VIC - Introduction to Visual Computing

Project Description

One of the main goals of the course is to provide the fundamental tools and algorithms that one can use in order to analyze imaging data from various domains and applications. To this direction, the main component of the course is the final project, where you will have the opportunity to develop quantitative and qualitative skills on computer vision methods and algorithms, and to obtain practical experience working with software tools. Furthermore, for those of you that are interested in research, the project will give a taste of computer vision and machine vision research.

In particular, there are several types of projects that one can choose to work on (some of them are related to each other; also think of interesting combinations among them):

- Experimental evaluation of algorithms and models on an interesting image dataset. For example, select a computer vision task that you are interested in, pick 2-3 different algorithms for this problem and do an empirical experimental evaluation (e.g., take three different object detection algorithms (or stereo vision algorithms), find a good dataset or construct your own dataset and compare the performance of the algorithms).
- A new algorithm for a computer vision task and evaluation on real/artificial data (e.g., a new object detection algorithm).
- Formulation of a problem using computer vision modeling, propose an algorithm that solves the problem (or use/adapt an existing one) and experimental evaluation (e.g., select an algorithm for grouping or segmentation and propose a modification which can lead to some better results).
- Efficient implementation of a computer vision algorithm and experimental evaluation.
- A problem that is related to your own research. If you are already working on a research project that computer vision might be applicable to, then finding out how to apply computer vision techniques to it will often make a very good project topic.

Note that, the above list is not exhaustive, and you can come up with other interesting types of projects. Ideally, projects will be a combination of an interesting application, algorithm implementation, experimentation on real/artificial data and some theoretical analysis. Moreover, our advice is to pick a project that you can get excited and passionate about. Do feel free to propose ambitious things that you are excited about. We will always be available to discuss with you on potential projects ideas.

Very important is that we will not accept projects that are deep learning based. The main objective of the course is to familiarize you with the main ideas of computer vision so you will have to propose a project that is based on these techniques. You can definitely compare or comment your results based on the ones obtained by deep learning-based algorithms; however this should not be the main purpose of your project!

The projects will be evaluated based on:

- **Significance**: Is the problem "real" and "interesting", or just a "toy" problem? How original, important and well defined are the questions posed? How novel is the approach? Is the work likely to be useful and/or have impact?
- **Technical Quality**: Is the approach and the methods appropriate and well described? Are sufficient details provided? Is the technical material correct? Are the proposed algorithms or applications creative and interesting? Are the methods and algorithms reproducible? Is the interpretation (discussion and conclusions) well balanced and supported by the data? It is

important to be noted, that we will not only judge the quantitative performance of your algorithm, but also your innovation and way to address the problem you chose. Your code will also be judged therefore you shall provide clean, well-documented code.

- **Organization**: Is the final project report well organized (e.g., following the structure of a paper published in a top computer vision conference)? Is the write-up clear and easy to read? Are the results presented in the most appropriate manner? Are figures and tables used appropriately?

Students should work in teams of maximum 3 people. Make sure to mention the names of all of your team members when submitting the project deliverables.

In general there are two main deliverables for the project:

Deliverables	Weight	Due date
Proposal	Not graded but mandatory	27/01/2025
Final Report + Presentation	70 % of the final grade	17/02/2025 (for the PS M2) 17/03/2025 (for the MSc AI)

All deadlines are at 23:59.

Deliverable 1: Project Proposal

In the proposal, you have to concisely describe your project: you have to clearly define the problem your project proposes to solve and how you plan to achieve it. In particular, the project proposal should be based on a number of related research papers. The idea is to survey the related work and identify what are strengths and weaknesses of the paper(s) you read and how they can be addressed. The proposal should then focus on what are some promising further research directions and questions. You should try to provide a concrete proposal for a model or algorithm that potentially extends or improves the topics discussed in the papers you've read. If no related work exists for your project, you should clearly mention it in the proposal. In general, from the proposal, one should easily identify the following:

Given <dataset X > **Use** <technique(s)> **To** <achieve "XYZ">
E.g., Given CamVid dataset Use object detection algorithms To detect pedestrians
Given multiple images Use 3d reconstruction algorithms To reconstruct large buildings

The proposal should be consisting of the following parts:
- **Motivation and Problem Definition**: What is the problem you are trying to solve? Why the problem is important ? What are a few potential applications? What is the main related work for the problem ?
- **Methodology**: How do you plan to address the problem? What are the steps you need to take? Which algorithms/models/tools do you plan to develop or extend? How is your methodology related to prior work for this problem?
- **Evaluation**: How will you evaluate your work? What experiments do you plan to do? What dataset will be used (existing datasets or are you planning to create new ones)?
- **References**: The proposal should include a preliminary list of at least 4-5 related papers that have been published in conferences/journals. [You can find in the introductory lecture conferences and journals that you can look for references.]

Formatting and Page Limits: The suggested length of the proposal is 2 pages and should be in PDF format. Please include in the header of the report the title of your project and the names of the members of the team. Also, indicate that this is the project proposal (adding "Project Proposal" as subtitle). All

reports should be formatted according to the Computer Vision and Pattern Recognition (CVPR) Conference Proceedings Template (format either for Latex or MS Word): https://github.com/cvpr-org/author-kit/releases

How to submit?

Please, send your proposal in a PDF format with name PP_nameoftheteam.pdf to celine.hudelot@centralesupelec.fr, with VIC-Project_Proposal in the subject of your email or for the MSc Students, on EDUNAO

Deliverable 2: Project Final Report and Project Presentation

The final report should represent all the completed work, having the following structure:

- **Abstract**: Short (200-250 words) abstract of your project.
- **Introduction/Motivation**: What is the project about? What is the problem you are trying to solve? What are the questions you want to answer? Why the problem is important? What are a few potential applications?
- **Problem Definition**: Introduce notation, provide formal definitions as needed, define any constraints or restrictions, define what you try to solve/optimize (e.g., maximize or minimize an optimization function, or the accuracy of an algorithm). Describe the problem in a formal way. Describe the hardness of the problem in a formal way.
- **Related Work**: Position the problem among the body of existing research. How does your project relate to previous research? How is your project replicating/different/complimentary to previous research? References to papers you cite should be explicit followed by a comment that describes how it is relevant.
- **Methodology**: How did you address the problem? What are the steps you had to take? Describe the data collection process. Provide any mathematical background necessary for the methods. Describe any algorithms or variations of the methods. Describe limitations or difficulties with your approach. Formally describe any important algorithms used from the literature. Try to be as specific as possible.
- **Evaluation**: How did you evaluate your work? What experiments did you run? What datasets did you use? Describe clearly your findings.
- **Conclusion**s: What are the conclusions of your work? Are there any highlights? What are some ideas for future work?
- **References:** In the final report, you should provide full list of references.

Note: Keep in mind however, that if there is a good reason why your project doesn't match the above description, we will take that into consideration when grading your report.

The evaluation of the final report and oral presentation will be based on the following guidelines:

Outlines	Weight
Introduction, Motivations, Problem Definition	15%
Related Work	10%
Model / Methodology/ Algorithm	25%

Evaluation Results	30%
Style and writing	10%
Presentation	10%

Formatting and Page Limits: The suggested length of the proposal is 7-8 pages and should be in PDF format (same template as above). Please include all team member names (as authors) and indicate that this is the final project report (adding "Final Project Report" as subtitle).

How to submit? Please, send your final project in a .zip format with name FP_nameoftheteam.pdf to celine.hudelot@centralesupelec.fr, with VIC-Final_Project in the subject of your email. The .zip should include the PDF with the report, and the code/ data (in case you have not used publicly available datasets). **Preferably, instead of a .zip file, you can send the link to a repository (Github or Gitlab) where you have uploaded the code/data and report.**

Project Presentation

The final presentation of the projects will be done during the last day of the course (March 17). You will prepare slides for your presentation, where you should briefly discuss each of the main parts of the project (e.g., introduction and motivation, briefly refer to the related work, description of the model/methodology/algorithm, experimental evaluation and some conclusions - take home messages). The exact duration of the presentation will be announced shortly (it will be determined based on the total number of teams - all presentations will be completed within ~3 hours).

We are also very happy to discuss with you in any aspect of the project :-)

Some project ideas :

- The Visual Microphone :
  - http://people.csail.mit.edu/mrub/VisualMic/#data

- Eulerian Video Magnification
  - http://people.csail.mit.edu/mrub/vidmag/

- Superpixels
  - https://www.tu-chemnitz.de/etit/proaut/en/research/superpixel.html

- Where is Waldo ?: people recognition in crowd
  - https://en.wikipedia.org/wiki/Where%27s_Wally%3F