CLAIMS:

1. A loading volume ratio measurement apparatus, comprising:

a monitoring area designation part configured to acquire a point group existing in a monitoring area in which an area in which a measurement object(s) is loaded is designated in a predetermined space among imaging data obtained by imaging the predetermined space using an imaging part;

a voxelization part configured to create array data obtained by validating a voxel(s) in which a number of points of the point group exist at a predetermined number or more into a valid voxel(s) among voxels in voxel grids obtained by dividing the monitoring area by a voxel having a voxel side length designated in advance;

a field angle occlusion voxel calculation part configured to calculate a dead angle invalid voxel position information related to a position of the dead angle invalid voxel(s) that cannot be visualized in an occlusion portion that is a dead angle of the imaging part in the voxel grids within the array data, based on imaging part mounting position information related to a position where the imaging part is mounted, field angle information related to a field angle of the imaging part, the monitoring area, and the voxel side length;

an array processing part configured to create estimated array data obtained by estimating a valid voxel(s) in a state excluding an occlusion portion in which an obstacle(s) in the front hides a measurement object(s) in the back of the obstacle(s) and makes the measurement object(s) invisible, based on the plurality of array data within a prespecified interval time, and when satisfying a predetermined condition, creating loading array data obtained by validating all of the dead angle invalid voxel(s) in the left or right direction or downward direction of the frontmost valid voxel(s) in the estimated array data into a valid voxel(s) and validating all of the invalid voxel(s) in a back direction of all of the valid voxel(s) after validation into a valid voxel(s); and

a loading volume ratio calculation part configured to calculate a

loading volume ratio which is a ratio of a volume of the measurement object loaded in the monitoring area relative to a total volume in the monitoring area based on the loading array data.

2. The loading volume ratio measurement apparatus according to claim 1, wherein the array processing part is configured to create the estimated array data when a valid voxel(s) exists in the monitoring area in the plurality of array data.

3. The loading volume ratio measurement apparatus according to claim 1 or 2, wherein the array processing part is configured to project the valid voxel(s) in the estimated array data onto a two-dimensional plane, and, as the predetermined condition, when the valid voxel(s) does not exist in a portion of the two-dimensional plane, invalidate all of the dead angle invalid voxel(s) in the left or right direction or downward direction of the frontmost valid voxel in the estimated array data into (as) a valid voxel(s).

4. The loading volume ratio measurement apparatus according to any one of claims 1 to 3, wherein when creating the loading array data, the array processing part is configured to validate all of the dead angle invalid voxel(s) in the left or right direction of the frontmost valid voxel(s) in the estimated array data into (as) a valid voxel(s), as the predetermined condition, when the dead angle invalid voxel(s) exists within a predetermined distance from a position of the frontmost valid voxel(s) in the past data, and validate all of the dead angle invalid voxel(s) in the downward direction of the frontmost valid voxel(s) after validation into a valid voxel(s).

5. The loading volume ratio measurement apparatus according to claim 4, wherein after validating all of the dead angle invalid voxels in the downward direction into a valid voxel(s), the array processing part is configured to validate all of the invalid voxel(s) in the inner direction of all of the valid voxel(s) after validation into a valid voxel(s).

6. The loading volume ratio measurement apparatus according to any one of claims 1 to 5, wherein when creating the loading array data, the array processing part is configured to create a loading array data in

which all of the invalid voxel(s) in the inner direction of all of the valid voxel(s) are validated into a valid voxel(s), as the predetermined condition, when the dead angle invalid voxel(s) does not exist within the predetermined distance from the position of the frontmost valid voxel(s) in the past data.

7. The loading volume ratio measurement apparatus according to claim 3, wherein the array processing part is configured to create loading array data obtained by validating all of the invalid voxel(s) in the inner direction of all of the valid voxel(s) into a valid voxel(s), as the predetermined condition, when the valid voxel(s) exists in an entire area of the two-dimensional plane.

8. A loading volume ratio measurement system, comprising:

an imaging part configured to output imaging data obtained by imaging a predetermined space; and

a loading volume ratio measurement apparatus according to any one of claims 1 to 7.

9. A loading volume ratio measurement method of measuring a loading volume ratio using a hardware resource(s), comprising:

acquiring a point group existing in a monitoring area in which an area in which a measurement object(s) is loaded is designated in a predetermined space among imaging data obtained by imaging the predetermined space using an imaging part;

creating array data obtained by using a voxel(s) in which a number of points of the point group exist at a predetermined number or more into (as) a valid voxel(s) among voxels in voxel grids obtained by dividing the monitoring area by a voxel having a voxel side length designated in advance;

calculating a dead angle invalid voxel position information related to a position of the dead angle invalid voxel(s) that cannot be visualized in an occlusion portion that is a dead angle of the imaging part in the voxel grids within the array data, based on imaging part mounting position information related to a position where the imaging part is mounted, field angle information related to a field angle of the

imaging part, the monitoring area, and the voxel side length;

creating estimated array data obtained by estimating a valid voxel(s) in a state excluding an occlusion portion in which an obstacle(s) in the front hides a measurement object(s) in the back of the obstacle(s) and makes the measurement object(s) invisible, based on the plurality of array data within a prespecified interval time, and when satisfying a predetermined condition, creating loading array data obtained by validating all of the dead angle invalid voxel(s) in the left or right direction or downward direction of the frontmost valid voxel(s) in the estimated array data into a valid voxel(s) and validating all of the invalid voxel(s) in a back direction of all of the valid voxel(s) after validation into a valid voxel(s); and

calculating a loading volume ratio which is a ratio of a volume of the measurement object loaded in the monitoring area relative to a total volume in the monitoring area based on the loading array data.

10. A non-transitory computer-readable recording medium storing thereon a program causing a hardware resource(s) to execute measuring a loading volume ratio, wherein the program causes a hardware resource(s) to execute:

acquiring a point group existing in a monitoring area in which an area in which a measurement object(s) is loaded is designated in a predetermined space among imaging data obtained by imaging the predetermined space using an imaging part;

creating array data obtained by using a voxel(s) in which a number of points of the point group exist at a predetermined number or more into a valid voxel(s) among voxels in voxel grids obtained by dividing the monitoring area by a voxel having a voxel side length designated in advance;

calculating a dead angle invalid voxel position information related to a position of the dead angle invalid voxel(s) that cannot be visualized in an occlusion portion that is a dead angle of the imaging part in the voxel grids within the array data, based on imaging part mounting position information related to a position where the imaging part is mounted, field angle information related to a field angle of the

imaging part, the monitoring area, and the voxel side length;

creating estimated array data obtained by estimating a valid voxel(s) in a state excluding an occlusion portion in which an obstacle(s) in the front hides a measurement object(s) in the back of the obstacle(s) and makes the measurement object(s) invisible, based on the plurality of array data within a prespecified interval time, and when satisfying a predetermined condition, creating loading array data obtained by validating all of the dead angle invalid voxel(s) in the left or right direction or downward direction of the frontmost valid voxel(s) in the estimated array data into a valid voxel(s) and validating all of the invalid voxel(s) in a back direction of all of the valid voxel(s) after validation into a valid voxel(s); and

calculating a loading volume ratio which is a ratio of a volume of the measurement object loaded in the monitoring area relative to a total volume in the monitoring area based on the loading array data.