Colour Adjustment Techniques for Digital Image

Pupil Name

Handbook Designed by Dr. Md Akmol Hussain

Timetable and Assignment Submission

Timetable – Tutorials

Tutorial	Date	Time	Location
1			
2			
3			
4			
5			
6 (Feedback)			

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1	write a scientific report about the essential elements of a digital screen	
Tutorial 2	write a report covering functions of digital camera and effects of lights	
Tutorial 3	write a scientific report describing the Grey World method, experimental setup and result	
Tutorial 4	write a scientific report describing the White Patch method, experimental setup and result	
Tutorial 5	Final assignment	
Tutorial 6	Feedback	

Assignment Submission – Lateness and Plagiarism

Lateness	
Submission after midnight on	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Uni Pathways – Pupil Feedback Report

Grade	Marks	Guidance
1st	70+	
2:1	60-69	
2:2	50-59	
3rd	40-49	
Working towards a pass	0-39	
Did not submit	DNS	No assignment received by The Brilliant Club

Lateness	
Any lateness	10 marks deducted
Plagiarism	
Some plagiarism	10 marks deducted
Moderate plagiarism	20 marks deducted
Extreme plagiarism	Automatic fail

Name of PhD Tutor	Md Akmol Hussain		
Title of Assignment	An investigation on the colour adjustment methods		
Name of Pupil			
Name of School	East Point Academy		
ORIGINAL MARK / 100		FINAL MARK / 100	
DEDUCTED MARKS		FINAL GRADE	

If marks have been deducted (e.g. late submission, plagiarism) the PhD tutor should give an explanation in this section:

Learning Feedback Comment 1 - ***Enter Key Learning Priority Here***	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Learning Feedback Comment 2 – ***Enter Key Learning Priority Here***	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Learning Feedback Comment 3 – ***Enter Key Learning Priority Here***	
What you did in relation to this Key Learning Priority *Enter feedback here*	How you could improve in the future *Enter feedback here*
Resilience Comment	
How you showed learning resilience during the course *Enter feedback here*	How you could build learning resilience in the future *Enter feedback here*

Contents

Course Rationale **P5**

Mark Scheme **P6**

Glossary of Keywords **P8**

Knowledge Organisers **P9**

Tutorial 1-What's in a digital screen? **P10**

Pixel and Resolution **P10**

Why digital image matters? **P12**

Binary pixels and RGB values **P12**

Homework 1: write a scientific report about the essential elements a of digital screen **P13**

Tutorial 2- Formation of a digital image **P14**

How colour produced by a digital camera? **P15**

Images under different lighting conditions **P16**

Home work 2: write a report covering functions of a digital camera and effects of lights **P16**

Tutorial 3- Image adjustment method 1: Grey World **P18**

The principle of the Grey World algorithm **P18**

Let's challenge the math! **P19**

Produced a correct block diagram of the Grey World method **P19**

Write a comparison between the input and output image **P20**

Homework 3: write a scientific report describing the Grey World method, experimental setup and result **P20**

Tutorial 4- Image adjustment method 2: White Patch **P21**

White Patch algorithm: Principle **P22**

Let's challenge the math! **P22**

Produce a block diagram of the White Patch algorithm **P22**

Compare the performance of two algorithms **P23**

Homework 4: write a scientific report describing the White Patch method, experimental setup and result **P23**

Tutorial 5- Final assignment **P27**

Structure of a scientific report **P24**

Final assignment **P24**

Tutorial 6 **P25**

Reflection on feedback **P26**

Appendices **P27**

Referencing correctly **P27**

Course Rationale

Human colour perception system is very good at judging what is white under different lighting conditions. However, digital image capturing devices have limited capability to do the same. The appearance of a digital image depends on the prevailing illuminant, reflection property of the objects and the camera's sensitivity functions. An image appears yellowish if it is captured under low lighting condition and may appear bluish if captured under too bright illuminant.

Thus, digital cameras, without some kind of adjustment, can easily capture unrealistic images with a strong colour cast. The presence of an extreme source illuminant could deteriorate the colour of the objects in the scene captured by a digital camera.

Colour adjustment algorithms try to correct for the ambient light with minimum input from the user, so that the resulting image looks like what our eyes would see. But which is the best colour adjustment algorithm to use?

In this coursework, we will learn the process behind colour adjustment and show how to compare and select the best algorithm.

Mark Scheme

STEM Mark Scheme

Skills	1st (70-100)	2:1 (60-69)	2:2 (50-59)
Knowledge and Understanding	▯ All content included is relevant to the general topic and to the specific question/title ▯ Good understanding of all the relevant topics. ▯ Scientific terms are defined and used accurately throughout ▯ Clear justification on how the content included is related to the specific issues that are the focus of the assignment	▯ Most of the content included is relevant to the general topic and to the specific question/title ▯ Good understanding of most the relevant topics ▯ Scientific terms are used accurately but not always clearly defined. ▯ Adequate justification on how the content included is related to the specific issues that are the focus of the assignment	▯ Some of the content included is relevant to the general topic and to the specific question/title ▯ Good understanding on some of the relevant topics but occasional confusion on others. ▯ Scientific terms are used mostly accurately with occasional confusion and often not defined. ▯ Some justification on how the content included is related to the specific issues that are the focus of the assignment
Critical Evaluation/ Problem solving	▯ Moved beyond description to an assessment of the value or significance of what is described ▯ Evaluative points are consistently explicit/systematic/reasoned/ justified ▯ Effective critiques on the reliability of sources provided ▯ Consistently demonstrate clear, analytical and logical steps to solving problems	▯ Mostly description but some assessment of the value or significance of what is described ▯ Evaluative points are mostly explicit/systematic/reasoned/ justified ▯ Some evidence of critiques on the reliability of sources provided ▯ Some examples of solving problems but not consistently clear, analytical and logical	▯ Only description with minimal assessment of the value or significance of what is described ▯ Evaluative points are at times explicit/systematic/reasoned/ justified ▯ Limited evidence of critiques on the reliability of sources provided ▯ Demonstrate clear steps to solving problems but not consistently analytical or logical

Structure and Presentation	Ideas are presented in paragraphs and arranged in a logical structure that is appropriate for the assignment The introduction clearly outlines how the essay/report will deal with the issues The conclusion summarises all the main points clearly and concisely All calculations, formulas and methods are clearly structured, clear to follow and correct Tables and graphs are effectively constructed including appropriate headings, units and scales. All sources are referenced correctly in an agreed format	Ideas are presented in paragraphs and arranged in a structure that is mostly appropriate for the assignment The introduction adequately describes how the essay/report will deal with the issues The conclusion summarises most of the main points clearly Calculations, formulas and methods are mostly structured, clear to follow and correct Most tables and graphs are well constructed Most sources are referenced correctly in an agreed format	Ideas are presented in paragraphs and arranged in a structure The introduction mentions how the essay/report will deal with the issues The conclusion summarises some of the main points clearly Calculations, formulas and methods are not always structured, clear to follow and correct. Some tables and graphs are well constructed but contains some errors Some sources are referenced correctly in the agreed format with occasional errors

Glossary of keywords

Word	Definition	In a sentence
Digital image	Numeric representation of image.	A digital image is a picture that is stored on a computing device.
Pixel	Smallest unit of a digital image.	A 'pixel' (short for ‘picture element') is a tiny square of colour. Lots of these pixels together can form a digital image.
Grey World	Average values of red, green and blue colour channel are achromatic.	Roughly equal mean values of red, green and blue channel represent neutral colour known as Grey World.
White Patch	Average of the maximum values of red, green and blue colour channel are achromatic.	Roughly equal Average of the maximum values of red, green and blue pixels produce white patch.
Colour cast	Extreme presence of source light.	Original colour of object deteriorated by the presence of source light and this is known as colour cast.

Knowledge Organisers

Key definitions	Impact of source light
Digital image- A digital image is a picture that is stored on a computing device. **Pixel-** A 'pixel' (short for 'picture element') is a tiny square of colour. Lots of these pixels together can form a digital image. **Colour cast-** Extreme presence of source light. **Colour adjustment-** Remove that unrealistic colour cast so that the image looks as if it has been taken under white light.	1. Colour of the source light deteriorate the colour of the object 2. Under low lighting condition image objects may appear yellowish. 3. Under bright lighting conditions image may appear bluish.
Grey World algorithm	**White Patch algorithm**
Principle- Roughly equal mean values of red, green and blue channel represent neutral colour known as Grey World. **Steps:** 1. Calculate the **average values** of all colour channels. 2. Calculate the **average values** of each colour channel individually. 3. Divide the average of all colour channel by the colour of the individual channels. 4. Scale every pixel of the input image with the results of step 3 to adjust the image	**Principle-** Roughly equal Average of the **maximum values** of red, green and blue pixels produce white patch. **Steps:** 1. Calculate the average of the **maximum values** of all colour channels. 2. Calculate the average of the **maximum values** of each colour channel individually. 3. Divide the average of all colour channel by the colour of the individual channels. 4. Scale every pixel of the input image with the results of step 3 to adjust the image.

Tutorial 1 – What's in a digital screen?

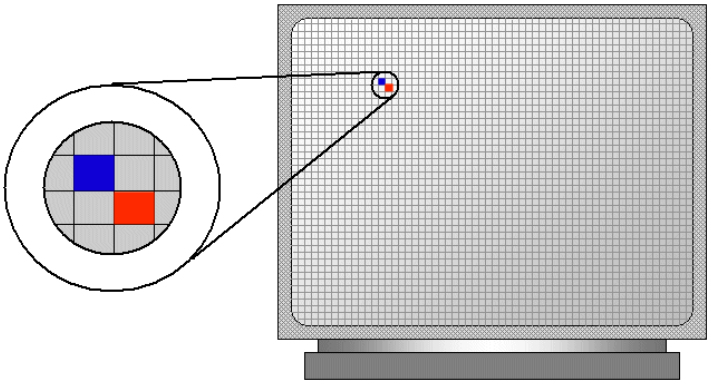
- Do you notice any difference between these two images?
- What is the key difference?

What is the Purpose of Tutorial 1?

- Pupils will learn about the key elements of a digital screen/image
- Pupils will have a clear concept on pixels and resolution
- Pupils will be able to differentiate between analogue and digital image
- Pupils will learn about binary number and RGB numbers

More information: https://www.bbc.com/bitesize/articles/z2tgr82

Pixels and resolution



(a)

What is the smallest part of image? If we zoom the image, what we will see?

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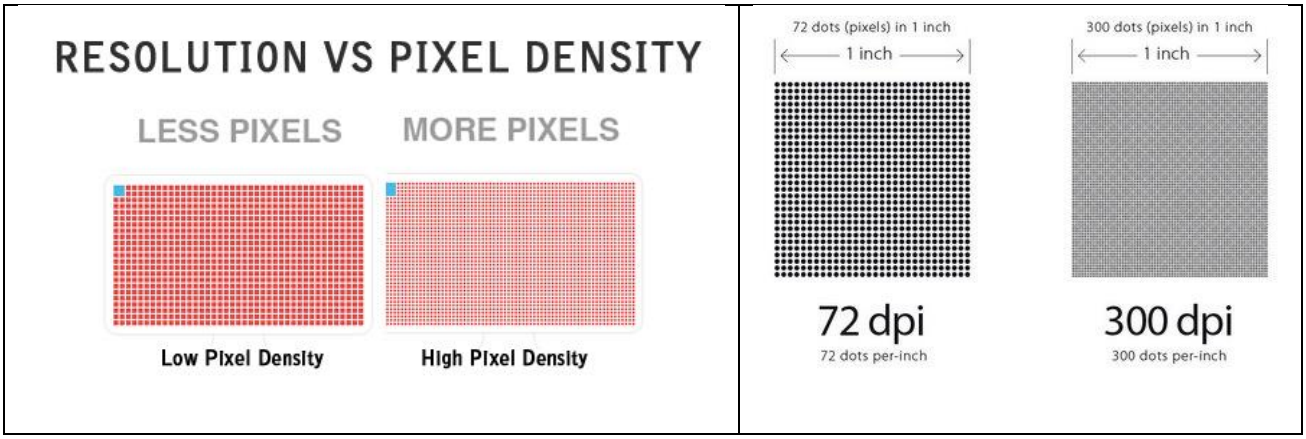

(b)

(c)

Think about figure (b) and figure (c) what happen if there are more pixels? Discuss the visual quality of a digital image in terms of pixels and resolution.

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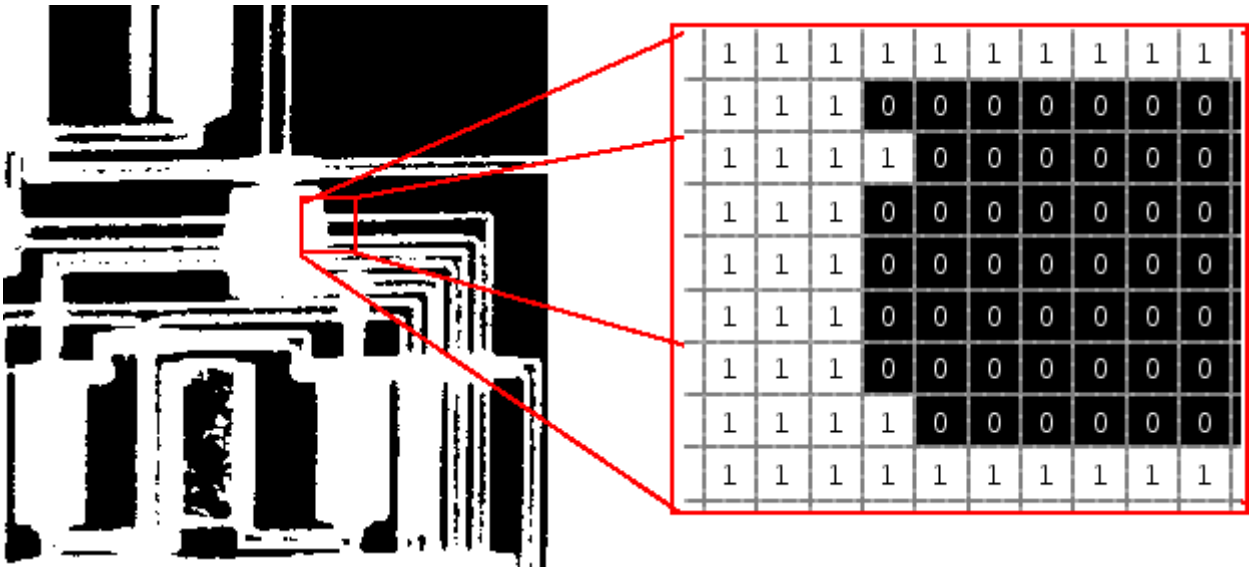
Why digital image matters?

Read the handout and discuss with your partner. Try to write at least three advantages of digital image.

Digital image

Binary pixels and RGB values



(d)

(e)

Define binary pixels and RGB pixels using figure (d) and figure (e).

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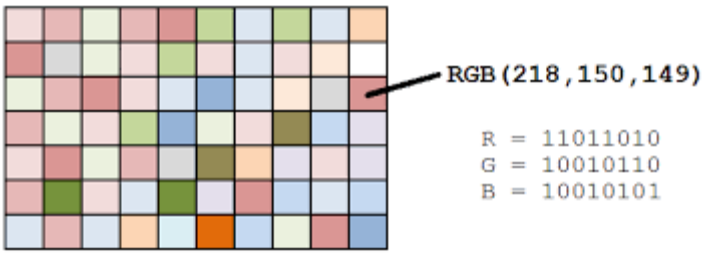
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9
1 0 1 0	10
1 0 1 1	11



(f)

Based on figure (f) discuss the relation between RGB colours values with binary numbers

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Homework 1- Baseline

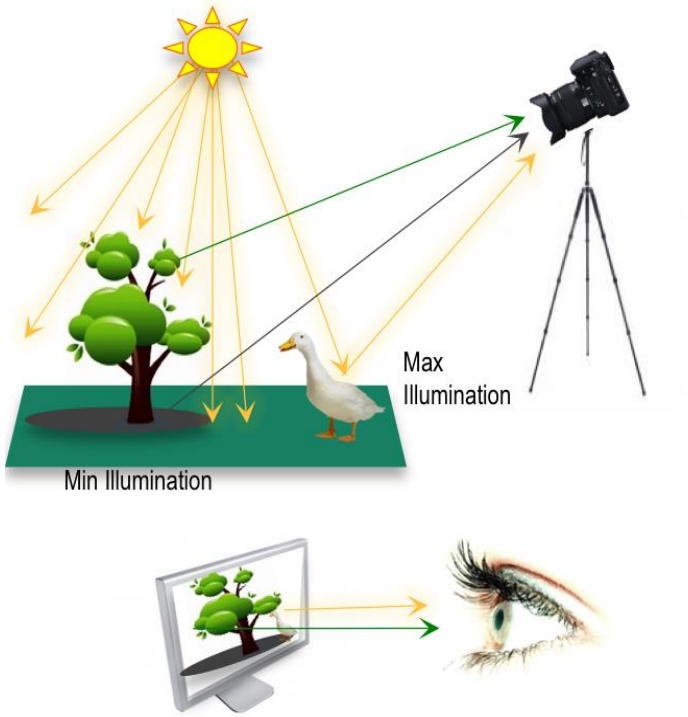
Write a small report covering the followings:

- What is a digital image?
- What is pixel and resolution?
- Define binary pixels and RGB pixels
- Discuss number conversion in terms of digital colour.

Success criteria

- Word limit: 250 words (word process and submit printed copy)
- Include the key words from the glossary and use images/figures to demonstrate your understanding by explaining what they mean and how they relate to the topic.

Tutorial 2 – Formation of a digital image



Wait! What is happening?

Can you write your thoughts in a few sentences about the figure above in few sentences?

1. What is it about?
2. How individual figures are correlated starting from incident light?

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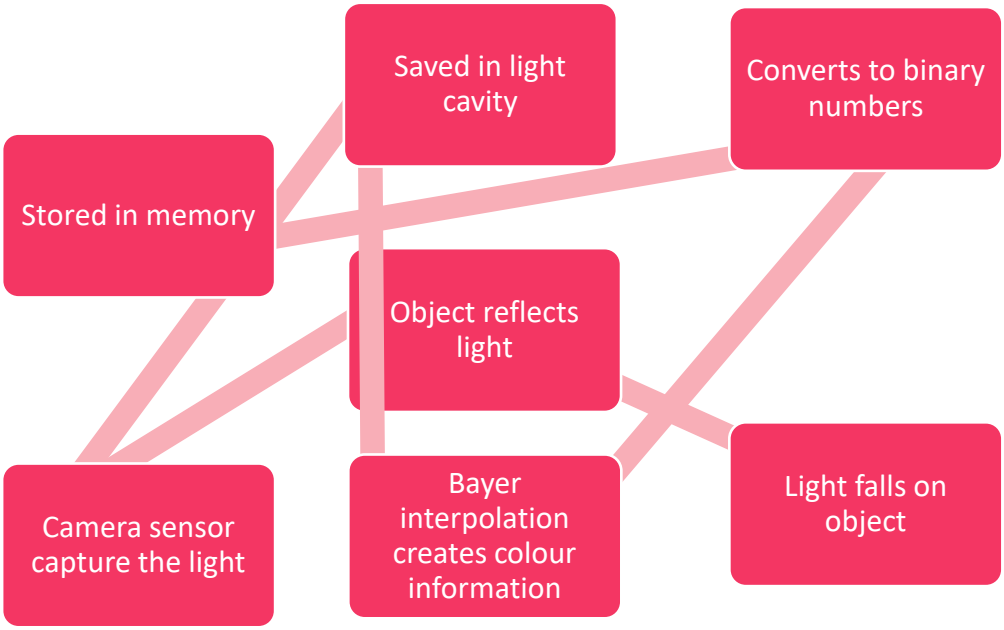
What is the Purpose of Tutorial 2?

- Objective 1: Pupils will have basic idea about the formation of an image
- Objective 2: Pupils will be able to imagine how colour information produced in a digital camera
- Objective 3: Pupils will learn the influence of lights on digital camera

How colour produced by a digital camera?

Based on the discussion reproduce the block diagram in correct order.



Draw the correct block diagram below-

Images under different lighting conditions

Write this lighting conditions of the images of each column.
Look for the followings:

- Describe the scenes of the images of columns a, b and c?
- What sort of colour effect?
- Which columns represent same scene under different lighting condition?
- Consider indoor and outdoor scene for your description.

(a) (b) (c)

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Homework 2- Baseline

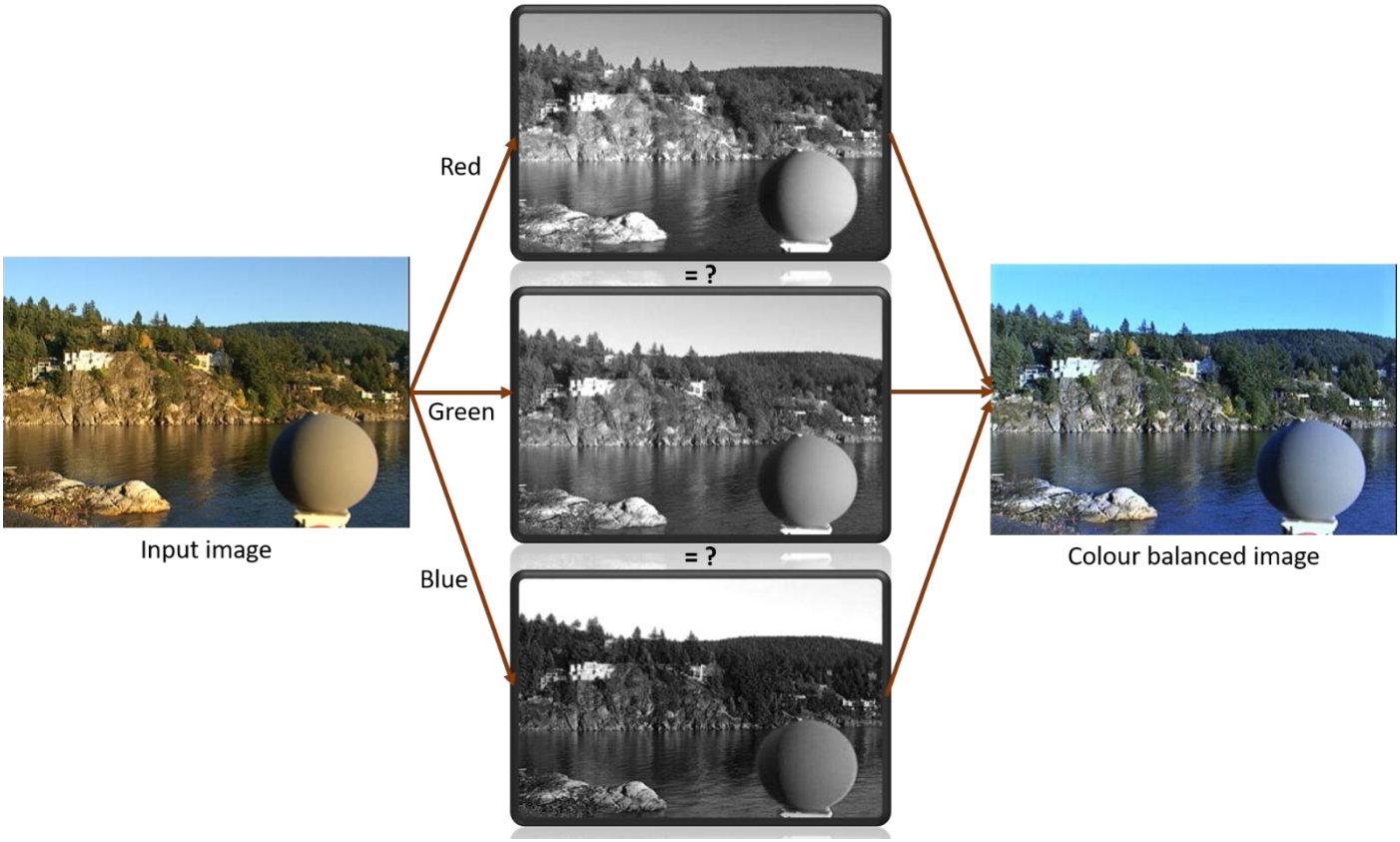
Write a scientific report covering the followings:

- How we see a digital image (brief)
- How digital camera capture a digital image (more detail)
- Write about the impact of source light on the appearance of a digital image. Use images under different lighting conditions and describe the appearance of the image.

Success criteria

- Word limit: 500 words (word process and submit printed copy)
- Include the key words from the glossary and use images/figures to demonstrate your understanding.
- Include research findings from a wide range of sources. You should be discovering some sources yourself from the independent work that you do outside of tutorials.
- Explain the sources that you have drawn on and how they relate to your work. Remember to reference sources correctly.

Tutorial 3 – Image adjustment method 1: Grey World



HMMMMM! What magic is going on?

What is the Purpose of Tutorial 3?

- Pupils will understand the Grey World colour adjustment method
- Pupils will have an experience of implementation of an algorithm on MATLAB software
- Pupils will learn how to assess an image

The Grey World algorithm: Principle

The Grey-World algorithm assumes that, under a white light source, the average colour in a scene is achromatic. This implies that any deviation of the average colour away from grey is caused by the effects of the light source.

Lets' challenge the math!

R: 26 G: 38 B: 0	R: 26 G: 40 B: 0	R: 27 G: 39 B: 0	R: 28 G: 39 B: 0
R: 71 G: 65 B: 24	R: 41 G: 48 B: 7	R: 28 G: 40 B: 0	R: 28 G: 39 B: 0
R:131 G:105 B: 56	R:111 G: 93 B: 46	R: 85 G: 75 B: 29	R: 56 G: 55 B: 13
R:132 G:106 B: 57	R:131 G:105 B: 56	R:120 G: 94 B: 47	R: 89 G: 69 B: 25

(a) (b)

Figure (a) shows an image with a pointer and figure (b) shows the pixels values within that regions. Your task is to do some calculation so that the mean values of R, G and B become roughly equal according to the Grey World theory.

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Produce the block diagram of the Grey World method in correct order (use arrow to show the correct order)

Wrong order!

Calculate the mean value of entire image

Split R, G and B

Input image

Re-calculate the mean values and compare with each other

Calculate the mean value of R, G and B channel individually

Multiply R, G and B with relevant scaling factors

Divide the total mean by individual R, G and B mean to have scaling factors

Correct order (Re-draw the diagram here!)

Let’s taste the code!

In this session, you will implement the algorithm and explore how the code reflects the algorithm.

Write a comparison between the input and output image

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Homework 3- Baseline

Write a scientific report covering the followings:

- Describe Grey World method
- Experimental set up (how you have done the experiment?)
- Discuss the results

Success criteria

- Word limit: 500 words(word process and submit printed copy)
- Include the key words from the glossary and use images figures to demonstrate your understanding.
- Organise your ideas in paragraphs with a logical structure.
- Make sure that you have referenced everything correctly.

Tutorial 4 – Image adjustment method 2: White Patch

.29	R:130	R:129	R:127	R:129	R:132
.69	G:170	G:169	G:165	G:165	G:166
230	B:231	B:230	B:227	B:225	B:227
.30	R:130	R:131	R:132	R:131	R:131
.70	G:170	G:169	G:168	G:165	G:165
231	B:231	B:231	B:230	B:226	B:226
.33	R:131	R:133	R:135	R:135	R:133
.71	G:169	G:169	G:171	G:169	G:167
233	B:231	B:231	B:233	B:230	B:228
.36	R:131	R:132	R:137	R:139	R:135
.74	G:169	G:168	G:173	G:173	G:169

Why are the numbers have been highlighted by red circle?
Are they random numbers or not?
How these numbers are related to colour adjustment?

What is the Purpose of Tutorial 4?

- Pupils will be introduced with another colour adjustment method.
- Pupil will be able to relate the theoretical principle with practical implementation.
- Pupils will experience of implementation of a new method and observe how it will work.

White patch algorithm: Principle

The White-Patch algorithm assumes that the maximum response in an image is caused by a perfect reflectance (i.e. a white patch, see figure to the right). In practice, this assumption is alleviated by considering the colour channels separately, resulting in the max-RGB algorithm.

Lets' challenge the math!

(a)

R: 61 G: 72 B: 94	R: 61 G: 68 B: 94	R: 81 G: 83 B: 75	R:103 G: 96 B: 52
R: 72 G: 78 B: 98	R: 61 G: 68 B: 96	R: 81 G: 86 B: 72	R:103 G: 96 B: 52
R: 86 G:101 B: 98	R: 61 G: 75 B: 89	R: 83 G: 83 B: 78	R:101 G: 96 B: 47

(b)

Figure (a) shows an image with a pointer and figure (b) shows the pixels values within that regions. Your task is to do some calculation so that the mean values of R, G and B become roughly equal according to the White Patch theory.

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Based on the previous tutorial, draw a block diagram of White Patch algorithm (Tips! Remember you need only maximum value from each column)

Let's taste the code!

In this session, you will implement the algorithm and explore how the code reflects the algorithm.

Now, apply both algorithm on the same image and compare the performance

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Homework 4- Baseline

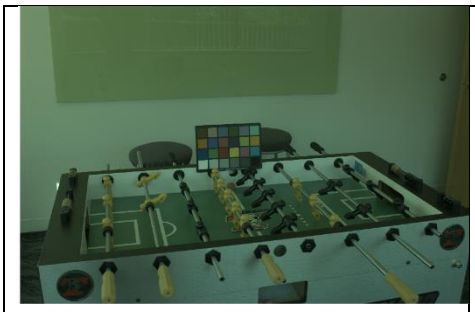
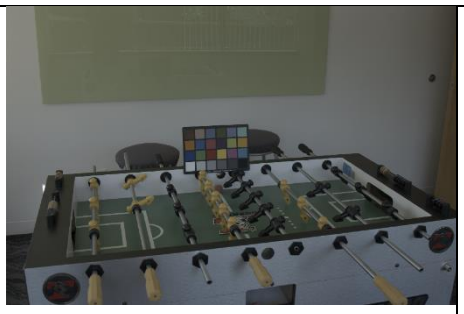
Write a scientific report covering the followings:

- Describe the White Patch method
- Experimental set up (how you have done the experiment?)
- Discuss the result

Success criteria

- Word limit: 500 words (word processed and submit printed copy)
- Include the key words from the glossary and use images figures to demonstrate your understanding.
- Organise your ideas in paragraphs with a logical structure.
- Make sure that you have referenced everything correctly.

Tutorial 5 – Final assignment

What is the Purpose of Tutorial 5?

- Pupils will know the detail about the final assignment
- Pupil will have a clear understanding about ideal structure of a scientific report
- Revise referencing

Your scientific paper should have the followings:

Section	Purpose
Title	A descriptive statement of your experiment.
Abstract	A short summary of the report: you aim, method, result and conclusion
Introduction	Background study. What is it about, why it is important, theory you are going to use.
Method	Explain your methods.
Experimental results and evaluation	Description of experimental setup and comparison of results.
Future works	How colour adjustment can be achieved?
Conclusion	A summary of the paper. What you have done and what you have observes
References	Sources you have used to write your paper.

Home Work: Final assignment (2000 words: word process and submit electronic copy)

Success criteria

- Include an introduction that clearly outlines what the assignment will contain.
- Organise your ideas in paragraphs with a logical structure.
- Include research findings from a wide range of sources. You should be discovering some sources yourself from the independent work that you do outside of tutorials.
- Make sure that you have referenced everything correctly
- Include a conclusion that summarises all the key points clearly
- Make sure that your spelling, grammar and punctuation are accurate.
- Use a formal writing style that is appropriate for an academic essay/

Good luck!

Tutorial 6 – Feedback tutorial

What is the Purpose of Tutorial 6?

- To receive feedback on final assignments.
- To share examples of best practice with the other pupils in your group.
- To write targets for improvement in school lessons.
- To reflect on the programme including what was enjoyed and what was challenging.

Final assignment feedback

What I did well…	What I could have improved on…
•	•
•	•
•	•

My target for future work is…

Reflecting on Uni Pathways

What did you most enjoy about Uni Pathways?
• • •

What did you find challenging about the programme?	How did you overcome these challenges?
• • •	• • •

Appendix 1 – Referencing correctly

When you get to university, you will need to include references in the assignments that you write, so we would like you to start getting into the habit of referencing in your Brilliant Club assignment. This is really important, because it will help you to avoid plagiarism. Plagiarism is when you take someone else's work or ideas and pass them off as your own. Whether plagiarism is deliberate or accidental, the consequences can be severe. In order to avoid losing marks in your final assignment, or even failing, you must be careful to reference your sources correctly.

What is a reference?

A reference is just a note in your assignment which says if you have referred to or been influenced by another source such as book, website or article. For example, if you use the internet to research a particular subject, and you want to include a specific piece of information from this website, you will need to reference it.

Why should I reference?

Referencing is important in your work for the following reasons:

- It gives credit to the authors of any sources you have referred to or been influenced by.
- It supports the arguments you make in your assignments.
- It demonstrates the variety of sources you have used.
- It helps to prevent you losing marks, or failing, due to plagiarism.

When should I use a reference?

You should use a reference when you:

- Quote directly from another source.
- Summarise or rephrase another piece of work.
- Include a specific statistic or fact from a source.

How do I reference?

There are a number of different ways of referencing, and these often vary depending on what subject you are studying. The most important to thing is to be consistent. This means that you need to stick to the same system throughout your whole assignment. Here is a basic system of referencing that you can use, which consists of the following two parts:

1. **A marker in your assignment**: After you have used a reference in your assignment (you have read something and included it in your work as a quote, or re-written it your own words) you should mark this is in your text with a number, e.g. [1]. The next time you use a reference you should use the next number, e.g. [2].
2. **Bibliography**: This is just a list of the references you have used in your assignment. In the bibliography, you list your references by the numbers you have used, and include as much information as you have about the reference. The list below gives what should be included for different sources.

    a. **Websites** – Author (if possible), title of the web page, website address, [date you accessed it, in square brackets].

    E.g. Dan Snow, 'How did so many soldiers survive the trenches?', http://www.bbc.co.uk/guides/z3kgjxs#zg2dtfr [11 July 2014].

    b. **Books** – Author, date published, title of book (in italics), pages where the information came from.

    E.g. S. Dubner and S. Levitt, (2006) *Freakonomics*, 7-9.

    c. **Articles** – Author, 'title of the article' (with quotation marks), *where the article comes from* (newspaper, journal etc.), date of the article.

    E.g. Maev Kennedy, 'The lights to go out across the UK to mark First World War's centenary', Guardian, 10 July 2014.

Notes

Notes

Notes

Colour Adjustment Techniques for Digital Image

Key Stage 4 Programme

researchersinschools.org