

CLAIMS

1. A method of navigating a vehicle, the vehicle comprising a scanning device and a self-contained navigation system (SCNS) being operatively connected to a computer, the method comprising: operating the scanning device for repeatedly
5 executing a scanning operation, where each scanning operation includes scanning an area surrounding the vehicle, to thereby generate respective scanning output data; operating the computer for generating, based on the scanning output data from multiple scanning operations, a relative map representing at least a part of the area, the relative map having known dimensions and being relative to a position of the
10 vehicle, wherein the relative map comprises cells, each cell being classified to a class selected from at least two classes, comprising traversable and non-traversable, and characterized by dimensions equal or larger than an accumulated drift value of the SCNS over a predefined distance; wherein non-traversable cells correspond to obstacles identified in the scanning output data; receiving SCNS data and updating a
15 position of the vehicle relative to the cells based on the SCNS data.
2. The method of claim 1, wherein updating a position of the vehicle relative to the cells based on the SCNS data includes updating the position of the vehicle relative to obstacles detected in scanning output data of a previous scanning operation from the multiple scanning operations and not detected in scanning output
20 data of a current scanning operation from the multiple scanning operations, while the obstacle is still located within the scanned area.
3. The method of any one of the preceding claims further comprising: generating instructions for controlling the vehicle within the area based on the relative map, to thereby avoid non-traversable cells.
- 25 4. The method of any one of the preceding claims, wherein the SCNS is a inertial navigation system.
5. The method of any one of the preceding claims, wherein the vehicle is any one of: unmanned ground vehicle; manned ground vehicle; unmanned aerial vehicle; manned aerial vehicle; unmanned marine vehicle; manned marine vehicle.
- 30 6. The method of any one of the preceding claims, wherein the relative map is generated by accumulating scanning output data from a plurality of scanning operations.

7. The method of any one of the preceding claims, wherein the relative map is generated by accumulating scanning output data in an advancement direction of the vehicle as the vehicle advances into the area, and omitting from the relative map representation of areas in an opposite direction.
- 5 8. The method further comprising, navigating the vehicle along a global path leading to a target destination and updating the path based on the relative map in order to avoid obstacles.
9. The method of any one of the preceding claims, wherein navigation along the global path is executed using GPS.
- 10 10. The method of any one of the preceding claims, wherein navigation along the global path is executed using computer vision.
11. The method further of any one of the preceding claims further comprising, aligning between a global map comprising the global path leading to the destination and the relative map thereby providing a combined map leading to the destination that comprises a global path which has been updated based on the relative map.
- 15 12. The method according to claim 11, wherein aligning between the global map and the relative map comprises:
- using time tags for temporally aligning between an update of the global map
- 20 and an updated of the relative map;
- spatially aligning between the global map and the relative map by matching between the position of the vehicle in the global map and the position of the vehicle in the relative map.
13. The method of to any one of claims 11 and 12, further comprising:
- 25 displaying on a display device a graphical representation of the combined map including an indication of: non-traversable cells, position of the vehicle, and the updated global path.
14. The method of any one of the preceding claims, wherein the predefined distance is selected to exceed a maximal distance expected to be travelled
- 30 by the vehicle between consecutive updates of the relative map.
15. The method of any one of claims 1 to 13, wherein the predefined

distance is equal to a dimension of the area represented by the relative map.

16. The method of any one of claims 1 to 13, the predefined distance is equal to half of a dimension of the part of the area represented by the relative map.

17. The method of any one of claims 1 to 13, wherein the predefined
5 distance is equal to a diagonal connecting opposite vertexes of the relative map.

18. The method of any one of claims 1 to 13, wherein the predefined distance is determined in accordance with a relation between an update rate of the relative map, and a maximal or expected velocity of the vehicle.

19. The method of any one of claims 1 to 18, wherein the area dimensions
10 are determined in accordance with a scanning distance of the scanning device.

20. The method of any one of claims 1 to 18, wherein the area is a square having an edge of up to double the scanning distance of the scanning device.

21. The method of any one of the preceding claims, wherein an obstacle detected during a scanning operation is indicated on the relative map as a non-traversable cell, and wherein a non-traversable cell representing an obstacle that is
15 detected in a scan and is not detected in at least one subsequent scans, is indicated on, for at least, one further map update.

22. The method of any one of the preceding claims further comprising: generating a graphical representation of the relative map and displaying the graphical
20 representation on a display device, to thereby enable an operator to control the vehicle while avoiding obstacles based on the graphical representation.

23. The method of claim 22, wherein the graphical representation is a 2.5 dimensional or 3 dimensional representations of the relative map.

24. A system mountable on vehicle, comprising:
25 a scanning device for scanning an area surrounding the vehicle, to thereby provide scanning output data providing information about distances between objects in the area and the vehicle in a multiplicity of directions;

a self-contained navigation system (SCNS) for providing data indicative of a current position of the vehicle relative to a previous position; and at least one
30 processor;

the scanning device is operable to repeatedly execute a scanning operation,

where each scanning operation includes scanning an area surrounding the vehicle, to thereby generate respective scanning output data;

the at least one processor is configured to:

generate, based on the scanning output data from multiple scanning
5 operations, a map representing at least a part of the area, the map having known dimensions and being relative to a position of the vehicle, wherein the map comprises cells, each cell is classified to a class selected from a group consisting of traversable and non-traversable, and characterized by dimensions equal or larger than an accumulated drift value of the SCNS over a predefined distance; wherein non-
10 traversable cells correspond to obstacles identified in the scanning output data;

receive SCNS data and update a position of the vehicle relative to the cells based on the SCNS data.

25. A vehicle, comprising a system comprising:

a scanning device for scanning an area surrounding the vehicle, to thereby
15 provide scanning output data providing information about distances between objects in the area and the vehicle in a multiplicity of directions;

a self-contained navigation system (SCNS) for providing data indicative of a current position of the vehicle relative to a previous position; and at least one processor;

20 the scanning device is operable to repeatedly execute a scanning operation, where each scanning operation includes scanning an area surrounding the vehicle, to thereby generate respective scanning output data;

the at least one processor is configured to:

generate, based on the scanning output data from multiple scanning
25 operations, a map representing at least a part of the area, the map having known dimensions and being relative to a position of the vehicle, wherein the map comprises cells, each cell is classified to a class selected from a group consisting of traversable and non-traversable, and characterized by dimensions equal or larger than an accumulated drift value of the SCNS over a predefined distance; wherein non-
30 traversable cells correspond to obstacles identified in the scanning output data;

receive SCNS data and update a position of the vehicle relative to the cells

based on the SCNS data.

26. A computer program product comprising a computer readable storage medium retaining program instructions, which program instructions when read by a processor, cause the processor to perform a method of navigation a vehicle,
5 comprising:

receiving scanning output data, generated in multiple scanning operations executed by a scanning device located on-board the vehicle and operable to scan an area surrounding the vehicle;

- using the scanning output data for generating, a relative map representing at
10 least a part of the area, the relative map having known dimensions and being relative to a position of the vehicle, wherein the relative map comprises cells, each cell being classified to a class selected from at least two classes, comprising traversable and non-traversable, and characterized by dimensions equal or larger than an accumulated drift value of the SCNS over a predefined distance; wherein non-
15 traversable cells correspond to obstacles identified in the scanning output data; receiving SCNS data and updating a position of the vehicle relative to the cells based on the SCNS data.