

UFMFRR-15-M Machine Vision Assignment Specification

Group Report on Apple Counting in Orchards

Submission Date	TUESDAY 9 JANUARY 2024 at 14:00
Marks Weighting	50% of module
Submission Method	Electronic via Blackboard Only one group member submits on behalf of the group
Deliverables & Format	<p>1. A 5000-word group report as a MS Word document; (<i>compulsory</i>) <i>For any student completing this assignment as a group of one, the word count limit is reduced to 2000</i></p> <p>2. A peer assessment form using the template “PeerAssessmentForm2022.xlsx” that can be found in Blackboard->Assessments (<i>compulsory</i>) <i>For any student completing this assignment as in a group of one, the peer assessment form is not applicable</i></p> <p>3. python scripts as .py files or .ipynb files, compressed into a single .zip file (<i>compulsory</i>)</p> <p>Please do not upload large files such as your datasets, trained models, etc.</p>
Grade & Feedback:	20 working days after submission
Group Size	No less than 4 and no more than 6
Version No. & Date	2.0, 26 SEP 2023

1. Learning Outcomes

- Interpret the current key research issues in machine vision.
- Identify requirements of an application task; formulate and constrain a machine vision problem.
- Design and implement machine vision solutions to real-world problems and evaluate algorithm performance.
- Explain, compare and contrast machine vision techniques including image acquisition, feature extraction and machine learning.

2. Background/Context

Detection, counting, and localisation of fruits in orchards are important tasks in agricultural automation, which can assist with automated fruit picking. Amongst the various types of sensor employed to achieve this reliably in a real-world environment, visual sensors - primarily cameras - have been the most widely used. Despite the differing computer vision approaches utilised to analyse fruit images in the literature, a number of challenges have not been resolved to date, including varying illumination

conditions, great variability in fruit/fruit tree appearance, fruit occlusions, and variable camera viewpoint.

3. Requirements

1. You are required to design, implement and evaluate algorithms for **apple counting** in an orchard environment.
2. You must use the **template at the end of this specification** for report writing. Read carefully the marking criteria that have been built into this template.
3. You are **not** expected to carry out physical data capture experiments, but you are required to identify relevant and publicly available datasets from the internet, such as (but not limited to) the MinneApple dataset (Naeni, Roy and Isler, 2019) downloadable from this [webpage](#).

Haeni, Nicolai; Roy, Pravakar; Isler, Volkan. (2019). MinneApple: A Benchmark Dataset for Apple Detection and Segmentation. Retrieved from the Data Repository for the University of Minnesota, <https://doi.org/10.13020/8ecp-3r13>.

4. You are required to propose, implement, and compare **a conventional image processing based approach** and **a machine learning approach** for apple counting ([one approach only for any student completing the assignment as a group of one](#)). It is not expected that both approaches will achieve outstanding performances, but you need to show that careful considerations have been made to the design of algorithms and analysis of results.
5. Each team member is expected to make an equal contribution to this assignment, although it is up to you how you would like to divide the project into work packages and to allocate resources.
6. You must use Python for coding. You may choose to use a python IDE on your local computer or use the Google Colab. Be aware that you *may* need a GPU if you employ certain deep learning models.
7. Use the [UWE Bristol Harvard referencing standard](#)

4. Project Structure and Group Work

Please refer to Blackboard->Module Information->GroupWorkpolicy2023.pdf for guidelines on working in a group including:

- *Group formation*
- *Deadlines and expectations*
- *Conflict resolution mechanism*

5. Submission/Report Information

The submission deadline is on **TUESDAY, 9 JAN 2024, at 2 pm**

Your submission will be run through SafeAssign to help assess originality.

Your submission will be graded according to the marking criteria (within the template) listed at the end of this specification.

You are expected to plan your workload to avoid being impacted upon by a minor illness or other causes, such as technical issues. **However, if you encounter unexpected difficulties, a 48-hour late submission window is available to all students/groups, during which you can submit your assignment without penalty.** You do **not** need to provide a reason or evidence indicating why you need to use the late submission window. Your programme or module team will not be able to provide with you any additional assignment support within this window. You will, however, be able to access support from other UWE services such as [Student Support Advisers](#) and the [Wellbeing Service](#).

5.1. Submission Requirements and Files

You are required to submit the following documents:

1. A 5000-word group report as a MS Word document (**compulsory**). If you use LaTeX to prepare the report, please submit a PDF file instead.
[For any student completing this assignment as a group of one, the word count limit is reduced to 2000.](#)
2. A peer assessment form using the template "PeerAssessmentForm2023.xlsx" that can be found in Blackboard->Assessments (**compulsory**). [Not applicable to any student completing this assignment as a group of one.](#)
3. python scripts as .py files or .ipynb files, compressed into a single .zip file (**compulsory**)

5.2. Limitations

You must use the template provided at the end of this specification. The maximum word count is 5000 ([or 2000 for any student completing this assignment as a group of one](#)), excluding references (bibliography if applicable) and appendices. All sections listed in this template are mandatory.

5.3. Plagiarism, Collusion, Contract Cheating, Falsification and Fabrication

Please note that plagiarism, collusion, contract cheating, falsification and fabrication are assessment offences. Ensure you are familiar with this policy (see http://www2.uwe.ac.uk/services/Marketing/about-us/pdf/Policies/Assessment_offences_policy.pdf)

At the time of writing, the policy lists some (but not exclusively) examples of plagiarism as

- “Copying from another person’s work without the use of quotation marks;
- “Copying from another person’s work without referencing/acknowledgement of the sources;
- “Summarising another person’s work by simply changing a few words or altering the order of presentation, without acknowledgement;
- “Paraphrasing material from a source without acknowledging the original author;
- “Presenting concepts or designs that have been created by others without acknowledging the original source;
- “Copying another student’s work with or without their knowledge or agreement (this may also be deemed as collusion);
- “Using computer code created by another person without appropriate referencing;
- “Downloading material from the web and submitting it as your own work;”

Group Report Template with Marking Criteria

Texts in Blue are not included in the word count

No.	Name of group members	Contribution to project	Contribution to report	Signature
	e.g., Wenhao Zhang	e.g., Data pre-processing, implementation of approach A	e.g., Section 1, 80% of section 5	
1				
2				
3				
4				
5				

1. Introduction (5%)

Introduce the background of the project. Illustrate any assumptions made, for example, the lighting conditions you need to deal with in an orchard environment. Clearly show the aim and objectives of this project and discuss the challenges.

2. Related works (10%)

Conduct a short literature review on methods relevant to apple counting. For example, if algorithms proposed in prior works on berry detection/counting are deemed applicable to apple counting, you may include a critical review of these as well.

In later sections, you may use this literature review to assist with justification of your methodology as well as with discussing its capabilities and limitations. You will be assessed on the breadth and depth of the review.

3. Data acquisition and datasets (10%)

Note that you are not expected to carry out any physical data capture experiment. Instead, illustrate the types of image sensors/imaging systems that can be employed to achieve effective apple counting in a real-world application. Describe the process of data acquisition using the sensor(s) of your choice.

Describe the dataset(s) you employed in this project. Discuss data quality, variability, appropriateness for use in this project, and briefly how they were used in this project with reason.

4. Methodology (30% in total, 15% per approach), (or for any student completing this assignment as a group of one, 25% in total)

Present the approach(es) you proposed. Show technical breadth and depth. Justify the use of specific algorithms. Use flowcharts to illustrate the process if applicable. You are welcome to use any image processing/machine learning approach, however basic it may seem, as long as you can justify it well, e.g. why do you think the proposed approach can deal with the challenges identified in Section 1 and 2. Refer to Requirement 4 for more information.

4.1 Approach A

4.2 Approach B (not applicable to an as a group-of-one assignment)

5. Experiment and Implementation (15%), (or for any student completing this assignment as a group of one, 20% in total)

Demonstrate that you are able to implement the proposed approaches (introduced in Section 3) using Python programming. Describe the Python IDE/platform/hardware used, core python packages used, how you trained your machine learning model(s) if applicable, parameter tuning/optimisation of key algorithms if applicable. For example, if you used manual thresholding for binarization, explain how you chose an appropriate threshold. If you used deep learning models, explain how you loaded your images and ground truth data; how you split the data for training, validation and testing; and justify the training epochs used. Note that you are not expected to describe each line of your code here. Use flowcharts, diagrams and/or pseudocode where applicable.

6. Results and Evaluation (15%)

Present results; evaluate the proposed approaches (quantitatively and qualitatively) using appropriate metrics; and interpret findings. Make sure you explain how results were obtained and what they mean. Having a method that can detect all apples in all your images does not automatically grant you high marks.

Compare approach A and approach B and discuss their respective capabilities and limitations. For a group-of-one assignment, compare your approach with those in the literature. Use your results to support your statements but also explain this from a theoretical point of view.

7. Conclusions and Future works (5%)

Conclude the project. Identify challenges relevant to apple counting (as well as detection and localisation) that have not been fully resolved within the scope of this project. Propose future works to deal with these challenges, e.g. is it possible to employ 3D approaches?

The remaining **10%** of the mark is allocated to report presentation including logical structure and clarity, quality of writing, spelling, grammar, diagrams, figures and tables, clarity of expression and use of English, and accuracy, consistency and completeness of citations and references.