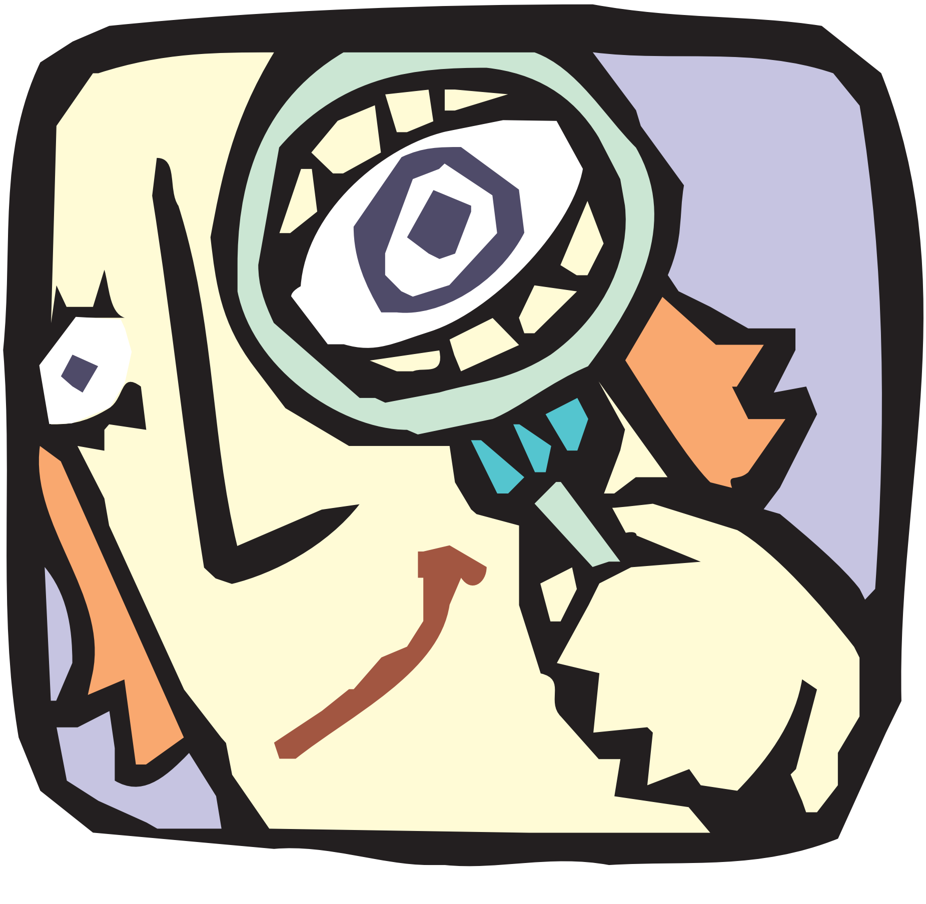
vision

Bulletin of the Applied Vision Association



Geoffrey J. Burton: Awards
AVA '97 Abstracts
Call for papers: depth perception
Book review: Smith & Atchison
References on Vision

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APPLIED VISION ASSOCIATION

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AIM OF THE AVA: TO PROMOTE AND ADVANCE THE APPLICATION OF RESEARCH WORK IN ALL AREAS RELATED TO VISION

Editorial

This is the second issue of the Bulletin of the AVA that is in a slightly larger format. We had favorable comments about the switch over to a large page size. The aim was to increase the quality of the Bulletin, both in production terms and content so that the Bulletin could be a useful reference and information source for AVA members.

In this issue we announce two awards from the Geoffrey Burton Memorial fund. We were particularly encouraged by the number and quality of applicants. The deadline for the next round of applications is 31st August 1997.

A new item for the Bulletin is inclusion of a book review. We would like book reviews to become a regular feature in the Bulletin. If you know of a book you think we should review then please let us know. There are already reviews in the pipeline for future issues.

In this issue we also have a call for papers for an AVA meeting on depth perception at Surrey University organised by Mark Bradshaw. Already there are an impressive array of speakers lined up. If you would like to organise a scientific meeting or have suggestions of a meeting topic then please contact a committee member.

I have recently returned from the AVA annual meeting and AGM in Dundee. The abstracts of papers and posters presented at that meeting in which Beau Watson gave the keynote paper are in this issue. The AVA AGM marked a change in the AVA treasurer. John Harris, who saw the AVA through the time when it was changing to a charity, stood down and was replaced by Graham Edgar. We are all grateful to the work that John has put in for the AVA.

Finally there are selected references on vision—produced by Chris Dickinson. I know that many members find this a very useful section. If you don't normally look at the references I would encourage you to do so: I usually find a number I wouldn't have discovered elsewhere.

Remember that the latest information on the AVA is on our web site:

http://www.dmu.ac.uk/ava/

If you have any comments on the Bulletin of the AVA then do contact me: mscase@dmu.ac.uk

Deadline for copy for the next Bulletin - 18th June 1997

Noticeboard

AVA on the World Wide Web

The Applied Vision Association now has its own world wide web pages at:

http://www.dmu.ac.uk/ava/

The pages contain details of who is on the committee, contact emails, latest details on forthcoming AVA meetings and links to other vision related pages. There are also archives of abstracts from previous AVA meetings.

Forthcoming AVA Meeting

Postgraduate Meeting. 5th November 1997, College of Optometrists, London.

There will be a meeting for postgraduates and researchers up to one year postdoctoral to present papers at the College of Optometrists. For more information contact the AVA Secretariat on: 0171 373 7765

AVA and OPO Subscriptions

Membership for 1996/1997 is the same price as last year. However, the price for OPO subscriptions has increased slightly. Those members who pay by standing order please don't forget to amend your standing order accordingly.

Geoffrey J. Burton Memorial Fund

The fund was established in 1986 with the aim of providing financial assistance to students (in non-established or fixed term posts) based in the UK travelling to any conferences or meetings at which they will be presenting a paper or poster. Donations to the fund can be directed to the AVA secretariat and cheques etc. should be made payable to "The Geoffrey J. Burton Memorial Fund".

The maximum award to any one individual is £200.

Awards can be made for any conference in the calendar year in which the award falls (1997 in this case). You do not have to be presenting at an AVA conference. The awards will be made twice a year.

The next closing date for applications is:

31st August 1997

To apply for an award you need to complete an application form which is available from:

The AVA Secretariat,
College of Optometrists,
10 Knaresborough Place,
London,
SW5 0TG.

Two people were awarded travel grants of £175 each from the last round of applications:

Alison Statham from the University of Birmingham to present a paper entitled "Depth perception can use first and second order disparities" at the AVA meeting in Dundee;

Ashley Shepherd from Glasgow Caledonian University to present a paper entitled "Development of the Pattern Reversal Visual Evoked Potential (PRVEP) in preterm and fullterm infants" at the 6th Meeting of the Child Vision Research Society Pisa, Italy.

Congratulations to both!

AVA books for sale

The AVA still has a number of new books for sale from conferences that it has organised over the years.

Payment can be by cheque or postal order in UK pounds (sorry, no credit cards) to "Applied Vision Association". Send your payment with the order to:

AVA Secretariat,
Applied Vision Association,
College of Optometrists,
10 Knaresborough Place,
London SW5 OTG.

Books available:

The cost for each book is £15 (including postage in the UK) for AVA members or £20 for non-AVA members. If you are outside the UK then add £5 per book to each of the prices above.

Gale, A.S., Astley, S.M., Dance, D.R. and Cairns, A.Y. (1994) **Digital Mammography**. Elsevier (424 pages).

Gale, A.S., Freeman, M.H., Haslegrave, C.M., Smith, P. and Taylor, S.P. (1988) **Vision in Vehicles II**. North Holland (420 pages).

Gale, A.S., Brown, I.D., Haslegrave, C.M., Kruysse, H.W. and Taylor, S.P. (1993) **Vision in Vehicles IV**. North Holland (355 pages).

Brogan, D., Gale, A. and Carr, K. (1993) **Visual Search 2**. Taylor and Francis (477 pages).

The cost of the Dalton conference book is £43 (including postage in the UK) for AVA members or £48 for non-AVA members. If you are outside the UK then add £5 per book.

Dickinson, C., Murray, I. and Carden, D. (1996) **John Dalton's Colour Vision Legacy**. Taylor and Francis (784 pages).

Book Review

The eye and visual optical instruments

George Smith and David A. Atchison

1997 Cambridge University Press, ISBN 0-521-47820-0, £35.00

This is a long book (over 800 pages) dealing comprehensively with all aspects of optical instruments. The book is divided into six parts. Part one deals with the general theory of optics covering refraction, reflection, aberrations and image formation with lenses, mirrors and prisms. It also has a chapter on basic photometry. Part two deals with optical instruments and systems. To start off there is a chapter describing the optics of the eye. Subsequent chapters describe conventional instruments such as simple magnifiers, microscopes and telescopes, and even old and now rarely used instruments such as the sextant. Part three covers much more recent instruments such as interferometers used to project interference fringes into the eye and diffractive devices such as laser speckle optometers. Part four of the book covers the tools of the trade for optometrists including focimeters, fadiuscopes and keratometers, ophthalmoscopes, and binocular vision testing instruments. Part five begins with aberration theory then goes on to describe aberrations of the eye and aspects of image quality. The final part of the book covers aspects of visual ergonomics—the interaction and interfacing of the eye with the instruments. In addition there are five appendices covering subjects such as advanced paraxial optics, schematic eyes, and a glossary of terms.

The authors say that the book was written with a number of professions in mind, such as ophthalmologists, optometrists, vision scientists, optical engineers and anyone who uses visual optical instruments on a regular basis, such as microscopists and metrologists.

Such a comprehensive book should certainly be bought by all optometry and vision science departments and it would not be out of place in psychology libraries. At a price of £35 (for the paperback version) it is just about in the price range of students as well.

Mark Scase

Applied Vision Association Meeting

4th September 1997
DEPTH PERCEPTION
(Physiology and Psychophysics)

Announcement and call for papers

Applied Vision Association invite paper and poster presentations for a special 1-Day Conference/Workshop on DEPTH PERCEPTION (Physiology and Psychophysics) September 4th 1997 at the Department of Psychology, University of Surrey, Guildford, UK.

Invited speakers:
Prof. A.J. Parker / Dr B.G Cumming,
Physiology Laboratory, University of Oxford.
Prof B.J. Rogers
Experimental Psychology, University of Oxford.
Prof. B.J. Gillam
Psychology Department, University of NSW, Australia

Abstracts will be published in Perception and authors will be invited to submit a paper to be published in a special issue of the journal within 3 months of the meeting.

Applications, in the form of a 250 word abstract, should be sent to:
Dr M.F. Bradshaw,
Psychology Department,
University of Surrey,
Guildford http://www.dmu.ac.uk/ava/meetings.html
GU2 5XH, U.K.
BEFORE the 30th JUNE 1997.

Further information can be obtained from Mark Bradshaw M.Bradshaw@surrey.ac.uk or Paul Hibbard P.Hibbard@surrey.ac.uk

Registration is £20 UK which includes refreshments and lunch.

Guildford is easily accessible from London (35 mins by train) and only 50 mins from Heathrow and Gatwick (rail-air links).

AVA '97
Image Quality
9th - 11th April 1997
University of Abertay, Dundee

Meeting Abstracts

Effects of stereo and motion manipulations on measured presence in stereoscopic displays

J Freeman, SE Avons, J Davidoff
Department of Psychology, University of Essex, Wivenhoe Park, Colchester, CO4 3SQ, UK.

Methods of assessing presence, a sense of 'being there' within a displayed virtual environment, include post-test subjective measures, discrimination tests and monitoring reflexive responses. Each is limited - either they do not provide a measure of temporal variation, are not feasible using current display technology or are overly content specific.

We present a measure of presence derived from a method of continuous evaluation of TV picture quality (ITU-R, BT 500-7) designed to overcome these limitations. The results of two experiments are presented. The first establishes that the methodology is usable under the optimal viewing conditions for the 20" Stereoscopic TV display upon which our stimuli are presented. It compares within subject variation on continuous TV picture quality ratings under two viewing conditions - at six picture heights in the light (standard for quality evaluations) and at 2 picture heights in the dark (optimal stereo TV viewing). The second investigates the effects of manipulations of the visual parameters of stereo, scene motion and observer based motion on participants' presence evaluations within edited sections of a stereoscopic film. Support is provided for theories predicting that extent of sensory information available to a participant is one of the factors determining presence.

ITU - R Recommendation BT.500-7 (REVISED) "Methodology for the subjective assessment of the quality of television pictures", 1995

Segregation of motion information via stereoscopic depth information

Robert J. Snowden and Melissa Rossiter
School of Psychology, University of Wales Cardiff, Cardiff CF1 3YG, Wales, UK

One can measure a subject's ability to see motion be degrading the signal by noise. One popular method is to use random dot patterns and move a certain percentage of the dots in one direction (the 'signal') and the remaining ones in random directions (the 'noise'). Can observers use non-motion cues as to which elements are signal and which are noise to aid in this performance of this task?

Croner & Albright (1994) suggested that if the signal were red and the noise green performance is far superior than if they are the same colour. However, this could be due to an attentional strategy. Subjects could simply pick a 'red' dot and ascertain its direction. Edwards & Badcock, (1996) used the technique of adding extra noise dots of a different colour - if subjects could segment these noise dots and ignore them performance should not be affected by them. However they found that it was suggesting that colour information can not be used in this manner. We have used very similar methodologies to look at the role of stereoscopically defined depth as a cue to motion segmentation.

When the signal dots have a different depth to the noise dots thresholds fell to very low levels. However this could be due to an attentional strategy. Using the technique of Edwards & Badcock (1996) we found that extra noise dots in a different depth plane did not disrupt performance. Thus stereoscopic depth behaves differently to colour and can be used to segment the information prior to motion judgements. The results have interesting parallels in the domain of conjunction search (Nakayama & Silverman, 1986)

References

Croner, L.J. & Albright, T.D. (1994). Investigative Ophthalmology and Visual Science Supplement, 35, 1643.
Edwards, M. & Badcock, D.R. (1996). Vision Research, 36, 2423- 2432.
Nakayama, K. & Silverman, G.H. (1986). Nature, 320, 264-265.

Relative size as an available coding dimension in stereoscopic space.

P Banton and Dr P Thomson.
Department of Psychology, University of York

As a non-fixated object moves closer to an observer, the visual angle it subtends at the eye increased and the binocular disparity between it and the point of fixation become increasingly negative (i.e. crossed disparity). If the object moves away from the observer its visual angle reduces and the binocular disparity between it and the point of fixation becomes increasingly positive (uncrossed disparity). Thus, relative size (difference in visual angle) and relative binocular disparity are coupled under normal viewing conditions.

If relative size is to be used to code a dimension other than depth in a steroscopic display the possibility exists for a confound of these two cues to depth: for two similar objects, the close object may subtend a smaller visual angle than the further object. Observers of displays using relative size in such a manner would be required to uncouple the normal relationship between relative size and relative disparity.

A series of experiments investigated subjects' ability to perform this task with two different stereo-image methods, mirror stereoscope and ferro-elective shuttering goggles. Subjects were required to make "closer/further" discriminations between a "test" disc and two "standard" flanking discs. The diameter of the flankers was 13.2 arc mins. That of the test symbol varied between 10.3 and 16.2 arc mins and its disparity relative to the flankers varied between +4.9 and -5.0 arc mins. All four subjects were able to make depth judgements when no size variation was present. However, when disparity was confounded by relative size, two subjects seemed unable to produce accurate relative depth judgements. Further experiments demonstrated that, for these two subjects, increasing presentation time from 500 ms to 100 ms increased their accuracy. The implications of these findings for the design of the stereoscopic aircraft radar displays are discussed.

Paper Depth Perception can use First and Second Order Disparities

Alison Statham & Mark Georgeson

School of Psychology, University of Birmingham, B15 2TT email:- A.K.Statham@bham.ac.uk & M.A.Georgeson@bham.ac.uk

We examined the nature and variety of mechanisms underlying the use of binocular disparity in depth perception. Stimuli were Gabor patches (Gaussian-windowed sine-wave gratings, 2c/deg) and disparities were produced by varying the phase of the carrier grating or the position of the Gaussian envelope (s.d. = 24 minarc) or both. Four different conditions were tested over a disparity range from - 180deg to +180deg of carrier phase (or the positional equivalent). Direction and magnitude of perceived depth were reported in a 2-IFC procedure where the comparison interval contained a zero disparity patch.

In the “patch” condition carrier phase and envelope disparity varied together, and perceived depth (PD) was found to vary monotonically with disparity. When phase information was ambivalent (at +/- 180deg) the direction of PD followed the envelope disparity. This result for a vertical carrier also held for carriers oriented 30deg, 60deg and 90deg from vertical, where phase disparity fell to zero. In the “envelope” condition phase disparity was also zero, while envelope disparity varied. No depth was seen. These results show that 2nd order (envelope) disparity can produce depth, but that it may be vetoed by 1st order (phase) information.

When carrier phase alone was varied PD was similar to the “patch” condition, except at the larger crossed disparities (-80deg to -180deg) where depth reversed. This suggests a role for occlusion cues in the interpretation of disparity. When carrier phase and envelope disparity were varied in opposite directions PD followed phase disparity up to +/-80deg disparity but outside this range depth reversed to follow the envelope disparity. When carrier phase is increasingly ambivalent, or first order signals are less dominant, depth perception can be driven by second order envelope disparity.

Surround effects in the rotary motion aftereffect

N. J. Wade[1], M. T. Swanston[2] and P. Fennah[1]
[1]*Department of Psychology, Dundee University, Dundee DD1 4HN, Scotland.*
[2]*School of Social Sciences, University of Abertay Dundee, Dundee DD1 1HG, Scotland.*

The linear motion aftereffect (MAE) reflects both early and late processes in vision: adaptation is retinocentric, whereas the MAE is patterncentric[1]. That is, the MAE is dependent on the global structure of the test pattern: if adaptation is to two moving gratings flanking a stationary central grating, an MAE is seen in the central grating if two gratings surround it, but in the flanking gratings when they are themselves surrounded in the test stimulus. A similar procedure was applied to rotating patterns: a sectored annulus rotated around a static sectored disc, and MAEs were measured in both regions. The MAE in the surround was in the opposite direction to the prior rotation. An MAE was measured in the central disc, and its direction was the same as prior rotation of the surround. The duration of the MAE in the centre was about 30% of that for the surround, and it was not affected by the relative areas of the centre and surround. Interaction between the surround and the centre was examined by presenting equivalent surround adaptation with and without a static centre. MAEs from rotation differ basically from those following translation.

Reference

[1]Wade, N. J., Spillmann, L. and Swanston, M. T. Visual motion aftereffects: Critical adaptation and test conditions. Vision Res. 1996, 36, 2167-2175.

Image quality measurements for evaluating stereoscopic display performance.

Arun Bhoopal
De Montfort University, Leicester.

This paper presents the results of a pilot study and a subsequent experiment to investigate stereoscopic image quality and its impact on stereoscopic display performance. Image quality metrics for monoscopic displays have been investigated extensively, for example, metrics based on models of the human visual system. In the field of stereoscopic displays, however, similar metrics are less common, based mainly on investigations into single aspects of image display. Many stereoscopic display evaluations have avoided image quality issues and concentrated on task performance specific to an application. It is proposed that general measures of stereoscopic display performance may be better modelled by considering a more complete range of artefacts associated with displaying stereoscopic images, such as depth, crosstalk and the accommodation/vergence mismatch.In the initial pilot study, subjects were asked to provide personal constructs to describe aspects of stereoscopic images shown to them on different displays; based on the repertory grid technique. It is intended to investigate the feasibility of relating subjective measures of quality to display features which can be objectively measured. To this end, a further experiment is described in which subjects were asked to rate displays according to particular aspects using a number of semantic-differential scales. These scales were derived from the constructs provided by subjects in the initial pilot study.

Duration Neglect in Television Picture Quality Evaluation

David Hands, Steve Avons, and Jules Davidoff
Department of Psychology, University of Essex

The duration of an episode has been shown to have negligible effect on retrospective affect evaluations. The present research investigates theeffect of varying the duration of poor quality video within generally high quality video pictures on both concurrent and retrospective television picture quality evaluations. Subjects were presented with 30s video sequences in which no severe quality degradations occurred (control), 5s of video was of very poor picture quality, and 10s of the sequence was severely degraded. Using an analog input device, subjects were able to continuously track the picture quality throughout a sequence,resulting in poorer mean ratings across time for the 10s condition. However, retrospective evaluations did not differentiate between the 5s and 10s poor quality video conditions. Thus, this test suggests that duration neglect is evident in evaluations of television picture quality where single, retrospective ratings are required. In addition, when forming an opinion of television picture quality subjects appear to place greater emphasis on the intensity of a negative event. Subjects concurrent ratings, and their retrospective evaluations reflect differential weighting of intensity and duration in these time-varying stimuli.

Encoding Faces in Byte-Sized Chunks

Mark H. Maxfield
Denbridge Digital

Faces represent a class of image with a well-defined and consistent global structure within which exemplars are differentiated on the basis of complex, and often, subtle variations in aspects of appearance. Sources of variation include differences in dimension, texture, and grey-scale or colour information. General purpose lossy compression algorithms, such as JPEG, typically achieve compression ratios of about 25:1 before degradation in image quality becomes prohibitive. It is expected that a compression scheme that takes account of the restricted nature of facial images will achieve much higher compression ratios.

The proposed scheme requires a large database of faces to be available at both the encoder and decoder, with reference images selected so as to provide a representative sample of the general population. A pre-processing stage registers individual images which are rescaled and rotated to a standard size and orientation relative to their pupil co-ordinates. At encoding, a given image is segmented into regular, non-overlapping blocks and each block is compared with the corresponding block from each reference face. The best match, according to a pre-defined error measure, is selected and serves to represent a given portion of the face. An index to the best matching block is stored and later used by the decoder in reconstructing the image.

At its simplest the proposed scheme represents a hybrid between vector quantisation and fractal image coding. However, the aim is to index each block in an image by a single byte of information such that a 48 x 64 pixel image, for example, could be adequately represented as a set of forty-eight 8 x 8 pixel vectors. This would permit a likeness of an individual to be stored on a single track of a magnetic swipe card. A novel technique for indexing the database is presented which employs a proprietary facial recognition algorithm to first define a region or subset of the database relative to which an individual face is subsequently encoded. This permits individual elements of the database to be indexed in 8 bits independent of the size of the database, whilst maintaining adequate image quality.

Evidence for the independence of first- and second- order vision.

Andrew Schofield and Mark Georgeson
School of Psychology, University of Birmingham, Birmingham B15 2TT.
email: a.j.schofield@bham.ac.uk, m.a.georgeson@bham.ac.uk

Signals that are conveyed by spatial variations in contrast of a carrier image (second-order signals), unlike luminance signals, do not contain a peak of energy at their own spatial frequency. Rather, their Fourier spectrum comprises energy at each spatial frequency of the carrier along with two side-bands around each component of the carrier. If the carrier is 2-D spatial noise, the power spectrum contains no salient structure at all. A simple linear Fourier analyser model would not be able to detect the second-order structure. Human observers can detect second-order signals, and this has suggested that there may be a separate second-order channel within the human visual system. Our experiments aimed to establish the extent of independence of the first- and second-order mechanisms. (i) First-order luminance contrast sensitivity functions were obtained, with and without noise backgrounds, and compared to sensitivity functions for contrast modulation, using noise as the carrier. Some difference in the shape of these transfer functions was noted. (ii) Sensitivity for second-order signals was found to increase with noise contrast, while that of first-order signals decreased. (iii) A model based on a local, first-order Fourier analyser, preceded by a compressive receptor, was unable to account for the threshold levels found for second-order stimuli. (iv) The detection of mixed first- and second-order stimuli revealed a pattern of performance that was inconsistent with both a linear summation model and complete channel independence. (v) When first- and second-order stimuli were used to mask one another, the degree of interaction between signals of opposite type was low and independent of phase. A model of human vision comprising separate channels for first- and second-order stimuli but with some (high level) crosstalk between the channels is proposed as the basis for further study.

A naive approach to visual coding

Richard Clement and Ian Moorhead
DERA, Fort Halstead, Sevenoaks, Kent, TN14 7BP

In one sense we know how the brain works - there are a collection of neurons which compute responses according to their synaptic imputs from sensory fibres and from each other - and that is all there is. The aim of this investigation was to understand how much of visual perception can be explained in terms of the simplest types of neural networks. The neural networks are assumed to have two properties: firstly they can carry out reversible coding of the input using Hebbian learning, and secondly, they can carry out irreversible coding of the input using the delta rule. The combination of these two processes enables the networks to give a least squares estimate of the physical stimulus that would need to be present to result in the given firing pattern of the neurons. This approach is most easily understood with reference to colour coding, where reversible coding corresponds to opponent colour coding and irreversible coding corresponds to estimation of the spectral characteristics of the stimulus. A more interesting extension of the approach is to apply it to the spatial domain. Do the spatial frequency channels have an optimal reversible coding corresponding to the opponent colour coding stage? Does the simple irreversible coding of the spatial channels give an estimate of the luminance profile which predicts phenomena such as Mach bands?

Spatial interactions between motion and colour.

Mark O. Scase
Department of Human Communication, De Montfort University, Leicester, LE7 9SU, UK.

In order to have reliable segmentation of moving objects the visual system has to have processes with conflicting requirements. There need to be mechanisms that can detect motion discontinuities and also mechanisms that can smooth or combine velocity signals. The differencing mechanisms are required in order to produce segmentation defined by motion and the smoothing is necessary because local motion signals can give ambiguous cues for object motion (the aperture problem). Perceptually, these mechanisms can cause motion contrast or motion assimilation, respectively. It has previously been shown that, depending on the spatial configuration, it is possible to promote either of these perceptual effects (Scase and Braddick, 1994). This previous work was performed with bright stimuli presented on a dark background. The results have now been extended by investigating whether discontinuities in mean luminance and also in colour can produce contrast and assimilation. The amount of capture and contrast have been measured in terms of the changes in motion coherence threshold of a display of random dots in the presence of an inducing region consisting of a drifting sine-wave grating. Either the grating luminance contrast was varied or the grating was isoluminant and modulated along a colour axis. If the grating was superimposed on the dots then motion assimilation occurred. If the dots were adjacent to two inducing regions then there was motion capture. These effects were found both for discontinuities in mean luminance and in colour for isoluminant gratings. Even though there is a degree of separation of motion and colour pathways in the visual system, isoluminant moving stimuli can produce these spatial motion interactions.

Reference

Scase, M.O. and Braddick, O.J. (1994) Motion contrast and capture between gratings and dots. Investigative Ophthalmology and Visual Science, 35, 2076.

Helmet mounted displays

Frank McColl.
GEC-Marconi.

Choice of waveband for target detection tasks in thermal imaging systems.

Herbert Runcieman.
Pilkington Optronics (Barr and Stroud Ltd.).

The choice of waveband for detection, recognition and identification (DRI) by thermal imaging depends on not only the characteristics of the target and the atmosphere, but on limitations of the imaging technology and the available aperture. This paper illustrates how DRI performance varies with cut-off wavelength for scanning and staring array imagers, taking into account typical atmospheres, electron storage limitations, non-uniformity, read-out noise and aperture limitations.

The analysis is based on spatial resolution and sensitivity, i.e. the effects of clutter are not examined. In the case of scanning imagers, the effective noise equivalent temperature difference including atmospheric effects is found as a function of cut-off wavelength by integration of the differential black body photon flux and the background photon flux, read out noise being included as appropriate. The atmospheres used are based upon the LOWTRAN standard atmospheres. For staring imagers, the integration time is often limited by the electron storage capacity per pixel. The spatial frequency required for the DRI tasks is defined in terms of the Johnson criteria, and a simple model of minimum resolvable temperature difference is used to generate a plot of sensitivity at the required frequency as a function of mid-band wavelength and instantaneous field of view to give a characteristic fingerprint of each detector technology.

Optics and Visual Performance.

Phil Rogers
Pilkington Optics (St. Asaph).

Electro-optics

Jim Jack
GEC Marconi, Electro-Optics Division.

Military imaging systems demand high levels of performance in very hostile environmental conditions. This paper will outline the general systems approach, indicate the typical fast jet scenario with the aid of some short video and describe the general design requirements. This will be illustrated by reference to a typical targeting system and the operational limitations will be illustrated by means of short examples of typical operational video. An indication of future directions in the search for a resolution of these limitations will be offered.

Geoffrey Burton Memorial Lecture

Image Quality

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The visual quality of an image is determined by two things: the resolution, dynamic range, and aesthetic sensibility with which the image was composed and captured, and the preservation of visual information by subsequent steps of processing, rendering, and display. While the former sort of quality must be evaluated by artists, the latter can be evaluated by scientists and engineers through psychophysical experiment and through the use of models of human vision. These experiments and models can evaluate the fidelity of the processed image, to determine whether visually significant information has been lost[1]. In this talk I will provide an overview of the elements of visual fidelity models, including light adaptation, local contrast, the contrast sensitivity function, multiple frequency channels, contrast gain control, and error pooling. I will also describe a concrete example of a particularly simple fidelity metric (DCTune) that operates directly upon the DCT coefficients that are the basis for all current image and video compression standards (JPEG, MPEG, H.261, H.263). It has been used for optimization of JPEG image compression[2-6], optimization of medical image compression[7-9], evaluation of image quality[7], spatially adaptive quantization[10], and digital watermark design[11]. Extensions of the general method to wavelets[12, 13], and to video compression will also be described. This example will illustrate the value of perceptual modeling of image quality. I will conclude with a discussion of the shortcomings of current fidelity models, and of profitable directions for future research.

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Changes in perceived image size after PRK surgery

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Before surgery HER was shortsighted and used spectacles with a prescription of RE -5.75DS, LE -2.50DS. The axial lengths were 26.51 mm for the right eye and 25.15 mm for the left eye. The calculated retinal image size (following Atchison, 1996) was greater in the right eye than the left eye by 1.1%, a minor difference that caused no fusion difficulties. She received PRK surgery for the right eye on 23.8.95 and for the left on 8.2.96. After the RE operation she was aware of enlargement of the perceptual world, which lasted for about a month. She continued to wear a correcting lens for the LE, which caused fusion difficulties, false tilt, and aniseikonia: RE images appeared larger than those in the LE. The fusion difficulties and tilt diminished slightly with time. After the second operation (when no spectacles were worn) there were no fusion difficulties or further perceptual enlargement. In a psychophysical experiment, HER made forced-choice judgements about which was the longer of two lines, one presented to each eye, thus measuring relative perceived size in the two eyes. The results showed an initial strong bias after the first operation towards judging right images as larger (7-16%), followed by a reduction to an average value of about 4%. The calculated retinal image size difference was 8.4%. The observed perceptual changes may reflect an initial reduction in image blur followed by perceptual adaptation (or increased test sophistication) of up to 5%. Alternatively, or additionally, the cortical image enlargement for the RE may be less than the calculated retinal image enlargement owing to stretching of the retina in the longer eye (Winn et al. 1988). However, the difference remained sufficiently large to prevent good fusion. After the LE operation, the calculated retinal image size difference was about 5.8% larger in the right eye. The left image was judged slightly larger (by about 2%) for about two months (perhaps due to image blur), but then the right image again appeared slightly larger. On repeating the test after an interval of nearly a year, there was a large bias towards judging the right image as larger, which diminished with repeated testing. This diminution suggests that the test results reflect test sophistication rather than perceptual adaptation.

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Defocus, ocular aberrations and the contrast sensitivity function.

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Spatial frequency selective minima (notches) in the contrast sensitivity function (CSF) have been reported in certain ophthalmic conditions. Similar notches in the CSF of otherwise normal eyes have been predicted from consideration of optical theory, yet surprisingly notches, until very recently, have been demonstrated only with astigmatic defocus. Recently we demonstrated how this can be generalised to spherical defocus (Vision Res 36: 3587). Following this, we used a full diffraction model to demonstrate that the CSF with both hyperopic and myopic defocus can be predicted very well from measurements of the transverse aberration function. These demonstrations were made under precisely controlled laboratory conditions. During a typical CSF measurement there are fluctuations in accommodation, pupil size and the alignment between eye and target. Off-axis aberrations may have a greater effect as stimulus size is increased. Hence we doubted the general or clinical relevance of defocus-induced notches in the CSF. Yet, when we measured the CSF using a polychromatic target, unrestrained head movements, active accommodation (no cycloplegia), natural pupils and spherical defocus we found notches in the CSF of a similar magnitude. Notches in the CSF were found with almost all levels of myopic defocus for all six subjects.

The spatial frequencies of the notches varied with defocus and between individuals. Multiple notches were apparent for some individuals. With hyperopic defocus, notches were only found in subjects with low amplitudes of accommodation. Increasing the stimulus size did not significantly effect the magnitude or position of notches in the CSF. The shape of the CSF measured under clinical conditions can be influenced by even small levels of defocus in some subjects. The position and magnitude of notches in the CSF is dependent on the level of defocus and the ocular aberrations. Hence careful refraction should be conducted prior to any CSF measurement.

Dark-adaptation as a model of the Parkinsonian visual system

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Parkinson's disease sufferers show a loss of contrast sensitivity at medium and high spatial frequencies. It has been suggested that the parkinsonian visual system is like the normal visual system, but is inappropriately dark-adapted.(1). The first experiment tests this by dark-adapting a group of normal subjects to see whether the results show a similar pattern to that found in Parkinson's disease (i.e. a reduction in apparent contrast, particularly at higher spatial frequencies). Subjects made judgements about the contrast of a peripherally viewed grating relative to one viewed foveally. Four spatial frequencies were investigated between 0.5 and 4.0 c/deg. In the dark-adapted condition, a 1.5 log unit neutral density filter was placed in front of the eye. The ANOVA shows an interaction between dark-adaptation and the spatial frequency of the gratings. Dark- adapting reduces the apparent contrast of the high-spatial frequency gratings only. Thus dark-adapting produces similar changes to those found in Parkinson's disease, and provides a model of the parkinsonian visual system in normal subjects. In a second experiment, the model was used to investigate the underlying mechanism which mediates the observed change in apparent contrast. Subjects were now required to make judgements about the apparent spatial frequency of the peripheral gratings. ANOVA shows no effect of dark-adapting on the apparent contrast of peripherally viewed gratings at high spatial frequencies produced by dark-adaptation (and seen in Parkinson's disease) is mediated by changes in contrast gain (2) rather than reorganisation of receptive field sizes (3). This conclusion will be discussed and reconciled with evidence that receptive field sizes change do due to dark-adaptation.

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Posters

Second-order vision requires second-order calibration.

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Human vision can detect information conveyed by both second-order, non-Fourier modulations of image contrast, and first-order modulations of luminance. This has led to models of human vision, especially motion perception, that include distinct channels of first- and second-order processing. We consider here some of the technical difficulties posed by experiments on second-order vision. It is possible to convert variations in contrast into variations in luminance by the introduction of almost any non-linearity. Unfortunately there are several sources of non-linearity, external to the visual system, that could produce artefactual first-order cues in ostensibly second-order images. Two such sources of artefact, local DC biases in the image itself, and the adjacent pixel non-linearity (APNL) were investigated. Clumps of light or dark pixels in the carrier introduce patches of luminance variation which could be detected by a first order system (Smith & Ledgeway, 1996). We show by experiment and by simulation that these biases can be avoided by careful selection of the noise element size and modulating frequency. The golden rule is to have at least 4 noise elements per period of modulation. APNL is related to the nonlinearity inherent in all cathode ray displays but it cannot be countered by simple gamma correction. Its effect is to reduce mean luminance in

areas of high contrast. Full correction against APNL requires costly recalculation of pixel values (Klein, Hu & Carney, 1996), but the problem can be minimized by careful consideration of image resolution and contrast.

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Gaze displacement with a moving visual frame

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We report performance data for a task in which subjects shift their direction of gaze in order to compare (same/different) letter triplets presented at two horizontally separated locations. The task is comparable to searching tabulated data (as in a spreadsheet), or to looking from one display window to another. Error rates and response times have been measured with no visible frame, with a surrounding frame and with a frame which undergoes a downwards displacement while the displacement of gaze is taking place. The latter condition increased the probability of a response based on the triplet presented below the location of the correct target and gave longer response times. In a further experiment the frame was either static, or displaced either upwards or downwards. Subjects' responses of same/ different were derived from the triplet in a position displaced in the same direction as frame movement. This task has also been examined with varying screen refresh rates (65, 89 and 126 Hz). No significant effects of refresh rate were found, which implies that this task may not be influenced by display intermittency in the way that reading linear text is known to be.

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References supplied (as usual!) by:

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Meetings Calendar

1997

May 11-16	*ARVO* Fort Lauderdale, USA http://www.faseb.org/arvo/
July 5-9	IRGCVD 14th meeting, Ghent, Belgium email: coa09@keele.ac.uk http://orlab.optom.unsw.edu.au/IRGCVD/
August 24-29	ECVP Helsinki-Espoo, Finland email: ecvp97@helsinki.fi http://www.psych.helsinki.fi/ecvp97
September 4	*AVA meeting on depth perception*. University of Surrey. email: M.Bradshaw@surrey.ac.uk
September 14-17	*Vision in Vehicles 7*, Marseilles, France. Contact: 01332-622287, email: avru@derby.ac.uk
November 5	*AVA postgraduate meeting*. College of Optometrists, London. Contact: 0171 373 7765
November 19-20	Brain mechanisms of selective perception and action. The Royal Society, London. http://www.royalsoc.ac.uk/rs/