Title

Conference report – International Congress of Imaging Science 2006.

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Abstract

This paper reports on ICIS 06. It is a personal perspective as the conference consisted of over 200 technical papers in 4 parallel tracks. The conference took place in Rochester NY, partly at the Rochester Institute of Technology. In addition to the 4 tracks there was a wide ranging tutorial programme and the conference finished with a seminar on the Frontiers of Imaging.

The conference covered all aspects of Imaging Science. Although digital imaging played a large part there were substantial contributions on new silver halide based imaging technologies.

The RPS is a member society of ICIS.

CONFERENCE SUMMARY

This meeting was the 30th International Congress of Imaging Science (ICIS) and was held in Rochester, New York from May 7th – 11th 2006. These meetings currently take place every 4 years, the first being in 1889 at the World's Fair in Paris. For many years it was called the International Congress of Photographic Science, the name being changed to reflect the recent expansion in imaging applications. The scale and focus of this conference duly reflected this change.

The RPS is a member society of ICIS.

The conference started with a plenary session and then divided into 4 parallel tracks with over 200 papers. These included a symposium investigating the Frontiers in Imaging on the final day. The Rochester Institute of Technology also arranged a tour of selected facilities and hosted a reception. As Rochester is also home to Eastman Kodak and Xerox these 3 organisations contributed significantly to the content of the congress. In addition there was a large contribution from Fuji Photo Film.

As the conference had 4 tracks this is a personal snapshot of approximately 25% of the conference. However, I hope that it will give you a perspective of the breadth and depth of the papers presented. Further details can be found on the conference web presence under http://www.imaging.org/conferences/icis06/index.cfm. I look forward to ICIS in 2010!

1.1 Track 1 – Digital and Analog Capture

The track started with a session on progress with the optics and processing systems for digital cameras. There were some particularly interesting papers on image artefacts produced by these systems and what is being done to correct these. A further session looked specifically at developments in image sensors for photography, video and high dynamic range applications. The session had a good mix of papers on both CMOS and CCD technology. It gave an excellent snapshot of the evolution of these technologies and some indications of what is to come.

1.1.1 Digital image sensors

A review paper on CMOS image sensors from Fairchild Imaging summarised the situation well. Image sensors using Metal Oxide Semiconductor (MOS) technology were devised in the 1960s when the existing technology for electronic image capture was the Vidicon tube. The Vidicon was a mature technology with more than 30 years development for television cameras. Although the image quality of the Vidicon was excellent size and weight disadvantages spurred on the development of MOS sensors. As MOS sensors had noise problems they were forced into limited applications by the advent of Charge Coupled Device (CCD) technology in 1969. Throughout the 1970s CCD technology dominated the image sensor market because of better noise performance. However, they were produced by a few companies for limited applications. As a result other organisations furthered the development of Complementary Metal Oxide Semiconductor (CMOS) image sensors. One specific advantage of CMOS technology is that it has a higher radiation tolerance than CCD making it attractive for military and space science applications. In addition it could be produced by many different semiconductor foundries and can have signal processing systems integrated on the same chip.

As a result the 1990s saw rapid development of CMOS image sensor technology. By the turn of the century it became clear that while CMOS had advantages for high speed cameras CCD was still better for many other applications such as astrophotography. However, the gap is narrowing as CMOS sensor development work is being funded by the rapidly expanding camera phone market. Advances in technology are enabling smaller pixels, higher resolution and better low light performance at almost fixed price. Current state of the art CMOS pixel pitch is between 2 µm and 2.5µm.

A paper in this session from DALSA Professional Imaging looked at CCD image capture devices aimed at professional digital imaging applications. It charted the progress from 6 and 11 Mpixel units in 24mm x 36mm format in 1998 and 2001 to 22Mpixels on a 36mm x 48mm format in 2004. It featured 2 new sensors. The first was a 33Mpixel imager with a 36mm x 48mm format for studio photography where resolution is seen to be a major driver. The second was a 28Mpixel unit with a 33mm x 44mm format for social photography where higher sensitivity and less storage capacity is required. These are intended for use in professional camera backs and large format digital SLR cameras and both employ 7.2µm square pixels with an optical fill factor of 70%. The higher sensitivity of the 28Mpixel unit is achieved by giving users the option of “binning” 4 pixels together to increase sensitivity, signal to noise and frame rate.

A paper from Eastman Kodak described an APS size 10Mpixel image sensor using 6.8µm pixels with an optical fill factor of 69%. However, each pixel has a microlens overlay to increase the effective fill factor to 78%. Quantum efficiencies of 35, 42 and 38% (RGB) were reported for the individual pixels at their peak wavelength sensitivities.

An interesting alternative to the dominant Bayer colour filter array is to allow image sensors to directly separate RGB image colours by virtue of their intrinsic absorption of light. By eliminating the need for the Bayer filter more of the incident light could be utilised and the need for low pass filtering for Moiré suppression is removed. Two papers were read on this concept. The first was given by representatives from Foveon. Their X3 imaging technology enables colour separation to be done within the depth of a silicon image sensor. While this technology imparts significant benefits there are still some design challenges such as image noise. The second paper from Fuji Photo Film described an experimental system fundamentally similar to the Foveon concept.

A later paper from Fuji and Mitsubishi explored a further alternative – using a monochrome camera and colour filters. This system, also used in multi-spectral imaging was shown to give high resolution and colour fidelity.

Some of the optical effects that can be produced by these sensors were also covered in this track by Kodak. Design methods using optics and spatial frequency filters for anti-aliasing were discussed as was the problem of lens dependent hue shift, caused by optical cross-talk. These papers emphasise the point that optics and sensor should be designed and considered as a complete imaging system.

A paper from the universities of Oxford, Alberta and Shizuoka described prototype CMOS image sensors with logarithmic light response. These are capable of simultaneously imaging more than 6 decades of light intensity which exceeds both CCD and other CMOS technologies. A further paper from Oxford

investigated methods of tone mapping to enable this technology to be applied in practice.

1.1.2 Digital camera applications

One of the reasons for my presence at this congress was to present a paper on digital imaging trends in consumer astronomical photography. The paper was written in collaboration with Cape Instruments, a manufacturer of high quality astronomical telescopes based in the UK. The paper shows that compact telescope optical design has progressed over the last few years with greatly enhanced price / performance ratios. These optical designs are now capable of much enhanced imaging performance and will very likely see applications outside of astronomy in the near future. As a result of the flat image fields of these designs there is now a significant market in electronic imaging devices for consumer astronomical photography.

An interesting piece of market research was presented by Seoul National and Syracuse universities on the relative perceptions of camera phones and digital cameras. The study, conducted in Korea found that these devices are substitutes and not complements which has obvious implications for the marketing of both types of device.

1.1.3 Analogue capture

A further session in this track was devoted to current developments in silver halide materials and systems. It was interesting to note that for all the emphasis being placed on digital photography significant research and development effort is still going into silver halide systems and sensitising dyes in Japan, Asia and the USA. While some of this is focussed on nanotechnologies there is still work going on in “traditional” photo imaging.

A paper presented by the ICIS President showed that there was still room for sensitivity improvements in colour films and work continues on this at Fuji Film. It was also pointed out that silver halide films are not prone to the sort of aliasing issues described above! Further papers from Kodak and Fuji showed advances in spectral sensitivities, reducing unwanted absorptions to increase colour fidelity. These papers also showed a good combination of objective and subjective measures of image quality.

1.2 Track 2 – Hard Copy and Photo Printing

This track started with presentations on electrophotography and photothermography. It continued with a session dedicated to silver halide systems and photofinishing. New business models, moving from centralised photofinishing to kiosk services were explored together with automatic image quality enhancement algorithms. Papers from Fuji showed work on colour papers and couplers, emphasising again the continuing work on silver halide systems. This session finished with another of my papers, this time on glass plate applications. The aim was to show how a century of photo experience with glass plates can be relevant to the future of imaging, particularly as we move into the age of Digital Fabrication.

1.2.1 Image Permanence and New Media

The session consisted of 8 oral papers covering a number of interesting themes and I was privileged to chair this session for ICIS.

The first 2 papers covered topics pertaining to accelerated aging tests for image permanence. As ISO standards for these tests are currently under development these contributions were particularly pertinent.

The second 2 papers were on subjects broadly about printed image gloss. The first covered the production of different gloss surfaces on thermal dye transfer prints, the second the visual perception of gloss on unprinted inkjet media.

The session then progressed onto 4 papers covering a wide range of new media and image recording topics. The first covered new techniques for document security targeted primarily at personal identity documents. The second covered the fabrication of functional structures by ink jet printing. It was particularly useful to be able to view a further poster on this topic during the "ICIS at RIT" reception that afternoon. The third paper covered a method to multiplex and address the increasing number of nozzles in ink jet print heads. The final paper covered development in organic optical recording media.

1.3 Track 3 – Image Science

The ongoing work being done at Kodak NexPress on the use of flatbed scanners for the evaluation of colour print graininess was presented in this track. The process is now capable of extracting the screen patterns in printed pages before computing the graininess and shows great promise with good correlation with perceived graininess.

A paper in this session described some work in progress on classification techniques for infrared spectra of stars gathered by the Spitzer Space Telescope. The study looked at the spectra of mass- losing asymtotic giant branch (AGB) stars. These very luminous red giant stars may be obscured by optically thick, dusty and expanding circumstellar envelopes. These dust clouds obscure the light at visible wavelengths but re-radiate in the infrared. This means that the objects can be investigated using the Spitzer Space Telescope Infrared Spectrograph.

A series of spectra of stars in the Large Magellanic Cloud were used in this study. This is our nearest neighbour galaxy and contains a large population of such objects at more or less the same distance which can act as models for objects in more distant high-redshift galaxies.

The aim was to classify these spectra into specific broad types using unsupervised computer algorithms. The first type is surrounded by carbon rich ejecta such as Silicon Carbide or Acetylene. The second are those with oxygen rich ejecta and the third are stars with spectra biased to long wavelengths and with narrow emission lines. These represent young, luminous stars embedded in star forming clouds.

Some of these models appear to work well and these may be applicable to stars in other systems.

1.4 Track 4 – Display Technologies

The last 10 years has seen an explosion in flat panel display technology and a paper from Kodak summarised the progress on Organic Light Emitting Diode (OLED) technology for this. As LCD displays need a backlight they are limited in how thin they can become. As OLEDs are by definition an emissive technology they have no such constraint and as half-lives now approach 100,000 hours they are becoming a practical alternative and prototype 40 inch displays are now being fabricated.

Some of these display technologies are adding a white emitter to produce a RGBW display to enhance luminance. However, some of these would appear to have sacrificed colour fidelity for light output. A paper from Kodak explored these issues with reference to a RGBW OLED display, showing the design constraints, benefits and trade-offs of this technology.

A paper from Kyung Hee University, Korea charted the progress of LCD technologies. Technologies for fabricating these devices, including inkjet printing were discussed, as were display sizes up 82 inches for LCD to 102 inches for plasma display. In a later session a subjective and objective comparison of these 2 display technologies was presented from Chiba University, Japan. The objective measurements were done by gonio-photometry and the subjective by paired comparison. The objective rating tended to a preference for plasma display while the subjective evaluation found plasma display to be best for dark scenes but LCD for lighter scenes.

1.5 Tutorials

The conference offered a strong programme of 19 tutorials covering a wide range of imaging topics. One of the most popular one appeared to be Professor Robert Hunt's tutorial entitled "The Basis for Accurate Digital Imaging". I mentored one on "Papermaking, Coating Fundamentals and Media for Digital Printing" which proved to be very interesting and informative. I also presented a tutorial entitled "Industrial Inkjet Technology and Applications". The aim was to explain the fundamentals of inkjet technology and the applications to both established conventional printing and the emerging Digital Fabrication areas. The tutorial will be repeated at the Non Impact Printing and Digital Fabrication conferences in September 2006.

1.6 ICIS at RIT

The conference spent an afternoon as the guest of the Rochester Institute of Technology (RIT). I spent most of the time in the Image Permanence Institute with the students on the Residence programme discussing photo imaging.

Later in the afternoon we were privileged to have a presentation by James Crocker, Vice President Civil Space at Lockheed Martin who gave his perspective on "The Vision for Space Exploration". In addition to leading the team that developed the COSTAR optical fix for the Hubble Space Telescope he managed the design teams for the Very Large Telescope in Chile and the Sloan Digital Sky Survey. He also worked on a number of other Hubble and Skylab programmes so his experience is very wide. As a result his presentation was wide ranging and very informative, covering the discoveries made using space imaging systems in the past and those planned for the future.

The visit was also a chance to see a display of student posters from RIT which were of uniformly high quality.

1.7 Frontiers of Imaging

The final day of the conference consisted of a series of presentations exploring the frontiers of imaging.

A session on image processing tools from Rodney Shaw looked at novel, automatic algorithms for image enhancement of consumer prints which were demonstrated real time. There was also significant medical colour imaging content to this session.

Of particular interest was a presentation from ITT on imaging chain analysis for space imaging systems. Imaging chain analysis seeks to break down into individual elements the imaging process from capture through processing to display. Examples of the use of this technique for earth-looking satellite imagery were shown in this presentation. In particular the presenter concentrated on the use of sparse aperture mirrors for space imaging. These are mirrors with areas removed to reduce weight for rocket launch.

The paper demonstrated the benefit of Modulation Transfer Function (MTF) and detected signal to noise ratios as metrics of image quality. In addition to optical obstructions reducing the MTF of the imaging chain it was also shown that increased obstruction has a serious effect on signal to noise ratios of the image.

1.8 Conclusions

ICIS 06 provided en excellent snapshot of the progress being made in Imaging Science technology and applications. As it takes place every 4 years it is a good forum to see reviews of recent progress in this field.

It is also a truly international conference with contributions from manufacturers, academia and user groups. I would recommend a visit to ICIS 2010!