

CONDITION DETECTION USING IMAGE PROCESSING**CLAIM FOR PRIORITY**

The present application is a national stage filing under 35 U.S.C. § 371 of PCT application number PCT/IB2015/001843, having an international filing date of August 6, 2015, the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

[0001] Unmanned vehicles (UVs), which may include unmanned aerial vehicles (UAVs), drones, unmanned land vehicles, even collaborative robots, etc., are typically operated without a human aboard. Manned vehicles such as aircraft, helicopters, manned land vehicles, etc., are typically operated with a human aboard. Vehicles, including unmanned and manned vehicles, with imaging systems, such as video cameras, infrared (IR) sensors, etc., may be used to capture images of an area of interest. The images may be analyzed with respect to entities that are disposed in the area of interest.

What is claimed is:

1. A condition detection using image processing system comprising:

a risks analyzer, executed by at least one hardware processor, to
receive at least one mask generated from images and telemetry data captured by a vehicle,
an altitude map, and alignment data for the at least one mask, wherein

the images are related to movement of the vehicle along a vehicle path and at least one of a
plurality of non-infrastructure entities along an infrastructure entity position of a
corresponding infrastructure entity, and

the telemetry data includes movement log information related to the movement of the
vehicle along the vehicle path, and

use the at least one mask related to the vehicle path and the at least one of the plurality of
non-infrastructure entities along the infrastructure entity position of the corresponding
infrastructure entity, a height map, the alignment data for the at least one mask, and an
infrastructure rule to detect a risk related to the infrastructure entity by

analyzing the at least one mask related to the vehicle path and the at least one of the
plurality of non-infrastructure entities along the infrastructure entity position of the
corresponding infrastructure entity, and the infrastructure rule,

determining whether the infrastructure rule is violated, and

determining a likelihood of the at least one of the plurality of non-infrastructure entities
along the infrastructure entity position of the corresponding infrastructure entity of falling
over the infrastructure entity, wherein the risk includes the at least one of the plurality of

non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling over the infrastructure entity.

2. The condition detection using image processing system according to claim 1, wherein the risks analyzer is to use the at least one mask related to the vehicle path and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, the height map, the alignment data for the at least one mask, and the infrastructure rule to detect the risk related to the infrastructure entity by identifying at least one infrastructure rule condition related to the infrastructure entity, determining whether the infrastructure rule condition is satisfied or not satisfied by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, and in response to a determination that the infrastructure rule condition is satisfied or not satisfied by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, determining the risk related to the infrastructure entity by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity.

3. The condition detection using image processing system according to claim 2, wherein the at least one infrastructure rule condition includes satisfying a height threshold, and wherein the risks analyzer is to further determine whether the height threshold is met or exceeded by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity by

determining a ground level in a region of analysis by using a ground mask and the altitude map related to the region of analysis,

determining a height map by using the ground level and the altitude map related to the region of analysis, and

identifying, by using the height map, the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity that includes a height that exceeds the height threshold.

4. The condition detection using image processing system according to claim 1, wherein the risks analyzer is to use the at least one mask related to the vehicle path and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, the height map, the alignment data for the at least one mask, and the infrastructure rule to detect the risk related to the infrastructure entity by determining a height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity is to fall over the infrastructure entity, wherein the risk includes the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling over the infrastructure entity, and generating a group by grouping the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity for which an actual height exceeds the height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity is to fall over the infrastructure entity.

5. The condition detection using image processing system according to claim 1, wherein the risks analyzer is to use the at least one mask related to the vehicle path and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, the height map, the alignment data for the at least one mask, and the infrastructure rule to detect the risk related to the infrastructure entity by determining a height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity is to fall to a specified region, wherein the risk includes the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling to the specified region.

6. The condition detection using image processing system according to claim 1, wherein the risks analyzer is to use the at least one mask related to the vehicle path and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, the height map, the alignment data for the at least one mask, and the infrastructure rule to detect the risk related to the infrastructure entity by generating a group by grouping the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity for which the likelihood is more than a predetermined threshold, and determining the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity in the group that includes a maximum likelihood of the risk of falling over the infrastructure entity.

7. The condition detection using image processing system according to claim 6, wherein the risks analyzer is to further

determine a distance between the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity in the group that includes the maximum likelihood of the risk of falling over the infrastructure entity.

8. The condition detection using image processing system according to claim 1, wherein the risks analyzer is to use the at least one mask related to the vehicle path and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, the height map, the alignment data for the at least one mask, historical masks, historical height maps, and the infrastructure rule to detect the risk related to the infrastructure entity by

comparing the risk of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity to historical risks of falling over the infrastructure entity,

determining whether a maximum likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity exceeds a historical risk of the historical risks of falling over the infrastructure entity, and

in response to a determination that the maximum likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the

corresponding infrastructure entity of falling over the infrastructure entity exceeds the historical risk of the historical risks of falling over the infrastructure entity, generating an alert related to the risk of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity.

9. The condition detection using image processing system according to claim 1, further comprising:

a risks consolidator, executed by the at least one hardware processor, to use risk masks derived from the at least one mask related to the vehicle path and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, and the alignment data for the at least one mask, to merge, based on an analysis of the risk masks and regions alignment data, risks of a same type located in different regions to a same location.

10. The condition detection using image processing system according to claim 1, wherein infrastructure entities including the infrastructure entity include a tower and a power line for a power system.

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

12. The condition detection using image processing system according to claim 1, further comprising:

a user-interface, executed by the at least one hardware processor, to generate a display of the risk from a plurality of available risks and the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity.

13. A method for condition detection using image processing, the method comprising:

receiving, by a risks analyzer that is executed by at least one hardware processor, at least one mask generated from images and telemetry data captured by a vehicle, an altitude map, and alignment data for the at least one mask, wherein

the images are related to movement of the vehicle along a vehicle path and at least one of a plurality of non-infrastructure entities along an infrastructure entity position of a corresponding infrastructure entity, and

the telemetry data includes movement log information related to the movement of the vehicle along the vehicle path;

identifying, by the risks analyzer, a boundary related to the infrastructure entity position;

determining, by the risks analyzer, whether the boundary is violated by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity;

in response to a determination that the boundary is violated by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the

corresponding infrastructure entity, determining, by the risks analyzer, a risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity; and

using, by a risks consolidator that is executed by the at least one hardware processor, risk masks derived from the at least one mask related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity to

merge, based on an analysis of the risk masks and regions alignment data, risks of a same type located in different regions to a same location.

14. The method for condition detection using image processing according to claim 13, wherein determining, by the risks analyzer, the risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, further comprises:

determining, by the risks analyzer, a height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity is to fall over the infrastructure entity, wherein the risk includes the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling over the infrastructure entity; and

generating, by the risks analyzer, a group by grouping the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity for which an actual height exceeds the height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the

corresponding infrastructure entity is to fall over the infrastructure entity.

15. The method for condition detection using image processing according to claim 13, wherein determining, by the risks analyzer, the risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, further comprises:

determining, by the risks analyzer, a likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling to a specified region, wherein the risk includes the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling to the specified region.

16. The method for condition detection using image processing according to claim 13, wherein determining, by the risks analyzer, the risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, further comprises:

comparing, by the risks analyzer, a risk of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity to historical risks of falling over the infrastructure entity;

determining, by the risks analyzer, whether a maximum likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the

corresponding infrastructure entity of falling over the infrastructure entity exceeds a historical risk of the historical risks of falling over the infrastructure entity; and

in response to a determination that the maximum likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity exceeds the historical risk of the historical risks of falling over the infrastructure entity, generating, by the risks analyzer, an alert related to the risk of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity.

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

receive, by a risks analyzer that is executed by at least one hardware processor, at least one mask generated from images and telemetry data captured by a vehicle, wherein the images are related to movement of the vehicle along a vehicle path and at least one of a plurality of non-infrastructure entities along an infrastructure entity position of a corresponding infrastructure entity;

identify, by the risks analyzer, an angular threshold related to the infrastructure entity;

determine, by the risks analyzer, whether the angular threshold is met or exceeded by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity by identifying the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding

infrastructure entity that is fully or partially located within the angular threshold for contacting the infrastructure entity; and

in response to a determination that the angular threshold is met or exceeded by the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, determine, by the risks analyzer, a risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity.

18. The non-transitory computer readable medium according to claim 17, wherein the machine readable instructions to determine, by the risks analyzer, the risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, further comprise machine readable instructions that when executed cause the least one hardware processor to:

determine, by the risks analyzer, a height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity is to fall over the infrastructure entity, wherein the risk includes the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling over the infrastructure entity; and

generate, by the risks analyzer, a group by grouping the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity for which an actual height exceeds the height for which the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity is to fall over the infrastructure entity.

19. The non-transitory computer readable medium according to claim 17, wherein the machine readable instructions to determine, by the risks analyzer, the risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, further comprise machine readable instructions that when executed cause the least one hardware processor to:

determine, by the risks analyzer, a likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling to a specified region, wherein the risk includes the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity falling to the specified region.

20. The non-transitory computer readable medium according to claim 17, wherein the machine readable instructions to determine, by the risks analyzer, the risk related to the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity, further comprise machine readable instructions that when executed cause the least one hardware processor to:

compare, by the risks analyzer, a risk of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity to historical risks of falling over the infrastructure entity;

determine, by the risks analyzer, whether a maximum likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the

corresponding infrastructure entity of falling over the infrastructure entity exceeds a historical risk of the historical risks of falling over the infrastructure entity; and

in response to a determination that the maximum likelihood of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity exceeds the historical risk of the historical risks of falling over the infrastructure entity, generate, by the risks analyzer, an alert related to the risk of the at least one of the plurality of non-infrastructure entities along the infrastructure entity position of the corresponding infrastructure entity of falling over the infrastructure entity.