

## **Claims**

1. An image processing system comprising:

a three-dimensional model generator, executed by at least one hardware processor, to

5 receive telemetry data related to movement of a vehicle along a vehicle path, wherein the telemetry data includes movement log information related to the movement of the vehicle along the vehicle path,

receive images captured by the vehicle during movement of the vehicle along the vehicle path, and

10 generate, based on the telemetry data and the images, at least one altitude map for the images, and world coordinates alignment data for the images; and

an entity recognizer, executed by the at least one hardware processor, to

receive the at least one altitude map for the images, the images,

15 the world coordinates alignment data for the images, the telemetry data, and predetermined information related to the vehicle path and entities along the vehicle path,

detect, at least one of the entities in the images and locations of the at least one of the entities detected in the images, wherein the detection is

20 based on the at least one altitude map for the images, the images, the world coordinates alignment data for the images, the telemetry data, and the predetermined information related to the vehicle path and the entities along the vehicle path,

consolidate the locations of the at least one of the entities  
detected in different images to determine a consolidated location for the at least  
one of the entities detected in the different images, wherein consolidating the  
locations of the at least one of the entities includes determining, based on the  
5 locations of the at least one of the entities detected in different images, an  
average location for the at least one of the entities, wherein the average location  
is used as the consolidated location, and  
generate, based on the consolidated location for the at least one  
of the entities detected in the different images, masks for images captured by  
10 the vehicle during movement of the vehicle along the vehicle path, wherein the  
masks indicate the at least one of the entities detected in the images captured  
by the vehicle.

2. The image processing system according to claim 1, wherein the three-  
15 dimensional model generator is to further generate, based on the telemetry data  
and the images,

an orthophotomap that represents the vehicle path or a chunk of the  
vehicle path, and wherein the chunk is defined by a plurality of the images for a  
part of the vehicle path.

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3. The image processing system according to claim 1, wherein  
the entity recognizer is to further perform ground classification for each of  
the images to classify, in the masks, whether pixels in the images represent  
ground or non-ground.

4. The image processing system according to claim 1, wherein the predetermined information related to the vehicle path and the entities along the vehicle path includes at least one of

5 training data that includes information that is to be used for machine learning for image recognition and detection of a type of the at least one of the entities in the images, wherein the training data is to be used by the entity recognizer to recognize the type of the at least one of the entities in the images, or

10 an entity map that includes a location and the type of the at least one of the entities detected in the images.

5. The image processing system according to claim 1, wherein the entities include infrastructure entities including towers and electric lines between the  
15 towers for a power system.

6. The image processing system according to claim 1, wherein the masks include at least one of

an infrastructure entity mask that highlights at least one infrastructure  
20 entity of the entities, or

a non-infrastructure entity mask that highlights a non-infrastructure entity that includes at least one of vegetation or an anthropogenic object adjacent the at least one infrastructure entity of the entities.

7. The image processing system according to claim 1, wherein the masks include a power lines mask that highlights at least one power line for a tower for a power system.
- 5 8. The image processing system according to claim 1, wherein the masks include a region entity mask that represents results of detection of the at least one of the entities in the images, wherein pixels related to detected entities of a same type include a same value, and wherein each pixel of the pixels represents
- 10 an infrastructure entity of the at least one of the entities,  
a non-infrastructure entity of the at least one of the entities, or  
ground.
9. The image processing system according to claim 1, wherein the entity  
15 recognizer is to further generate an image ground mask that displays at least one area of ground in the images by
- excluding, in the images, areas that are relatively high from a ground altitude level,
- excluding, in the images, areas that do not include altitude information,
- 20 and
- excluding, in the images, areas between high positive and negative derivatives of altitude data.

10. The image processing system according to claim 1, wherein the vehicle is an unmanned aerial vehicle (UAV), and the movement log includes a flight log.

5 11. The image processing system according to claim 1, wherein the entity recognizer is to further

detect the at least one of the entities using information related to a season during which a vehicle flight is conducted.

10 12. The image processing system according to claim 1, wherein the entity recognizer is to further

detect, based on the at least one altitude map for the images, the images, the world coordinates alignment data for the images, and the predetermined information related to the vehicle path and the entities along the

15 vehicle path, the at least one of the entities by

extracting ridges of the at least one of the entities, and

retaining or deleting ridges from the extracted ridges that include heading limits that exceed a predetermined heading limit threshold based on a type of the at least one of the entities.

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13. The image processing system according to claim 1, wherein the entities include electric lines, and wherein the entity recognizer is to further

detect, the at least one of the electric lines in the images and locations of the at least one of the electric lines detected in the images, wherein the

detection is based on the at least one altitude map for the images, the images, the world coordinates alignment data for the images, and the predetermined information related to the vehicle path and the electric lines along the vehicle path, and wherein the detection includes

5 identifying the at least one of the electric lines based on a determination of whether a plurality of ridges are within a predetermined angular deviation.

14. The image processing system according to claim 1, wherein the entity  
10 recognizer is to further

detect, the at least one of the entities in the images and locations of the at least one of the entities detected in the images, wherein the detection is based on the at least one altitude map for the images, the images, the world coordinates alignment data for the images, and the predetermined information  
15 related to the vehicle path and the entities along the vehicle path, and wherein the detection includes

performing machine learning and blob detection to identify potential entity blobs, and

discarding, based on the blob detection, blobs that are a  
20 predetermined percentage wider or a predetermined percentage narrower than a width of the at least one of the entities.

15. The image processing system according to claim 1, wherein the entities include electric lines, further comprising a three-dimensional curve reconstructor to:

detect, based on the images, the world coordinates alignment data for the images, images power lines masks, and consolidated towers positions, at least one electric lines' curve equation by

defining surfaces that are composed of rays from cameras of the vehicle to the electric lines, or from a camera of the vehicle that is used at different locations along the vehicle path to capture the images of the electric lines to the electric lines detected in corresponding images,

defining planes that are perpendicular to a main direction of the electric lines, wherein the planes are derived from towers positions and distributed between adjacent towers positions,

determining curves in the defined planes, wherein the curves are determined by intersections between the defined planes and the defined surfaces,

determining density points of locations of the curves, wherein the density points are defined from intersections between the determined curves, which include electric lines curves from different images,

generating a point cloud from the determined density points from the defined planes, and

fitting sets of point cloud points with equations that describe a three-dimensional position of an electric line.

16. The image processing system according to claim 1, wherein the masks include values that indicate where entities have been detected in the images.
17. The image processing system according to claim 1, wherein each mask  
5 is a matrix of values and the values classify, in the matrix, where entities have been detected in an image corresponding to a mask.
18. The image processing system according to claim 1, wherein consolidating  
10 the locations of the entity further includes comparing the detected locations of the entity to an average location for all of the detected locations of the entity, and wherein:
- if all of the detected locations of the entity are less than a predetermined distance from the average location for all of the detected locations of the entity,  
15 the average location for all of the detected locations of the entity is used as the consolidated location for the entity; and
- if a detected location of the entity is greater than the predetermined distance from the average location for all of the detected locations of the entity,  
20 the detected location of the entity that is greater than the predetermined distance from the average location for all of the detected locations of the entity is removed from further consideration, and the average location is re-determined for the entity from the remaining detected locations of the entity, and the re-determined average location is used as the consolidated location for the entity.

19. A method for image processing, the method comprising:

receiving, by an entity recognizer that is executed by at least one hardware processor,

5 predetermined information related to a vehicle path and entities along the vehicle path, and

at least one altitude map and alignment data based on images and telemetry data captured by a vehicle during movement of the vehicle along the vehicle path;

10 detecting, by the entity recognizer, based on the at least one altitude map for the images, the images, the alignment data for the images, and the predetermined information related to the vehicle path and the entities along the vehicle path

at least one of the entities in the images, and

15 a location of the at least one of the entities detected in the images;

consolidating, by the entity recognizer, the locations of the at least one of the entities detected in different images to determine a consolidated location for the at least one of the entities detected in the different images, wherein consolidating the locations of the at least one of the entities includes

20 determining, based on the locations of the at least one of the entities detected in different images, an average location for the at least one of the entities, and wherein the average location is used as the consolidated location; and

generating, by the entity recognizer, based on the consolidated location of the at least one of the entities detected in the images, at least one of

an infrastructure entity mask for images captured by the vehicle during movement of the vehicle along the vehicle path, wherein the infrastructure entity masks highlights at least one infrastructure entity of the entities, or

5 a non-infrastructure entity mask for images captured by the vehicle during movement of the vehicle along the vehicle path, wherein the non-infrastructure entity mask highlights a non-infrastructure entity that includes at least one of vegetation or an anthropogenic object adjacent the at least one infrastructure entity of the entities.

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20. A non-transitory computer readable medium having stored thereon machine readable instructions for image processing, the machine readable instructions when executed cause at least one hardware processor to:

receive, by an entity recognizer that is executed by the at least one hardware processor,

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predetermined information related to a vehicle path and entities along the vehicle path, and

at least one altitude map and alignment data based on images and telemetry data captured by a vehicle during movement of the vehicle along the vehicle path;

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detect, by the entity recognizer, based on the at least one altitude map for the images, the images, the alignment data for the images, and the predetermined information related to the vehicle path and the entities along the vehicle path

at least one of the entities in the images, and  
a location of the at least one of the entities detected in the images;  
consolidate, by the entity recognizer, the locations of the at least  
one of the entities detected in different images to determine a consolidated  
5 location for the at least one of the entities detected in the different images,  
wherein consolidating the locations of the at least one of the entities includes  
determining, based on the locations of the at least one of the entities detected in  
different images, an average location for the at least one of the entities, and  
wherein the average location is used as the consolidated location; and  
10 generate, by the entity recognizer, based on the consolidated location of  
the at least one of the entities detected in the images, masks for images  
captured by the vehicle during movement of the vehicle along the vehicle path,  
wherein the masks include a region entity mask that represents results of  
detection of the at least one of the entities in the images, wherein pixels related  
15 to detected entities of a same type include a same value, and wherein each  
pixel of the pixels represents  
an infrastructure entity of the at least one of the entities,  
a non-infrastructure entity of the at least one of the entities, or  
ground.