

CLAIMS

1. Apparatus for remote imaging of at least one region of interest (ROI) in a terrestrial area, the apparatus comprising:

a camera array having a focal length f and a photosensor comprising pixels characterized by a pixel pitch P that acquires a sequence of images of the terrestrial area, the images acquired from different 3D spatial locations and camera orientations;

an inertial measurement unit (IMU) and satellite navigation system (GNSS) receiver that acquire data responsive to the 3D spatial locations and/or orientations of the camera array during acquisition of the sequence of images;

a data base comprising a terrain map that provides elevation data having an uncertainty Δe that satisfies a constraint $P \geq \Delta e \cdot f \cdot \sin \alpha / A$, where A is a maximum distance of the camera array from the terrestrial area and α is a maximum oblique angle at which the camera array images the terrestrial area; and

a controller that:

registers at least one image of the sequence of images to an orthographic image of the terrestrial area or another image of the sequence of images to determine corrections to the IMU and/or GNSS data;

uses the corrected IMU and/or GNSS data to crop each image of the sequence to an ROI cropped image portion of the image that images an ROI of the at least one ROI; and

registers each ROI cropped image portion to an orthographic image of the terrestrial area responsive to elevation data in the terrain image of the terrestrial area to stabilize the ROI cropped image portion so that a same feature in each of the ROI cropped image portions is located at a same location to within a distance of pitch P in each of the registered ROI cropped image portions.

2. The apparatus according to claim 1 wherein P is less than or equal to $15\ \mu\text{m}$ (micrometers).

3. The apparatus according to claim 2 wherein P is less than or equal to about $10\ \mu\text{m}$.

4. The apparatus according to claim 3 wherein P is less than or equal to about $3\ \mu\text{m}$.

5. The apparatus according to any one of claims 1-4 wherein A is greater than or equal to about 500 m (meters).
6. The apparatus according to claim 5 wherein A is greater than or equal to about 5,000 m.
7. The apparatus according to claim 6 wherein A is greater than or equal to about 10,000 m.
8. The apparatus according to any one of claims 1-7 wherein a number of the photosensor pixels is equal to or greater than about 10^9 .
9. The apparatus according to claim 8 wherein a number of the photosensor pixels is equal to or greater than about 5×10^9 .
10. The apparatus according to any one of the preceding claims wherein the controller registers at least 1 of every 10 images of the terrestrial area acquired by the camera array to the orthographic image to determine corrections to the IMU and/or GNSS data.
11. The apparatus according to claim 10 wherein the controller registers at least 1 of every 5 images of the terrestrial area acquired by the camera array to the orthographic image to determine corrections to the IMU and/or GNSS data.
12. The apparatus according to claim 11 wherein the controller registers at least 1 of every 3 images of the terrestrial area acquired by the camera array to the orthographic image to determine corrections to the IMU and/or GNSS data.
13. The apparatus according to any one of the preceding claims wherein the camera array acquires images of the terrestrial area at a frequency greater than or equal to about 3 Hz.

14. The apparatus according to any one of the preceding claims wherein the controller samples data provided by the IMU at a frequency greater than or equal to about 100 Hz.
15. The apparatus according to claim 14 wherein the controller samples data provided by the IMU at a frequency greater than or equal to about 200 Hz.
16. The apparatus according to any one of the preceding claims wherein the controller samples data provided by the GNSS receiver at a frequency greater than or equal to about 1 Hz.
17. The apparatus according to any one of the preceding claims wherein the camera array comprises a camera that operates in a rolling shutter mode.
18. The apparatus according to any one of the preceding claims and comprising a database comprising data that the IMU and/or GNSS acquires.
19. The apparatus according to any one of the preceding claims wherein the camera array is stabilized by a two axis gimbal system.
20. The apparatus according to any one of the preceding claims wherein the camera array is not stabilized by a gimbal system.
21. Apparatus for remote imaging of at least one region of interest (ROI) in a terrestrial area, the apparatus comprising:
 - a camera array having a focal length f and a photosensor comprising at least 10^9 pixels characterized by a pixel pitch P , the camera array operable in a rolling shutter mode without gimbal stabilization to acquire a sequence of images of the terrestrial area, the images acquired from different 3D spatial locations and camera orientations;
 - an inertial measurement unit (IMU) and satellite navigation system (GNSS) receiver operable to acquire data responsive to the 3D spatial locations and/or orientations of the camera array during acquisition of the sequence of images; and
 - a controller configured to:

register at least one image of the sequence of images to an orthographic image of the terrestrial area or another image of the sequence of images to determine corrections to the IMU and/or GNSS data;

use the corrected IMU and/or GNSS data to crop an image of the sequence to an ROI cropped image portion of the image that images an ROI of the at least one ROI; and

register the ROI cropped image portion to an orthographic image of the terrestrial area responsive to elevation data in a terrain image of the terrestrial area to stabilize the ROI cropped image portion.