

**ON-LINE  
DIGITAL IMAGE PROCESSING  
LAB-SESSIONS**

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# ON-LINE DIGITAL IMAGE PROCESSING LAB-SESSIONS

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**Abstract**  $\frac{3}{4}$  A digital support can be exploited more efficiently if it is linked to a processing unit. In this way, electronic illustrations by adding computational ability improve the common illustrations. For instance, an electronic illustration can be recomputed with different parameters. This technical report presents an environment allowing lab-sessions in Digital Image Processing (DIP) to be held on-line. A particular application and one of its possible output results is described. Finally, an URL for the whole DIP lab-session is given.

**Index Terms**  $\frac{3}{4}$  Digital Image Processing, virtual laboratory.

## INTRODUCTION

Lab-sessions and practical experiments are another important aspect of teaching. Consequently, there is a need for an environment allowing practicing exercises interactively [1]. This environment could be seen as a virtual laboratory. Such an environment could be useful in supervising exercise sessions as well. Digital Image Processing is an area depending on mathematics and its lab-sessions are performed using MATLAB, thus, the on-line lab-sessions are performed using MATLAB Web Server (MWS). In such a way, every one of the concepts studied, should be examined through recomputing its MWS application while varying some input parameters. Each session fulfill strictly defined structure.

## MATLAB WEB SERVER

MATLAB Web Server [3] exploits the power of WWW by integrating the visualization/computational capabilities of MATLAB with the remote access capabilities of WWW browsers. It enables creating MATLAB applications in such a way that allows students to transfer their data through WWW to MATLAB for the necessary computations. Consequently, the output of the computation, whether numerical or graphical, is accessible on the client's browser through the WWW.

These features of MWS allow students to run MATLAB applications through the Internet without having MATLAB software installed on their machines. To achieve this purpose a Web browser runs on the student's PC, whereas MATLAB, MWS and the Web Server daemon (httpd) run on the server machine.

The students are interacting with MATLAB over a network using a TCP/IP protocol. This interaction takes place through HTML forms, which serve as a point-and-click GUI for MATLAB applications. These capabilities not only allows students to use MATLAB based tools without any prior MATLAB programming knowledge, but also prevents unauthorized student access to source code and the MATLAB command lines.

The interaction between students and MWS and the role of HTML forms as GUIs for MATLAB application is shown on Figure 1.

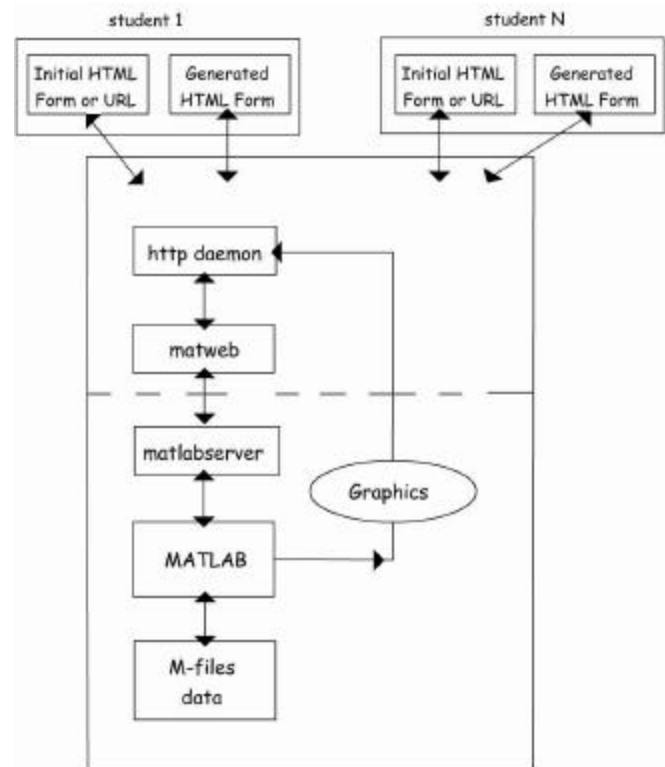


FIGURE 1

CONFIGURATION AND INTERACTION BETWEEN STUDENTS AND MWS

The student enters appropriate data in the relevant spaces before pressing the respective submit button in an HTML form. The data is then transferred to the server machine, housing the MATLAB software and the corresponding m-file. This step is initiated by *matweb* (the client of MWS that uses Common Gateway Interface (CGI)), which takes the

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data from the HTML form and transfers the information to MWS. The MWS then runs the application that is written in m-files to produce desired responses. These responses travel in the opposite path to arrive at the related output HTML file.

### LAB-SESSIONS' ORGANIZATION

Basically, Digital Image Processing [2] contains three main lab-sessions. Each one consists of number of exercises following the scheme:

#### Lab session I:

Basic Manipulations With Image Gray Levels. Introduction to 2D Fourier Transform.

1. Image quantization
2. Weber's law
3. Image subsampling
4. 2D Discrete Fourier Transform.
  - 4.1 Oppenheim's Experiment.
5. Image contrast
6. Image circular shift

#### Lab-session II:

Filtering in Spatial and Fourier Domain. Human Visual System (HVS). Watermarking.

1. Gabor Filter
2. Watermarking
  - 2.1 White Noise
  - 2.2 Image Energy
  - 2.3 Noise Modulation

#### Lab session III:

Multiresolution Image Analyses. Filterbanks and Wavelets.

1. Laplacien Pyramid Coder/Decoder
2. PSNR
3. Entropy

Each lab-session consists of Theoretical part, Practical part and Questions as described on Figure 2.

Theoretical part gives a brief description of the studied concept with respect to the manipulations, which will be done in Practical part.

The connection with MWS is in Practical part. In this way, it is possible to recompute the application while varying its input parameters, and thus showing how the image processing technique under study affects the image in every particular case.

The questions are created in such a way that the correct answers lead to the main conclusions that must be withdrawn.

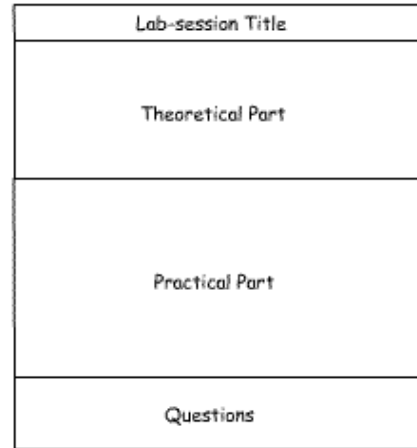


FIGURE 2. ORGANIZATION OF A LAB-SESSION

### LAB-SESSIONS' IMPLEMENTATION

All the applications are implemented using HTML, JavaScript and Macromedia Flash.

For better understanding of the organization, a particular example is provided. This is an example concerning watermarking (Lab-session II, 2.3). In the theoretical part is presented the main concept of the last step in studied type of watermarking, namely modulating of the noise and adding it to the image. In Practical part is available the block diagram of the process, where through an input form is given the possibility for changing the input image, parameters of the Gabor filter bank – crown, depending on how many filters are building the filterbank; filter orientation, and scale; and finally the PSNR (Figure 3.)

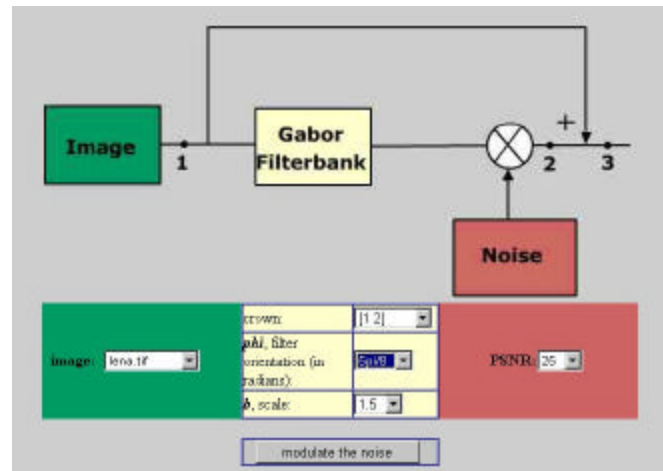


FIGURE 3. PRACTICAL PART FOR LAB-SESSION II, 2.3

The interactions in this part generates the output results where is given the processed image at points marked on the

diagram (points (1), (2), (3)). The Particular output form is generated in a separate window, shown on Figure 4. This is a particular case, where the input image is “lena”, there are 2 filters in the filter bank, the filter orientation is  $\frac{5p}{8}$  and PSNR=25. The resulting images in points (1), (2) and (3) are shown.



FIGURE. 4  
OUTPUT DISPLAY FOR LAB-SESSION II, 2.3

After examining number of different combination of parameters, according the tasks specified for each application, some questions are asked so that the main conclusions could be withdrawn.

## CONCLUSIONS

The Digital Image Processing Lab-sessions held on-line through MATLAB Web Server showed themselves efficient in the teaching process.

The users of such Web-applications don't need any prior programming knowledge in MATLAB, and in the same time MWS gives possibility for a remote access to all MATLAB toolboxes.

On the other hand, having the possibility for playing with concrete parameters for any of the applications and providing computed image results in MATLAB, describes better the affect of the studied image processing technique.

The on-line Digital Image Processing lab-sessions are available at:

{<http://ltspc16.epfl.ch/labs/DIP/index.html>}

## REFERENCES

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