CLAIMS

1. A method of processing electroluminescence (EL) images of a PV array, comprising

extracting a plurality of frames of a PV array subsection of the PV array from the EL images, the PV array subsection including one or more PV modules of the PV array;

determining a reference frame having a highest image quality of the PV array subsection from among the extracted frames;

performing image alignment of the extracted frames to the reference frame to generate image aligned frames by

arranging the extracted frames in a stacked arrangement, wherein respective corner points of the PV modules are stacked; and

aligning the respective corner points of each PV module in the extracted frames to the corresponding corner points of the PV module in the reference frame; and

processing the image aligned frames to produce an enhanced image of the PV array subsection having a higher resolution than the reference frame.

2. A method according to claim 1, wherein extracting the frames from the images comprises

determining the respective corner points of each PV module in the images; and

constructing respective frames for each PV module based on the identified corner points of each PV module.

3. A method according to claim 1 or 2, wherein determining a reference frame having a highest image quality comprises evaluating the image quality of each frame based on at least one of sharpness, signal-to-noise ratio, and completeness of the frames.

4. A method according to any one of claims 1 to 3, wherein processing the image aligned frames comprises grouping the image aligned frames according to the PV

module in each frame; and performing image averaging on each group of image aligned frames to obtain respective enhanced frames for each PV module.

5. A method according to claim 4, further comprising associating each enhanced frame with a horizontal index and a vertical index according to each PV module's position in the PV array subsection; and arranging the enhanced frames according to its horizontal and vertical index to produce the enhanced image of the PV array subsection.

6. A method according to any one of claims 1 to 5, further comprising mapping the enhanced image of the PV array subsection onto a base-map of the PV array subsection, the base-map including geo-location of each PV module.

7. A method according to claim 6, wherein mapping the enhanced image onto the base-map comprises orientating the enhanced image to align the PV array subsection in the enhanced image to the PV array subsection in the base-map.

8. An image processing device for processing EL images of a PV array, comprising

an image processor configured to

extract a plurality of frames of a PV array subsection of the PV array from the EL images, the PV array subsection including one or more PV modules of the PV array;

determine a reference frame having a highest image quality of the PV array subsection from among the extracted frames;

perform image alignment of the extracted frames to the reference frame to generate image aligned frames by

arranging the extracted frames in a stacked arrangement, wherein respective corner points of the PV modules are stacked; and

aligning the respective corner points of each PV module in the extracted frames to the corresponding corner points of the PV module in the reference frame; and

process the image aligned frames to produce an enhanced image of the PV array subsection having a higher resolution than the reference frame.

9. A method of controlling movement of an aerial vehicle having a camera for capturing EL images of a PV array, the method comprising

controlling the aerial vehicle to fly along a flight path to capture EL images of corresponding PV array subsections of the PV array;

deriving respective image quality parameters from at least some of the captured EL images, wherein the image quality parameters include a SNR scanning factor and a motion blur scanning factor; and

dynamically adjusting a flight speed of the aerial vehicle along the flight path, based on the respective image quality parameters for capturing the EL images of the PV array subsections by

deriving a target flight speed based on a minimum of the SNR scanning factor and the motion blur scanning factor; and

dynamically adjusting the current flight speed of the aerial vehicle to match the target flight speed.

10. A method of claim 9, wherein the SNR scanning factor is dependent on a target SNR, a measured SNR, and an estimated number of EL images captured that include a particular PV module of the PV array subsection.

11. A method of claim 9, wherein deriving the target flight speed comprises

applying the minimum of the SNR scanning factor and the motion blur scanning factor to a current flight speed of the aerial vehicle to derive a target scanning speed; and

selecting the target scanning speed as the target flight speed if the target scanning speed is below a maximum flight speed of the aerial vehicle.

12. A method according to any one of claims 9 to 11, further comprising detecting an EL signal emitted by one or more PV modules from the PV array, prior to controlling the aerial vehicle to fly along the flight path to capture EL images of corresponding PV array subsections of the PV array.

13. A method according to claim 12, further comprising manoeuvring the aerial vehicle to an initial position wherein the aerial vehicle's yaw axis and the camera's optical axis are perpendicular to the ground before detecting the EL signal.

14. A method according to any one of claims 9 to 13, further comprising aligning the camera's field-of-view (FOV) to the corresponding PV array subsections by

determining respective key points of a reference PV module in the corresponding PV array subsections;

deriving target aligned points from the respective key points for the camera's FOV to be aligned to the corresponding PV array subsections;

performing a perspective transformation to align the respective key points to the target aligned points; and

maneuvering the aerial vehicle relative to the corresponding PV array subsections based on the perspective transformation.

15. A method according to claim 14, wherein aligning the camera's FOV to the corresponding PV array subsections further comprises manoeuvring the aerial vehicle to an appropriate elevation, wherein the corresponding PV array subsections are at a predefined size ratio within the camera's FOV at the appropriate elevation.

16. An aerial vehicle, comprising

a camera for capturing EL images of a PV array;

a propulsion device for actuating movement of the aerial vehicle; and

a controller communicatively coupled to the camera and the propulsion device and configured to

controlling the aerial vehicle to fly along a flight path to capture EL images of corresponding PV array subsections of the PV array;

deriving respective image quality parameters from at least some of the captured EL images, wherein the image quality parameters include a SNR scanning factor and a motion blur scanning factor; and

dynamically adjusting a flight speed of the aerial vehicle along the flight path, based on the respective image quality parameters for capturing the EL images of the PV array subsections by

deriving a target flight speed based on the minimum of a SNR scanning factor and the motion blur scanning factor; and

dynamically adjusting the current flight speed of the aerial vehicle to match the target flight speed.

17. The aerial vehicle of claim 16, wherein the controller is further configured to

detect an EL signal emitted by one or more PV modules from the PV array, the PV array having an array axis, and the one or more PV modules being aligned to the array axis and includes a planar surface;

determine the array axis of the PV array; and

control the camera to capture the EL images of the PV array along the array axis while dynamically adjusting the propulsion device to align the camera's optical axis to be perpendicular to the one or more PV module's planar surface.

18. An aerial vehicle according to claim 17, wherein the controller is further configured to locate the EL signal emitted by the one or more PV modules of the PV array by dynamically adjust the propulsion device to rotate the aerial vehicle about the vehicle's yaw axis while simultaneously increasing the camera's optical axis angle until the EL signal is located.

19. A method of obtaining an enhanced image of a PV array subsection of a PV array from EL images of the PV array subsection captured by an aerial vehicle having a camera, the method comprising

controlling the aerial vehicle to fly along a flight path to capture EL images of corresponding PV array subsections of the PV array;

deriving respective image quality parameters from at least some of the captured EL images;

dynamically adjusting a flight speed of the aerial vehicle along the flight path, based on the respective image quality parameters for capturing the EL images of the PV array subsections;

extracting a plurality of frames of the PV array subsection from the EL images; determining a reference frame having a highest image quality of the PV array subsection from among the extracted frames;

performing image alignment of the extracted frames to the reference frame to generate image aligned frames by

arranging the extracted frames in a stacked arrangement, wherein respective corner points of the PV modules are stacked; and

aligning the respective corner points of each PV module in the extracted frames to the corresponding corner points of the PV module in the reference frame; and

processing the image aligned frames to produce an enhanced image of the PV array subsection having a higher resolution than the reference frame.

20. A system for capturing and processing EL images of a PV array subsection of a PV array, comprising

an aerial vehicle including

a camera for capturing EL images of a PV array;

a propulsion device for actuating movement of the aerial vehicle; and

a controller communicatively coupled to the camera and the propulsion device and configured to

controlling the aerial vehicle to fly along a flight path to capture EL images of corresponding PV array subsections of the PV array;

deriving respective image quality parameters from at least some of the captured EL images; and

dynamically adjusting a flight speed of the aerial vehicle along the flight path, based on the respective image quality parameters for capturing the EL images of the PV array subsections; and

an image processing device including

an image processor configured to

extract a plurality of frames of a PV array subsection of the PV array from the EL images, the PV array subsection including one or more PV modules of the PV array;

determine a reference frame having a highest image quality of the PV array subsection from among the extracted frames;

perform image alignment of the extracted frames to the reference frame to generate image aligned frames by

arranging the extracted frames in a stacked arrangement, wherein respective corner points of the PV modules are stacked; and

aligning the respective corner points of each PV module in the extracted frames to the corresponding corner points of the PV module in the reference frame; and

process the image aligned frames to produce an enhanced image of the PV array subsection having a higher resolution than the reference frame.