

**Course:** 282.762 Robotics and Automation

**Assessment:** Assessment 03: Written Assignment

**Course Learning Outcomes Assessed:**

- Write a program that uses relevant machine vision tools to complete a relevant task.

**Weighting:** 25 %

**Due Date:** 11/05/2020, 5:00 PM

This is an individual assessment.

## **Introduction**

Machine vision is widely used in industry; for example, it is used in quality control processes to ensure parts and products are defect free; to ensure workers are safe when working in hazardous environments; and verify parts are placed correctly in automated manufacturing applications.

Recent developments in robotics and automation have benefited from the use of machine vision; for example, Abundant Robotics recently announced the world's first automated apple picking robot. It uses machine vision to detect the location of apples in-situ and this information is used to control an end-effector to pick them. Other companies, e.g. Robotics Plus, are also using machine vision in post-harvesting applications, such as packing apples into trays.

In this assessment, you are required to develop and implement an algorithm that counts the number of apples in a tray, and write a report documenting your work.

## **Aims**

The assessment's aims are to:

- Practise using relevant machine vision tools and libraries to solve a problem.
- Further develop your software development skills.

## **Objectives**

The assessment's objectives are to:

- Develop an algorithm that can count the number of apples in an image and show where each one is.
- Use an appropriate programming language and relevant machine vision tools and libraries to implement the algorithm.
- The developed program should be able to process images in a "data" sub-directory. It should work without user interaction.

## **Requirements**

You are required to:

- Develop and implement an algorithm that achieves the assessment's objectives.
- Write a report detailing what you did, how, and why.

## **Resources**

You will be provided with the following:

- Three reference images.

Note: The reference image will be available of the course's Stream site.

## **Submission Instructions**

Add all your work to a .zip archive and name it in the following format: FIRSTNAME\_LASTNAME\_ID.zip.

Upload your submission to Stream before the due date. A 5 % per day penalty will be applied to late submissions.

## Frequently Asked Questions

Q. How long should the report be?

A. It should be around 2000 words.

Q. What Integrated Development Environment (IDE) should I use?

A. If you're using Windows, I would recommend either Microsoft's Visual Studio Code or Visual Studio. Both are excellent IDEs and allow for you to program in either C++ or Python. Also, Code can be used on Windows, Linux, and Mac.

Q. What compiler should I use?

A. If you're using Windows and you're using Visual Studio, it's likely you've already installed Microsoft's C++ compiler. If you're using Code, you'll need to install either Microsoft's C++ compiler or an alternative, e.g. Minimalist GNU for Windows (MinGW). If you're using Linux, it's likely you've already installed GCC's compiler.

Q. Do I need to use CMake?

A. No, but I would also suggest you do. CMake can be used on Windows, Linux, and Mac and ensures that your projects can be compiled on another Operating System (OS) without trouble. You can use CMake with both Code and Visual Studio, or with a terminal window, e.g. PowerShell on Windows or Terminal on Linux.

Q. What library should I use?

A. I would suggest using the Open Computer Vision (OpenCV) library.

Q. What programming language should I use?

A. OpenCV is written in C++, but has a Python Application Programming Interface (API); therefore, you can use either C++ or Python to write a program that uses OpenCV.

Q. Can I get an extension?

A. Yes, but only if it's for a good reason. Extensions will be granted at course or offering coordinator's discretion.

If you have any questions, please post them on the course's Stream site.

## Report Marking Rubric

The report is worth 100 % of the assessment's final grade.

	<b>E Range (0 – 39.99)</b>	<b>D Range (40 – 49.99)</b>	<b>C Range (50 – 64.99)</b>	<b>B Range (65 – 79.99)</b>	<b>A Range (80 – 100)</b>	<b>Weighting</b>
	<i>Doesn't Meet Expectations</i>	<i>Below Expectations</i>	<i>Meets Expectations</i>	<i>Above Expectations</i>	<i>Exceeds Expectations</i>	
Introduction	The Introduction section doesn't meet expectations. It presents the developed algorithm and program.	The Introduction section is below expectations. It summarises the assessment's aims and objectives. It presents the developed algorithm and program.	The Introduction section is adequate. It presents the assessment's aims objectives. It describes the developed system. It presents the report's structure.	The Introduction section is good. It describes the assessment's aims objectives. It describes the developed algorithm and program in terms of the aims, objectives, and specifications. It presents the report's structure.	The Introduction section is excellent. It describes the assessment's aims objectives. It describes the developed algorithm and program in terms of the aims, objectives, and specifications in detail. It presents the report's structure.	5 %
Algorithm	The Algorithm section doesn't meet expectations. It presents the developed algorithm.	The Algorithm section is below expectations. It describes the developed algorithm.	The Algorithm section is adequate. It describes the developed algorithm. It relates the algorithm to the assessment's aims and objectives. A figure is used to illustrate the algorithm.	The Algorithm section is good. It describes the developed algorithm and its key stages. It discusses the algorithm in relation to the assessment's aims and objectives. A figure is used to illustrate the algorithm.	The Algorithm section is excellent. It discusses the developed algorithm; justifying its key stages, and highlighting its advantages and disadvantages. It also discusses the algorithm in relation to the assessment's aims and objectives. Appropriate figures are used to illustrate the algorithm.	20 %
Methodology	The Methodology section doesn't meet expectations. It summarises what was done. A few code snippets are presented.	The Methodology section is below expectations. It presents what was done. Some code snippets are presented. Few tables,	The Methodology section is adequate. It describes what was done. The tools, libraries, and language used are presented. Code snippets are presented.	The Methodology section is good. It describes what was done and how. The tools, libraries, and language used are described. Relevant code snippets	The Methodology section is excellent. It discusses what was done, how, and why. The tools, libraries, and language used are discussed. Relevant code	40 %

	Very few tables, figures, or listings are used.	figures, or listings are used.	A few tables, figures, and listings are used to help explain the work done.	are explained. It relates what was done to the assessment's aims and objectives. Some relevant tables, figures, and listings are used to help explain the work done.	snippets are explained in detail. It clearly relates what was done to the assessment's aims and objectives. A lot of relevant tables, figures, and listings are used to help explain the work done.	
Results	The Results section doesn't meet expectations. It summarises the developed algorithm and program's performance.	The Results section is below expectations. It presents the developed algorithm and program's performance.	The Results section is adequate. It presents a limited analysis of the developed algorithm and program's performance; critiquing it in terms of a few relevant metrics.	The Results section is good. It presents an analysis of the developed algorithm and program's performance; critiquing it in terms of some relevant metrics.	The Results section is excellent. It presents a detailed analysis of the developed algorithm and program's performance; critiquing it in terms of relevant metrics.	20 %
Conclusion	The Conclusion section doesn't meet expectations. It summarises the developed algorithm and program's performance.	The Conclusion section is below expectations. It presents the assessment's aims and objectives. It presents the developed algorithm and program's performance.	The Conclusion section is adequate. It presents the assessment's aims and objectives. It describes the developed algorithm and program's performance, linking to the aims, objectives, or specifications. A few recommendations to improve the system are presented.	The Conclusion section is good. It describes the assessment's aims and objectives. It describes the developed algorithm and program's performance, linking clearly to the aims, objectives, and specifications. Some recommendations to improve the system are described.	The Conclusion section is excellent. It describes the assessment's aims and objectives. It discusses the developed algorithm and program's performance, linking very clearly to the aims, objectives, and specifications. A lot of recommendations to improve the system are discussed.	5 %
Overall	The report doesn't meet expectations. It summarises what was done. Spelling, grammar, and punctuation issues significantly impact the report's fluency.	The report is below expectations. It includes a few tables, figures, or listings. It presents what was done. Spelling, grammar, and punctuation issues	The report is adequate. It includes a few relevant tables, figures, and listings. It describes what was done. Spelling, grammar, or punctuation	The report is good. It includes some relevant tables, figures, and listings. It is easy to read. It describes what was done and how. Spelling, grammar, or punctuation	The report is excellent. It includes a lot of relevant tables, figures, and listings. It is very easy to read. It discusses what was done, how, and why. Spelling, grammar, or	10 %

		impact the report's fluency a lot.	issues impact the report's fluency a little.	issues do not significantly impact the report's fluency.	punctuation issues do not impact the report's fluency.	
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