A Dual-Swath BuckEye EO Imaging System and its Applications for Emergency Response to Natural Disasters

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In recent years, Flight Landata, Inc in Massachusetts, US has developed a series of innovative electro-optical (EO)[1,2], multispectral[3], hyperspectral[4], and multi-sensor imaging systems[5,6] for advanced airborne remote sensing applications. Among them, the BuckEye EO is a series of portable photogrammetric imaging systems that have been flown aboard fixed wing aircraft, helicopters, and unmanned aerial vehicles (UAVs) to acquire large-format natural-color imagery with centimeter-level resolution. The latest Dual-Swath BuckEye EO systems have been further enhanced with 78-megapixel and 120-megapixel panoramic imaging options for fast and wide-coverage high-resolution aerial image collection.

The Dual-Swath BuckEye EO is fully integrated with a tightly coupled precision GPS/IMU device into the small format airborne computer with a total system weight of approximately 25 lbs. A remote client terminal, either wired onboard or wireless connected on the ground, is used to access the airborne computer. An easy-to-use autonomous software package runs the system as a “black box”. All high throughput imaging data streams and GPS/IMU measurement data streams are recorded on a local solid state drive and optionally distributed to remote drives for simultaneous onboard processing. All imaging and non-imaging measurements are assigned with GPS-referenced time. The frame metadata files are automatically generated in real time to provide, the position, velocity, and attitude solutions for each of BuckEye imaging exposures. These real time attitude measurements comprise the camera absolute orientation at the instant of the exposure in the form of pitch, roll, and yaw angles. GPS/IMU data post-processing improves the absolute position accuracy to 1cm and the angular accuracy of the attitude better than the instantaneous field of view.

The Dual-Swath BuckEye EO has an interchangeable modular design. The current 78-megapixel and 120-megapixel configurations use optional 75mm, 105mm and 185mm lenses. Their imaging specifications are listed in the Table below.

Dual-Swath BuckEye EO Specifications	
Imaging Parameters	Ranges and Values
Frame size of 78 Megapixel configuration	14,200(H) X 5,400 (V) pixels
Frame size of 120 Megapixel configuration	18,800(H) X 6,700 (V) pixels
CCD pixel dimensions for 78 MP configuration	6.8 µm x 6.8µm square
CCD pixel dimensions for 120 MP configuration	6.0 µm x 6.0µm square
Sustained framer rate (frames/minute)	Programmable, up to 30
Focal lengths of Interchangeable lenses (mm)	75, 105, 185
Shutter speed (sec)	1/1/4000
Quantization depth (bits)	16

The prototype Dual-Swath BuckEye EO systems have been flown on a Cessna 182 light passenger aircraft at an altitude from 3,000 to 10,000 feet above ground level, providing photogrammetric imagery with a swathwidth up to 1 nautical mile and a resolution down to 3 cm using a 185mm lens. The 78 megepixel Dual-Swath BuckEye EO has been performed rapid airborne corridor mapping missions in June and July 2008 in response to two natural disasters in the US. The first is for the Iowa flood of June 2008, or the "Iowa's Katrina", the worst flood disaster involving most of rivers in Eastern Iowa including the Iowa River, the Cedar River, and the Upper Mississippi River in past 15 years. The second is the Tornado that swept through Deerfield to Epsom, Barnstead and Alton of New Hampshire on July 24, 2008.

The large format 11cm resolution and one (1) mile wide corridor mosaics over the flooded Upper Mississippi river in Iowa and the single-pass Tornado damage mapping in New Hampshire are presented. They show the effectiveness of Flight Landata's Dual-Swath BuckEye EO system, which collects twice as much high-resolution aerial imagery in a single flight line, providing greater efficiency for fast airborne mapping and data processing.

Bibliography

[1] M. Kauchak, "New Eye in the Sky," *Millitary Geospatial Technology,*vol. 4, no 3, pp. 5-7, 2006

[2] X. Sun, W. Chen, J.J. Baker, D.E. Florence, R.L. Fischer, J.G. Ruby, J.C. Eichholz, "A Precision Geo-referenced Digital Airborne Camera," Proceedings of 2006 IEEE International Geoscience and Remote Sensing Symposium & 27th Canadian Symposium on Remote Sensing, Denver, Colorado, USA, July 31 – August 4, 2006, pp.2048-2051.

[3] X. Sun, J. Baker, P. L. Coronado and F. Stetina, "Airborne VNIR and SWIR Imaging Spectrometer and its Multi-sensor Remote Sensing Applications," Proceedings of 2006 IEEE International Geoscience and Remote Sensing Symposium & 27th Canadian Symposium on Remote Sensing, Denver, Colorado, USA, July 31 – August 4, 2006, pp1103-1106.

[4] X. Sun and J. Baker, "A High Definition Hyperspectral Imaging System," Proceeding of the Fifth International Airborne Remote Sensing Conference (CD-ROM, ISSN 1076-7924), Held in Miami, Florida, May 22-24, 2002.

[5] X. Sun, W. Chen, B. C. Patterson, D.E. Florence, R.L. Fischer, M. Jones, J.C. Eichholz, J. E. Richards, P. Shu, M. Jhabvala, A. La, D. Kahle, and J Adams "An Advanced Airborne Multisensor Imaging System for Fast Mapping and Change Detection Applications," Proceedings of 2007 IEEE International Geoscience and Remote Sensing Symposium, Barsalona, Spain, July 23-28, 2007, pp600-605.

[6] X. Sun, and W. Chen, "A PORTABLE AIRBORNE MULTI-SENSOR IMAGING SYSTEM," Proceedings of 2007 IEEE International Geoscience and Remote Sensing Symposium, July 6-11, 2008 |Boston, Massachusetts, U.S.A.