Report on the latest ASPRS Symposium on Remote Sensing

Pecora-17 – The Future of Land Imaging

The ASPRS Pecora Symposium is only held once every three years. Without doubt, it is one of the most important conferences on remote sensing that is held in the United States. The 17th edition of the Pecora Symposium was held at the Sheraton Hotel in Denver, Colorado between 16th and 20th November, 2008.

By Gordon Petrie

Fig. 1 A–E: The Operational Land Imager (OLI) that will be utilized on the Landsat Data Continuity Mission (LDCM).

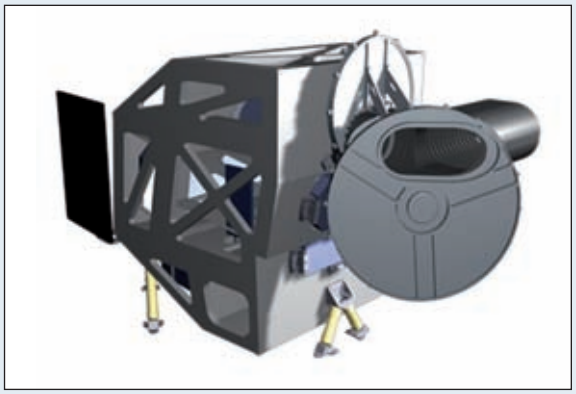

Fig. 1A: A drawing of the imager mounted in its supporting frame.

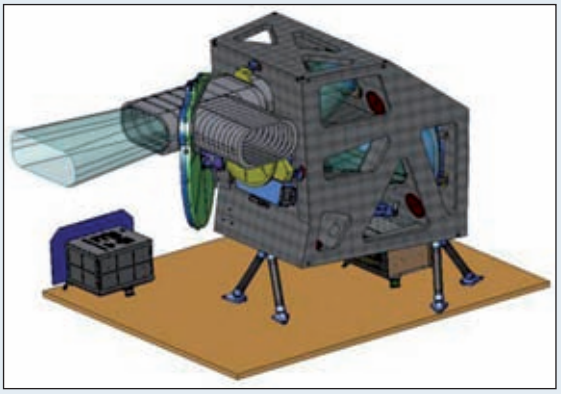

Fig. 1B: The pushbroom scanner concept of the OLI imager.

This marked the return of the Symposium to the city where it had been held previously in 1999 and 2002. In this respect, Denver is a major centre of the industry with Lockheed, Raytheon, Ball Aerospace, DigitalGlobe and GeoEye (formerly Space Imaging) all having major facilities located either in or close to the city. Besides which, many of the sponsors of the Symposium were the major U.S. Federal government agencies that are involved in remote sensing. They included NASA, NOAA, USGS, NGA, USDA, EPA and the National Park Service (NPS) – most of which also have operational centres or units located either in the Denver metropolitan area or in the adjacent towns of the Front Range of the Rocky Mountains. The sponsorship of the Symposium by these Federal agencies underlined the special importance of the meeting to the government sector.

The same agencies also contributed strongly to the Symposium's programme of activities, especially in terms of providing speakers and in swelling the overall number of participants (which reached a total of 550).

Overall Programme

The first two days (16th and 17th November) of the Symposium were really a preliminary to the main event, being devoted to a series of concurrent workshops. These were concerned with the processing, analysis, interpretation, classification and measurement of remotely sensed imagery. The remaining three days (18th to 20th November) comprised the main part of the Symposium. They included a series of "general sessions", that were held on their own with no competition from other presentations. These plenary sessions were separated by a series of "technical sessions", which comprised numerous lectures on specific themes or subject areas than ran simultaneously in six parallel streams. The various oral and visual presentations given in these general and technical sessions were further supplemented each day by various "poster sessions". All of which provided plenty of choice for the participants, enough to satisfy every type of interest. However this also meant that it was impossible for anyone to attend more than a small fraction of the overall lecture programme. Besides these sessions, there was also a fairly substantial technical exhibition running simultaneously over two days of the Symposium (on the 18th and 19th of November). This featured not only the large stands of the many Federal government agencies mentioned above, but also the booths of numerous prominent commercial system and software suppliers and service providers. These included BAE Systems (SOCET GXP software); Leica Geosystems (ADS80 pushbroom scanner and RCD105 frame camera); Applanix (DSS camera); DiMAC Systems (digital airborne cameras); ITT Systems (ENVI software); Optech (with its new Lynx and Orion laser scanners); Riegl (with still more scanners!); Cardinal Systems (with its Vr line of digital photogrammetric software); Overwatch Geospatial (Remote View + Feature and Lidar Analyst software}; ESRI (GIS software); and many more!

General Sessions

All five of these general sessions were held in the impressive Grand Ballroom of the Sheraton Hotel that had been converted for the purpose.

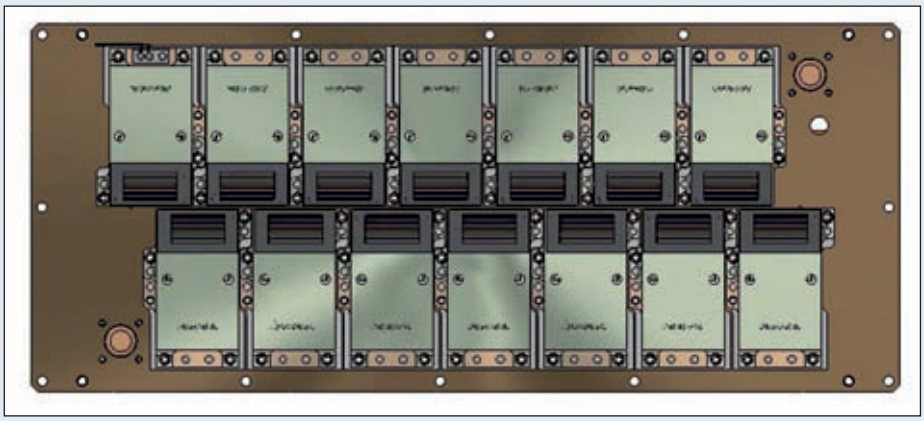

Fig.1C: The layout of the focal plane modules in two banks of seven modules within the focal plane.

General Session I was held on the morning of 18th November and acted as the opening session of the main part of the Symposium. It had the title "From a Vision in the '60s to an Operational Program in the 21st Century". The keynote speaker was Berrien Moore, who was the leader of the Inter-governmental Panel on Climate Change, and a shared recipient of the Nobel Peace Prize in 2007. Dr. Moore spoke lucidly about the complexities and instabilities of climate change, the effects of atmospheric carbon and the melting of glaciers and ice-sheets and the steps needed to try to stabilize the situation. He was followed by Gene Whitney, who formerly worked in the White House Office of Science and Technology and gave a really insightful account of the steps that need to be taken to educate and persuade politicians about the value of a fully operational Landsat programme. In this, he was backed by the third speaker, Kass Green, the president of ASPRS, who set out the case for the planned National Land Imaging Program (NLIP) to be implemented.

The next ***General Session II***, which was held in the afternoon of the 18th, was devoted to the "Insights and Visions of Land Imaging as Seen Through the Eyes of Past Pecora Award Recipients" – and was given by four of these past recipients. This was followed by the presentation of the 2008 Pecora Awards. The individual award was made to Prof. Sam Goward of the University of Maryland for his leadership in ensuring the continuation of the Landsat Program. The group award was given to the QuikSCAT Mission team comprising individuals from NASA, Caltech's JPL laboratory, Ball Aerospace and the University of Colorado. The global measurements of microwave backscatter and surface wind speed and direction that are being made by the satellite's instruments over the world's ocean surfaces have greatly improved weather forecasting, especially over oceanic areas.

General Session III, which was held in the morning of 19th November, was concerned with "Satellite-borne Radar in Today's Remote Sensing Community". As the speakers showed, with the advent of the Japanese PALSAR L-band radar (mounted on the ALOS satellite); the Canadian Radarsat-2 with its C-band SAR; and the two new Italian COSMO-SkyMed satellites and the German TerraSAR-X with their X-band SAR systems (besides the existing ESA and Radarsat-1 satellites), the situation regarding the availability of radar imagery has been totally transformed over the last two years. Furthermore, in the near future, the remaining COSMO-SkyMed and TerraSAR-X satellites will be coming into operation, together with the Indian RISAT with its C-band SAR. For the longer term, various Russian radar satellites, the ESA Sentinel-1 and the SAOCOM satellites from Argentina are all currently under construction and will be added to the fleet. Judging from the remarks from the audience that followed the presentations, all of this information made rather painful listening for the majority of the audience – since there are no American civilian SAR satellites in orbit. All the various proposals, such as JPL's LightSAR, have not been implemented due to lack of funding on the part of NASA.

General Session IV, which was held in the afternoon of the 19th, was entitled "Availability of Multi-Spectral Spatial Data from Non-US Providers". This gave the platform for John Ahlrichs of RapidEye; Nicolas Strassi of the U.S. branch of SPOT Image; David Hodgson of DMCII; and Tim Puckorius of EOTec, representing the Indian Antrix Corporation, to provide interesting information on their respective medium-resolution satellites and image products. Again it was easy to discern and understand the frustration expressed by some of the audience regarding the current U.S. situation in this area. Landsat-5 is nearing the end of its operational life after 25 years of very successful service, while Landsat-7 is limited in its data collection capabilities by the failure of its scan line corrector mechanism. For the American remote sensing community, the forthcoming Landsat Data Continuity Mission (LDCM) cannot come into operation soon enough. However, it will be

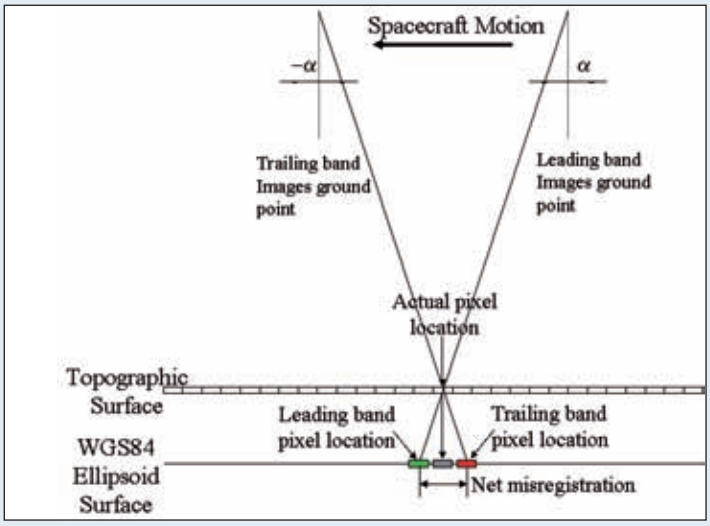

Fig.1D: Diagram of the small parallax that results from the twin bank layout of the focal plane modules.

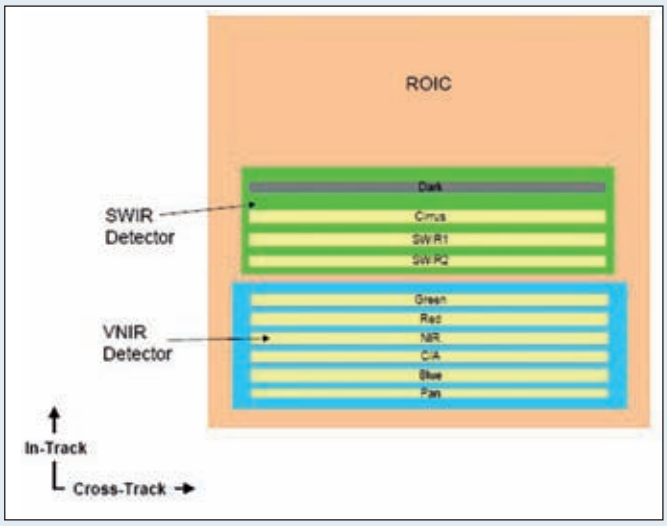

Fig.1E: The detailed layout of the spectral bands within an individual focal plane module. (Source: Ball Aerospace)

Fig. 2A The NASA Ikhana UAV, which is a modified Predator-B unmanned aircraft, is shown in flight.

Fig. 2B The NASA Ikhana UAV is being checked out on the ground – note the under-wing pod which houses the imager.

2011 at the very earliest before it can be launched and brought into service. Furthermore a commitment to building another satellite in the series needs to be made soon if data continuity is to be assured for the future.

General Session V, which also acted as the closing session of the Symposium on 20th November, had the title "Entering a New Landsat Era – the Future is Now". In this respect, it had already been preceded by two technical sessions on the LDCM, each comprising four papers, that had been held on 18th November. These gave very detailed information about the satellite – which is due to be called Landsat-8 after it has been launched. The contract for the construction of the satellite platform has been awarded to General Dynamics Advanced Information Systems; the Operational Land Imager (OLI) is already being built by Ball Aerospace; the Atlas-5 launcher will be supplied by the United Launch Alliance (of Lockheed + Boeing); while the contract for the Mission Operational Element (MOE) has been awarded to the Hammers Company based in Greenbelt, Maryland. NASA is responsible for the provision of the spacecraft, imager, launch vehicle and support services using these contractors. The USGS will then take over the operation of the satellite after its successful launch and check-out. Thus USGS is providing the mission operations centre and ground processing systems, as well as the flight operations team.

Fig. 2C The Autonomous Modular Scanner (AMS) thermal-IR imager is being loaded into the under-wing pod prior to being mounted on the wing of the Ikhana UAV.

Of special interest to the audience were the details of the ***OLI imager*** [Fig. 1 (a) & (b)] All the previous Landsat missions had used an optical-mechanical whiskbroom scanner for the acquisition of their ground images. By contrast, the OLI imager on the LDCM will be a pushbroom line scanner. However, instead of this using a set of parallel CCD linear arrays for the acquisition of its multi-spectral imagery (as in the SPOT and IRS satellites), the OLI will utilize two sets of focal plane arrays (FPAs) – which are essentially area arrays. Since these arrays cannot be butted together to form a continuous line, they are arranged in two banks, each of seven arrays, that are offset relative to one another to ensure that a continuous swath image of the ground will be produced by the OLI imager in the cross-track direction [Fig. 1 (c)]. This arrangement will result in some complications during the subsequent processing of the image data. In particular, when the individual images are merged together, a small parallax may be present between the images of specific ground objects that will be recorded by the two separate banks of FPAs [Fig. 1 (d)]. This effect will need to be eliminated during the image processing operations that will be carried out by the ground processing system.

Compared with the ETM+ imager on the previous Landsat-7 satellite, the OLI imager will feature two additional spectral channels [Fig. 1 (e)]. The first is an "ultra-blue" band centred at 443 nanometres for use in coastal and aerosol studies, while the second is a band centred at 1,375 nanometres in the short-wave infra-red (SWIR) that is intended for cirrus cloud detection. At the present time, no thermal-IR bands will be acquired during the mission.

Unmanned Aerial Vehicles (UAVs)

Besides the general and technical sessions on the LDCM, I also attended those on UAVs. In total, the various sessions on this particular subject area virtually constituted a special symposium on UAVs within the overall Pecora-17 Symposium – since it continued as an overflow meeting or workshop that 58 of us attended at the USGS facility in Denver on the day (21st November) after the main Symposium at the Sheraton Hotel had formally closed! In total, 13

Fig. 2D NASA engineers check out the planned flight paths prior to the take-off of the Ikhana UAV on a fire monitoring mission in California. (Source: NASA-DFRC).

Fig. 3 – One of NASA's Global Hawk UAVs is being pushed back into its hangar at the Dryden Flight Research Center (DFRC) in California. (Source: NASA-DFRC)

papers on UAVs were given in three technical sessions in the main Symposium held at the Sheraton, while a further 9 presentations were delivered at the follow-on workshop held at the USGS facility. The authors of these 22 papers on UAVs came almost exclusively from U.S. Federal government agencies and armed forces.

The biggest player by far in all of this non-military UAV activity is NASA. The agency has acquired a Predator-B UAV from General Atomics, the manufacturer of the standard medium-altitude military Predator-A UAV. The NASA aircraft has been christened "Ikhana", which is the Chocktaw Indian word for "intelligent" or "aware". It is fitted with longer wings; a distinctive Y-shaped tail; and a turbo-prop engine to provide greater control, a higher operational altitude and a longer range than the standard military reconnaissance version of the Predator [Fig. 2 (a)]. The aircraft has already had considerable involvement in the monitoring of the wildfires and firestorms that are an annual occurrence in California. Indeed the Ikhana aircraft flew four long-duration missions over Southern California during the 2007 fire season and a further three missions over both the northern and southern parts of the state in 2008. For these missions, the Ikhana UAV is fitted with a special pod that is attached to one wing of the aircraft [Fig. 2 (b)]. This contains the Autonomous Modular Scanner (AMS), which is a modified and re-built version of a Daedalus multi-spectral scanner that is used as a thermal imager during these fire monitoring missions [Fig. 2 (c)]. The Ikhana UAV also has an on-board image processing facility. The processed data is sent via a radio link through a communications satellite to different command centres that can then pass the resulting information to the fire-fighters on the ground [Fig. 2 (d)].

NASA has also acquired two flyable Global Hawk UAV development aircraft from the USAF that can fly at altitudes greater than 50,000 ft. with an endurance of over 30 hours. It plans to use these aircraft on very long-range and long-duration missions to carry out research over the oceans and the cryosphere (glaciers, ice sheets and ice caps) in partnership with NOAA. The first flights in this collaborative programme will be made from NASA's Dryden Flight Research Center (DFRC) at the Edwards Air Force Base located in the Mojave Desert of California, where NASA is building a special ground control station for the Global Hawks [Fig. 3]. The planned flights from the Dryden DFRC include long-range flights carrying out oceanic and climatic research over the Pacific Ocean and flights to Alaska and onwards over the Arctic Ocean to monitor the extent of sea ice. Later flights from the NASA flight facility in Wallops Island, Virginia are planned over the Greenland ice cap and over the tracks of the hurricanes that ravage the Atlantic and Gulf coasts of the United States. Still further flights are planned over Antarctica based on the Royal Australian Air Force (RAAF) air base located at Edinburgh, near Adelaide in South Australia.

Besides NASA's activities, the Customs & Border Protection (CBP) agency of the U.S. Department of Homeland Security is also operating two long-endurance Predator-B UAVs equipped with imagers that are used routinely to patrol parts of the country's southern border with Mexico to help detect illegal immigrants and drug smugglers. Two more Predator-B aircraft are now entering service with the CBP, for the monitoring of the northern border with Canada. Still further UAV activities have involved the use of military Global Hawk and Predator aircraft to provide assistance to the civilian emergency services by monitoring and imaging the after-effects of disasters such as floods, earthquakes, hurricanes and wildfires. At the other end of the scale, there was a delightful and informative presentation by Dana Sullivan of the USDA about her routine use of a small model aircraft to acquire thermal-IR imagery of research plots in irrigated areas of Georgia and Alabama. It was a pity however that there were no presentations from any of the commercial operators of low-altitude robotic mini-helicopters – who now appear to operate quite substantial numbers of these tiny UAV aircraft to acquire aerial photography, even though the regulatory side of this activity is far from clear.

Summary

I benefited greatly from my participation in this excellent and well organised Symposium. It fully reflected the facts that, in the United States, (i) civilian use of UAVs for remote sensing purposes is now becoming a reality, and (ii) the Landsat programme is getting back on track through the implementation of the LDCM.

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