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RIGOROUS IMAGE FORMATION FROM AIRBORNE AND SPACEBORNE DIGITAL ARRAY SCANNERS

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Abstract. Sensor builders in the digital era have design limitations due to the constraint of maximum available digital array size. A straightforward solution exists, for example, when four cameras that each simultaneously captures an image from essentially the same perspective centre; they can be re-sampled to form a virtual large format image that can be exploited using a single (instead of four separate) instantiation of a frame model. The purpose of this paper is to address the less trivial time-dependent cases where the sensor scans the ground and the detector arrays obtain chips of imagery that need to be stitched together to form a single conveniently exploitable image. Many operational techniques warp the imagery to form a mosaic, or ortho-rectify it using an imperfect digital surface model (DSM), thus eliminating the possibility for accurate geolocation and uncertainty estimation. This algorithm, however, forms a single virtual image with associated smooth metadata, which can be exploited using a simple physical sensor model. The algorithm consists of four main steps: 1) automated tie point matching; 2) camera calibration (once per sensor); 3) block adjustment; and 4) pixel re-sampling based on an "idealized" virtual model. The same geometry model used to form the image, or its true replacement, must be used to exploit it. This paper verifies the algorithm using real imagery acquired from the Global Hawk (GH) UAV. Registration of the virtual image to a WorldView1 stereopair using four tie points yielded an RMS below 0.6 meters per horizontal axis.

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