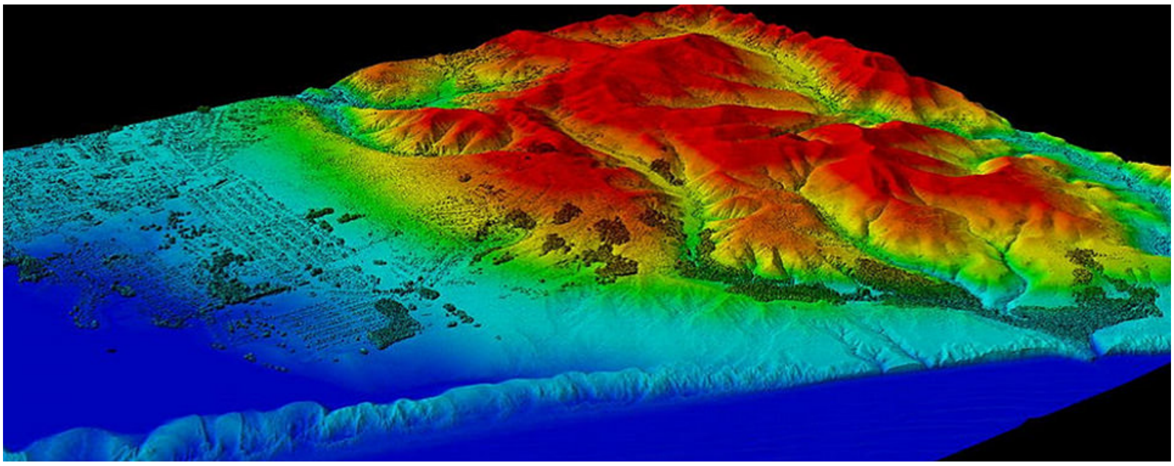
Centre for EO Instrumentation & Space Technology

## Future Challenges for EO Instruments in New Remote Sensing Applications



*A LIDAR (Light Detection and Ranging) image created with data collected by NOAA's National Geodetic Service.*

Remote sensing has tremendous potential to help us manage the modern world and our planet. Applications and services are already emerging in markets such as Fire & Rescue, inspection of oil & gas rigs, and survey work, while emerging markets such as precision agriculture, international development, environmental monitoring, and management of natural resources are rapidly developing. In parallel, the miniaturisation of remote sensing instruments is converging with the increasing payload capabilities of the rapidly emerging commercial UAV market, enabling a whole new range of applications and services.

And yet this potential is not being realised as fast as the market opportunities are emerging. Why? The core of the issue goes back to the original purpose of remote sensing and earth observation instruments. The large majority, especially those on satellite platforms, are designed and deployed for scientific research objectives. As a result, their performance profile makes it difficult for the data they produce to be utilised fully in commercial applications for which they have not been designed. It is only now, with the Copernicus constellation of satellites starting to be deployed, that remote sensing data suitable for many types of commercial services will become available, with reliable long-term delivery guaranteed.

A recent Industry Consultation Workshop run by the Centre for Earth Observation Instrumentation and Space Technology (CEOI-ST) explored this issue and examined the key challenges facing remote sensing instrumentation if it is to be adopted more widely in commercial applications. The round table discussion focussed on three areas: earth observation instruments; instrumentation for unmanned aerial vehicles; and remote sensing data (sources, provenance, characterisation (e.g. meta-data), and quality).

The major challenge for commercial applications in earth observation is temporal resolution; spatial resolution is generally sufficient for current and potential applications. Substantial improvements in temporal coverage (i.e. the frequency and length of time a satellite is over a specific geographic location and able to image the ground) will enable a wide range of new applications, including "persistent" monitoring. Nanosats are one route to addressing this issue as the reduced cost of deployment makes larger constellations with more frequent revisit rates economically viable. Their ability to provide continuity through redundancy and rapid replacement of failed satellites can give commercial companies the security of service needed. However, the size, weight, cost, and power needs of EO instruments need to be reduced substantially, whilst delivering adequate performance, if this is to become a reality.

Commercial thermal imaging may be the next big opportunity in earth observation. DMCii revolutionised optical imaging, while NovaSAR is revolutionising radar imaging. Not included in the Copernicus constellation, missions providing reliable, long-term thermal imaging may open up significant new markets.

There are also major future opportunities for hyper-spectral imaging, especially with high spatial resolution. However, current temporal resolution is insufficient, there are significant calibration issues, and data interpretation is sufficiently complex to be a major barrier to adoption. This issues will need to be resolved if hyper-spectral imaging is not to remain a research tool.

The civil use of UAVs and the number of commercial applications has started to grow rapidly over the past year, as has interest in their wider exploitation. The main emerging applications are imaging and survey using video cameras, still cameras, and a limited amount of Lidar. Hyper-spectral imaging is just starting to be evaluated. The main markets for these UAV applications are media, utilities, oil & gas, and property.

UAVs and earth observation satellites have vastly different spatial and temporal coverage, and UAVs have the potential to fill the gaps caused by the orbit and swath width limitations of many satellites, resulting in better solutions by combining data from these two sources for a wide range of current and emerging applications. Emerging market opportunities include insurance, agriculture, oil & gas, mining, support for data services such as mobile and fixed telcos, and maritime.

This combined approach could be a “game-changer” but there are a range of challenges that need to be addressed if UAVs are to achieve this. They include:

- Major reductions in the weight, size, cost, and power consumption of remote sensing instruments while providing performance that is fit-for-purpose. The regulatory limit for UAVs (airframe / fuel / payload) is 40 Kg with airworthiness certificates, and 20 kg without. Wide spread deployment of remote sensing instruments on UAVs is dependent on overcoming these constraints.
- A better understanding of the current and future applications to enable optimum data types and datasets to be identified and new techniques for combining them effectively to be developed. Meta data from these sensors is also a key issue in order to enable the outputs to be incorporated into different applications.

In the data arena, a translational tool is needed that enables users to find databases with right spatial and meta-data attributes for their applications. There are further significant challenges in using remote sensing data, including standardisation of meta-data; gaps in data sets; inter-operability of data; data management; data fusion and synthesis from different data sets. Finally, quality assurance of data is a growing problem as data volumes get larger.

Funded by the UK Space Agency, the mission of the Centre for EO Instrumentation and Space Technology (CEOI-ST) is to stimulate and support the development of remote sensing capabilities that will enable the next generation of instruments and missions. The CEOI-ST strategy will continue to address the issues of size, weight, cost, power consumption, calibration and ground-truth referencing of instruments. The additional issues identified will be highlighted to Government and relevant other bodies.

Further information about this technology and others funded by the CEOI can be found at www.ceoi.ac.uk.

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