Introduction to the structure and orientation of the course

Image-making

Cave paintings from up to 32,000 years ago can teach us many things of value. Figure Int.1 (http://commons.wikimedia.org/wiki/File:Chauvethorses.jpg) shows one example.

Figure Int.1 (Cropped) Image of horses, Chauvet cave, France {pd}

Our ready appreciation of what these images represent, at least at the level of outward appearance, suggests that the human visual system and awareness have not changed fundamentally since then. Humans at that time clearly valued pictorial representations of their experience and aspirations, and devoted great effort to ensuring high levels of realism. The evocative nature of those ancient images is still strong for us, to the extent that we try to interpret them in terms of our likely rationales for production that can include records of past activity and representation of intent as a magical aid to future achievement.

In any case, the significance of image making to ancient peoples is evidently important for its evocative effects. Realism of appearance and attempts to represent movement and three dimensions on a static two-dimensional surface was a problem that exercised much thought and physical effort, not least given that the location of some images, within cave systems, does not allow for ready access.

Perception

At a fundamental level this half unit course depends on sense and perception, while directly addressing only the computational aspects for generating images to be perceived. Hence, as background, it is necessary to have a model for perception informing the approach to computation and display. In earlier units some aspects of perception, in terms of the physiology of the eye and perceptual effects, have been mentioned. As this course relates image making to artist's painting and drawing practice, here it is useful to extend this a little by some background reading on the development of ideas about the relationship between artists' (including those who paint) and scientists' (including those who compute what to paint) views of how and what we perceive. A suitable introduction to this, as required reading, is in relevant sections of the course text [Kemp92, pp.234–249 and 249–257].

The discussion by Kemp thus gives a useful starting point for thinking about how some artists have taken perception issues into account and how these considerations have affected their work. It is important for you to have some understanding of these matters in order to make conscious and intelligent decisions on what effects you wish to produce and how to set about computing them.

However, the orientation of this half unit is towards **computing**. Hence perception issues are not studied in detail but considered to be informed by earlier units, excepting some standard variations such as colour vision anomalies.

Display

Accepting that human visual equipment and aspiration have had a common base for so long, there is much to be learned from looking at how image makers have struggled with problems of representation in the past.

As part of this, image makers seem to have been eager to invent or embrace new technologies as tools to facilitate their work, be they improvements in brush and paint systems or mechanical devices to aid representation (such as the camera obscura), through to our increasing use of computers with interaction and display aids today.

This helps to set the scope of this half unit.

For this course the standard for display of two- or three-dimensional scenes is in some two-dimensional form, such as on a raster monitor. We shall not consider direct three-dimensional image generation or holographic representations.

Computation

To give a fully coherent account of all the aspects, of Computer Graphics (CG), Image Processing (IP) and the background to creative image makers, needed to fully prepare the ground for every topic mentioned in this half unit, easily could occupy four half units of study (probably two on CG, one on IP and one on the science of art). Thus this guide leans heavily on the introductory links in the first and second year units that include some aspects of these topics. Also, we study topics in a limited framework to restrict the need for extensive preparatory work. This is done in several ways. One is by using the facilities of the Processing language in which to embed the features that are considered, which saves time in developing a model, and implementation, for a fully-featured CG package, even though some fundamental aspects of general CG (such as the mapping between model and device systems – Processing having inbuilt geometric and raster graphics models) are ignored.

Thus some basic aspects of CG will be presented and code for them developed even though some of them are already present in Processing. This is done to give sufficient understanding to enable implementation in other, more general programming languages, and to enable you to implement your own variants of effects and methods. This is important in order to be able to work in a wider range of programming environments. For example, much 3D games programming is in C++.

Similarly, in considering IP, many mathematical aspects are considered in a very simplified way, which is acceptable in a course concerned with creativity in computing, not least since it is often the case that simple IP operations have fine aesthetic effects. Thirdly, a non-systematic study of creative image makers is rendered sufficient by focusing only on a sample of those relevant to the specific issues corresponding to the CG or IP operations and effects under study.

Coding

In terms of programming approach, the code presented illustrates particular cases of functionality as clearly as possible to give you a basis for implementing your own extensions and original ideas. Thus the approach, idea by idea, is procedural/functional rather than coherently structured in object-oriented terms. Also for clarity of individual aspects, data structures are kept as simple as is practicable. In this way, you will be aided in understanding aspects of the underlying operation of many general systems, such as those based on OPENGL, that you may come across. Hence while simple features of Processing for 2D graphics (such as anti-aliased line drawing) are used as a basis without providing directly coded equivalents, some more general facilities, such as lighting and surface shading, are coded directly to explore and illustrate the underlying concepts. The Processing language is used as it is familiar and so enables the code functionality to be more easily understood.

Art and image background

For many thousands of years, artists have expressed individual creativity in making two- and three-dimensional images. More recently, photography and film (‘moving’ image) have provided additional media through which visually creative people have been able to express themselves. The intermixing of other sensory experience (such as hearing and touch) with visual aspects has also become more prevalent, although this will not be the primary concern in this half unit.

Thus, in addressing how computers may be utilised in visual creativity, this half unit will reference and analyse some of the historical wellspring of creative experience in order to see how a number of artists and image makers have approached representation of the world around them, including how analysis and emotion affect perception, and enable an image maker to capture and project the perceptions and emotions that he/she wishes. This is done by examining examples of works of art, including how the artist was affected by, and utilised, available technology. To help understand this, some historical and

social background for the artist is included, for reflection on such context will help students better understand some of the influences acting upon themselves. The artists considered are predominantly from the Western European canon, this being a reflection that this half unit is part of a University of London degree.

The examination of past artistic development provides a basis to motivate some formal aspects of computer graphics (CG) and image processing (IP) that enable description and application (sometime in an automated way) of the techniques used by past and present creative image makers.

In turn some aspects are then considered of how CG and IP techniques can be extended and applied to achieve representations that are unavailable to an artist without such technology.

Content and structure

Broadly, the content includes: art and film interpretation into graphics and image processing; elements of style, form and colour in fine art and film; realisation of fine art and film effects with computer graphics and image processing; algorithmic processes for representation of fine art effects. Examples include light and shade, painting style, realism and abstraction, sculpture analysis for form modification, non-Euclidean space, motion representation in still image, film effects for drama and emotion, games.

The guide is written as a set of chapters. Each chapter addresses some aspect of image description and image making. The first section of each chapter looks at that aspect of still or moving image making in terms of past creative practice. Following sections consider how the realisation of these effects may be approached through the use of computers with appropriate software and display capabilities. Detailed technical and coding aspects of the computational approaches are in the last sections of each chapter.

Frequently it will be found that the analysis/examination of some work of art in one chapter will contribute to discussions of effects also in other chapters, since any one work of art can illustrate many different features that can be addressed through the study of different topics in CG and IP. For example, a picture may be examined because of lessons to be learned about the effects of light and shade, while also contributing to the study of how spatial representation evolved through developments in the understanding of perspective and its geometrical description.

After all, a visual representation is **not** the thing represented (vis. Magritte, '*Ceci n'est pas une pipe*', 1928 [see, for example: http://www.foucault.info/documents/foucault.thisIsNotaPipe.en.html], one of the series *La trahison des images*), and in areas such as animation for interactive games it is important to achieve the maximum perceptual effect for the minimum (or, at most, the available) computing power.

Thus La Hire's list [Kemp92, p.236] of elements contributing to judgement of depth, and the sub-list available for static, single viewpoint observation of a painting or a computer screen, is a useful starting point.

In summary, this half unit is too short to provide a full and complete course in all or any one of computer graphics, image processing or the science of art. What this half unit does provide is a view that spans fine art and image making from a technical computing perspective, with an internally consistent structure that provides you with useful knowledge sufficient to create novel tools for creating original work.

Learning outcomes

On completion of this half unit and the relevant readings and activities, you should be able to:

1. Critically evaluate and implement systems for painting, and for 3D modelling and animation.
2. Interpret and appropriately select from libraries for image and animation design, using determinable aesthetic principles and knowledge of motion perception.
3. Synthesise new knowledge in the form of visual and systems design using knowledge of perception, aesthetics, advanced paradigms and technologies.
4. Present new ideas and observations in emerging areas of computing relating to motion perception, aesthetics, painting and gaming.

5. Develop original methods, images and aspects of games using high level programming languages and research-oriented tools and libraries.
6. Understand aspects of creativity and representation in traditional still and moving image media and be able to realise these through techniques of computer graphics and image processing, with extensions to novel effects enabled by computing.

Essential reading – examinable

Kemp, M. *The Science of Art – Optical Themes in Western Art from Brunelleschi to Seurat*.
(Yale University Press, revised edition, 1992) [ISBN 0300043376 cloth, 0300052413 (pbk)].
The paperback version can be obtained for about £20 sterling at the time of going to press.
This book will be of great value in understanding many issues to do with developments in artists' understanding of creating more realistic representations, particularly with regard to perspective and colour. It will provide most students with greater insight into the creative process for a visual artist and thus provide additional impetus for those attempting to develop their own visual creativity.
{in this guide referred to as Kemp92}

Reas, C. and B. Fry *Processing: A Programming Handbook for Visual Designers and Artists.*
(The MIT Press, 2007) [ISBN 0262182629].
While this text will be well-known already from use earlier in the programme of study, students should ensure a copy is to hand and that the contents are familiar.

Supplementary reading

Angell, I.O. *High-Resolution Computer Graphics Using C.*
(MacMillan, 1990) [ISBN 0333498720; 0333498739 (pbk)].
The source of the approach, and many of the methods, used in Chapters 3 and 4.

Eisner, Lotte H. *The Haunted Screen*.
(University of California Press, 1974) [ISBN 0520024796 or 978-0520024793].
Although not a recent book, this is excellent in text and pictorial coverage of German Expressionist film, giving clear illustrations of techniques and effects.

Foley, J.D., A. van Dam, S.K. Feiner, J.F. Hughes and R.L. Phillips
Introduction to Computer Graphics.
(Addison-Wesley, 1997) [ISBN 0201609215].
{in this guide referred to as FDFHP97}
This is the book used by the guide authors.

or

Foley, J.D., A. van Dam, S.K. Feiner and J.F. Hughes
Computer Graphics: Principles and Practice.
(Addison-Wesley, 1995) [ISBN 0201848406].
{in this guide referred to as FDFH95}
This covers essential topics at greater length than FDFHP97 and may not be so easy to follow on some topics.

Gombrich, E.H. *The Story of Art*.
(Phaidon, first edition, 1964; sixteenth edition, 1995) [ISBN 071483355X (hbk); 978-0714832470 (pbk)].
Those parts related to artists discussed in the subject guide should be read, to broaden understanding of the influences on how artists worked and on what they produced. While the authors consider the book to be of great value, the book is kept to Supplementary reading to avoid excessive emphasis on Art History within a BSc programme. It should be readily available in any good library and used extensively for background reading.
{in this guide referred to as Gom95}

Kemp, M *Seen|Unseen*. (Oxford University Press, 2006) [ISBN 0199295727 or 9780199295722].
An excellent book for thoughtful views on the relationships between artists' and scientists' developing understanding in several areas including representation of spatial relationships in nature.
{in this guide referred to as Kemp06}.