COMP 0137 Machine Vision: Homework #2
Due 8th January 2025 at 4:00 pm on Moodle
Worth 10% of your overall grade
(Grading scheme: 50% is a basic pass, 70% is a low 'A')

For this homework, we'll revisit two practicals: Homographies and Particle Filters. Though some of this will feel repetitive, it should solidify what we learned in the practicals. There are multiple parts, so please read the instructions carefully. Everything you turn in must be YOUR OWN WORK, except obviously the helper-code and data given to you on Moodle. See below for more details. As always, list names/references for anything you're submitting that is not your own work.
Late Policy: We follow the official UCL late-policy, and this gets applied *after* your coursework is marked on Moodle, based on the Moodle timestamp. The instructor/TA's have no control over this – at all: https://www.ucl.ac.uk/academic-manual/chapters/chapter-4-assessment-framework-taught-programmes/section-3-module-assessment

What to turn in (all inside one YourParticipantNumber.zip file):
- Four jupyter notebooks containing your code and explanations for the Homographies lab. Like Homework #1, you should complete all the TO DO's. For every figure or plot that is generated by the code (for videos, a few frames are enough), put a copy in your notebook, and write 1-3 sentences (maximum) explaining what the figure shows or pros/cons of what is happening.
- Two jupyter notebooks for the Particle Filter lab, with your explanations – as above.
- Two jupyter notebooks for the additional tasks in parts G and H, for which we created templates for you to fill in your code. Include explanations – as above.
- Limit file-uploads to 250Mb, maximum enforced by Moodle. Hopefully, that will make it easier for you to submit all the notebooks with the relevant outputs saved (**see ** below**). If the zip'd file still doesn't fit for you, then save the rendered output for the tracking of Upper right corner "ur", and not the other three.
- To reiterate: just annotated Python code is not a valid coursework submission!
- One folder containing all your code. Do not use subfolders.
- Please write your Participant Number in the first line of EACH notebook. Please name your zip-folder YourParticipantNumber.zip. And check that your zip file isn't corrupted.
- Please do not write your explanations as comments, but as markdowns.
- Please save your notebooks with outputs. For repetitive tasks, show the output for each task in your notebook. Make sure you do not accidentally overwrite outputs.
- Keep in mind: Clearly structured code and explanations are easier to read and make your graders happy! (Read the **Special Notes** below; they contain advice/tips)

Homographies Part I (25%)

A) 06_Practical_Homographies\practical1A.ipynb
Besides completing the TO DO's, make sure to describe and illustrate the first two TO DO's in the list of three: scale ambiguity and exact mapping of pairs of four points.

B) 06_Practical_Homographies\practical1B.ipynb
Complete TO DOs and document in your notebook. You may use PracticalDataSm.mat instead of PracticalData.mat to go faster.

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Homographies Part II (25%)

C) 06_Practical_Homographies\practical2A.ipynb

Complete TO DOs and document in your notebook.

D) 06_Practical_Homographies\practical2B.ipynb

Complete TO DOs and document in your notebook.

Particle Filter, also known as Condensation (25%)

(**Special Note:** Be aware that there are some small differences between the code given in the lab practical #7, and the code used in G) below.)

E) 07_PracticalCondensation\labA.ipynb

Complete TO DOs and document in your notebook.

F) 07_PracticalCondensation\labB.ipynb

Complete TO DOs and document in your notebook. **Special Note**: You do NOT need to document the three TO DOs from the bottom of the intro (i.e. varying # of particles, modeling velocity in **w**, and visualizing the top-scoring particles). Though feel free to experiment with these.

Combining Tracking and Homographies (25%)

G) **HW2\HW2_Practical7c. ipynb**

Complete TO DOs and document in your notebook. **Special Note**: This task is mainly a repeat of F), so you can apply what you did for the TO DOs in 07_PracticalCondensation\labB.ipynb, but note the differences.

- This function will be performed four times in the next part. But for now, you can run it by passing in 'll' as the lower-left *corner* argument.
- Also, the image sequence is now converted to grayscale when computing the likelihood.
- Some other tips & advice have been provided as comments.

H) **HW2\HW2_TrackingAndHomographies.ipynb**

Complete TO DOs and document in your notebook. **Special Note:** This task is mostly a repeat of D), so you can apply what you did for the TO DOs in 06_Practical_Homographies\practical2B.ipynb, but note the differences.

- Most importantly, consider this simplistic example, and mention at least <u>two</u> actions or changes we could make to improve the results (excluding actions from the Not-for-Credit Extensions).
- Other tips and advice have been provided as comments.

**** 250MB is the upload limit for your entire CW2 submission .zip file. Here are some notes to help get under that threshold, particularly in parts G and H.** Note that getting below the TurnItIn limit of 100MB is not required.

1. Make sure you aren't unnecessarily printing any large matrices in any cell.
2. When you finalize your code, clear the output of all cells, and then run for final output before you save the notebook.
3. For 'Try varying the number of particles: 2000, 500, 100,...," you don't need to save a run for each value (keep the original run in the notebook though), but you do just need to tell us what you've observed and why.

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4. For part G, you only need to show the results for 'ur' (upper-right) in the notebook if you're hurting for space. The marker will decide if they need to run your code to see results for the other corners.
5. For part H, you don't need to show us the intermediate corner output on the sequence of images - that's already been covered in part G. Instead, what we want to see is the final output sequence specific to this notebook, i.e. the cube mapped onto the marker through time.
6. If you've done all this and are still having trouble, then please change the size of the figures in parts G and H by modifying the figure size line in the top cells of notebooks G and H from 'pylab.rcParams['figure.figsize'] = (12.0, 10.0)' to 'pylab.rcParams['figure.figsize'] = (6.0, 5.0)'. This should cut down each figure's size by half in each dimension.
7. Also a note about Participant numbers: it's not critical what you name your .zip file - but it would help if you follow the CW2 instructions. It's not obvious, but you have a different participant number for CW2 than you had for CW1 - these were auto-assigned, and by design, staff don't have access to these and don't know the mapping between #'s and names.

Not-for-Credit Extensions

- Reduce the search space where particles can land by using an edge-detector.
- Choose (or film!) a different video and/or 3D mesh, and augment the video as we did here.
- Each particle filter's state space **w** here was just the 2D image location of an interest point. Each interest point was tracked independently. Consider making a particle filter whose **w** represents the state of an affine transformation of the whole pattern (black square on white paper). This will require modifying how new measurements are incorporated.