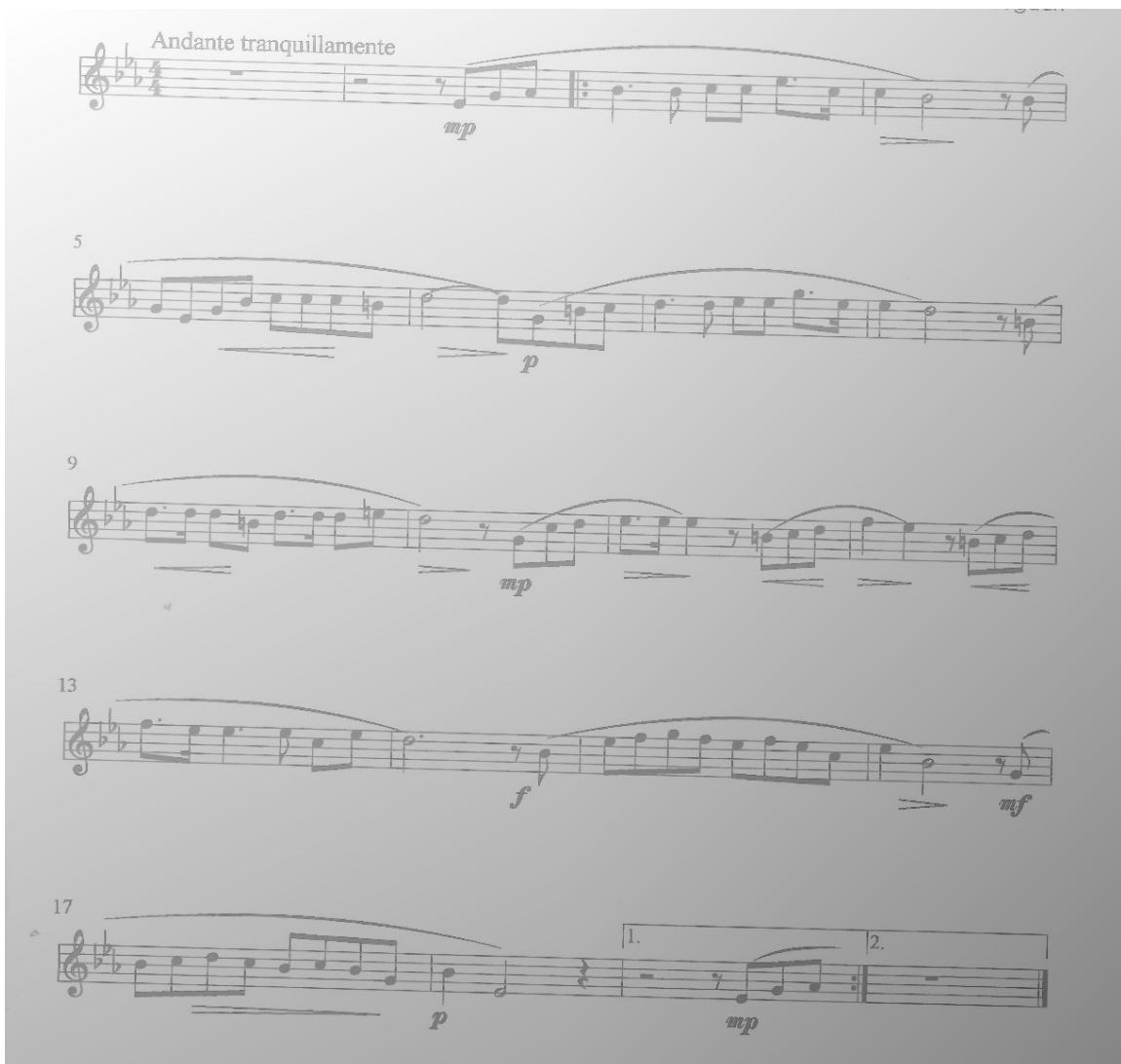
- Exercise and images part II is available: Friday 13. November
- Deadline for part II: December 2
- Notification part I: one week after submission

Evaluation

The two exercises will be evaluated separately. The two exercises will together form the final product and will be given a letter mark. This mark will count for 30% of the final mark. In order to take the exam the mandatory exercise must be passed.

How to work

The exercise is an individual work, and each student should deliver a written report. Your report should be genuine, in particular we will check that each report provides its own discussion of all method and parameter choices. Include references if you use external sources. The report should contain the description of the problem, theory, chosen methods, results and algorithms used. You have to document all steps in the algorithms, with all parameter values selected clearly listed so that the execution of your program could be repeated to reproduce the results. One of the images is included below.



Part I: Noise removing, pre-processing and segmentation of symbols

The exercise consists of segmenting images with music symbols.

You will work on three images of musical scores that need preprocessing, segmentation and object detection. The images are:

http://www.ifi.uio.no/~inf3300/bilder/score1_2009.png

http://www.ifi.uio.no/~inf3300/bilder/score2_2009.png

http://www.ifi.uio.no/~inf3300/bilder/score3_2009.png

The images show music sheets. The horizontal lines are called staff lines ("notelinjer"). The vertical lines are bar lines that separate individual measures ("takter"). Your task will be to find the location of music notes.

Your report can have subsections for each of the tasks below.

You should design an algorithm that solves the following tasks:

1. Find the rotation angle of each image and rotate back.
The images are scanned musical sheets and they have been rotated during scanning. Discuss methods for estimating the rotation angle from the images. Implement one method for finding the angle. **A good method should estimate the angle automatically and work well on all three images.** Rotate the image back using the estimated angle. Discuss how well your method works. State the estimated angle for each image.
2. Segment the image to separate background from foreground objects. The images have some noise and a varying background. The segmentation step should identify pixels that are part of the music notation (black). Segmentation can be done using thresholding, but your algorithm needs to handle the noise and the background. There are two main alternatives to segmentation: either use a locally varying threshold, or estimate the local background and subtract it before applying a global threshold. **A good algorithm should estimate the threshold value automatically, and give segmented images where the objects can be separated from the background.** Discuss and choose a segmentation approach, include the segmented images in your report. Discuss how good your segmentation works.
3. Find the location of the vertical lines (staff lines). A common step in optical music recognition is to remove the staff lines before further processing to find the location of the notes. The goal is to remove the staff lines, but keep the other musical symbols, e.g. notes and accidentals ("fortegn") etc that will overlap the staff lines. Make some assumptions on how wide the staff lines are from inspecting the images. Write an algorithm that first locates all staff lines, then removes them line by line. Staff lines can be removed by following each line from left to right. For each pixel on the line, the algorithm must decide if the pixel is part of a musical object. A hint here can be to check deviations from the common line width. The staff spacing gives hints on the size of objects like notes etc. Include images showing the result after staff line location and removal.
4. Design and implement an algorithm to find the note heads. The note heads are the circular/elliptical parts of the notes. Whole and half notes are not filled, while shorter notes are filled and have a vertical line that determines the duration. Your task is only to find the note heads, not their duration/vertical bar.

Whole



Half



Quarter



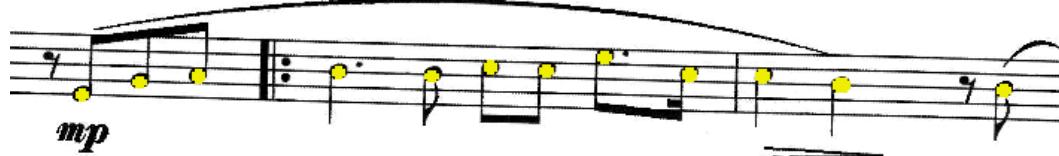
Eighth



Sixteenth



There are several ways to find the elliptical note heads, discuss how you want to do it. The results after this step should be an image where the location of the center point of the note heads is overlaid on top of the result from step 2 (segmented image). Mark the position of the estimated note head center point e.g. with a small rectangle with a given color (can be inserted into the result image)



5. Evaluate how good your note head segmentation works on at least one of the images by counting the number of notes, and the number of estimated note heads. In this process, you can count the number of matches manually by inspecting the output image from part 4 and comparing it to the input image. A match can be defined as true if the estimated note head center is inside a note in the original image. Also count the number of false negatives/missed notes (notes visible in the input but not found in your segmentation), and the number of false positives (estimated note heads in locations where there is no note visible in the input image). Discuss how good your segmentation is.

You are expected to find the location of the note heads, but not their duration. You are not expected to find and recognize the other musical symbols in the sheets as this would imply too much work.

Good luck!

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