CLAIMS

WHAT IS CLAIMED IS:

1. A method of identification of previously observed subsets of a volume being explored through recognition of similar sequences of partial observations, the method comprising:

for each observation of subsets of a volume, calculating a descriptor that characterizes the observation;

determining a similarity value between any two descriptors to form a similarity matrix; and

identifying candidates for re-observed snapshots of the previously observed subsets of the volume based on the similarity matrix,

wherein the identifying of the candidates for re-observed snapshots comprises:

identifying a plurality of first-type square sub-matrices along main diagonal of the similarity matrix;

identifying a plurality of second-type square sub-matrices along the main diagonal of the similarity matrix as similar sequences, each of the plurality of second-type square sub-matrices containing multiple first-type square sub-matrices of the plurality of first-type square sub-matrices;

identifying at least one third-type sub-matrix, each of the at least one third-type sub-matrix being an intersection of two second-type square sub-matrices in such a way that rows of the third-type sub-matrix in the similarity matrix are the same as rows of one of the two second-type square sub-matrices in the similarity matrix and columns of the third-type sub-matrix in the similarity matrix are the same as columns of the other of the two second-type square sub-matrices in the similarity matrix; and

identifying largest elements along main diagonal of the at least one third-type sub-matrix as the candidates for re-observed snapshots.

2. The method of claim 1, wherein each similarity value within each of the plurality of first-type square sub-matrices is greater than a threshold value.

3. The method of any one of claims 1-2, wherein each of the plurality of second-type square sub-matrices starts from a beginning of a first first-type square sub-matrix and ends at an end of a subsequent first-type square sub-matrix.

4. The method of any one of claims 1-3, wherein the identifying of the at least one third-type sub-matrix comprises identifying similar second-type square sub-matrices by comparing patterns of the plurality of second-type square sub-matrices.

5. The method of any one of claims 1-4, wherein the descriptor changes in proportion to changes of the observation.

6. The method of any one of claims 1-5, wherein the descriptor is a list of eigenvalues of Laplace-Beltrami operator over a surface mesh generated from 3-dimensional point cloud data.

7. The method of claim 6, wherein the 3-dimensional point cloud data is obtained by scanning visible subset of the volume.

8. The method of any one of claims 1-7, wherein a similarity value is determined by comparing descriptors of two observations.

9. An apparatus for identification of previously observed subsets of a volume being explored through recognition of similar sequences of partial observations, the apparatus comprising:

at least one memory; and

at least one processor coupled to the at least one memory and configured to:

for each observation of subsets of a volume, calculate a descriptor that characterizes the observation;

determine a similarity value between any two descriptors to form a similarity matrix; and

identify candidates for re-observed snapshots of the previously observed subsets of the volume based on the similarity matrix,

wherein, to identify the candidates for re-observed snapshots, the at least one processor is configured to:

identify a plurality of first-type square sub-matrices along main diagonal of the similarity matrix;

identify a plurality of second-type square sub-matrices along the main diagonal of the similarity matrix as similar sequences, each of the plurality of second-type square sub-matrices containing multiple first-type square sub-matrices of the plurality of first-type square sub-matrices;

identify at least one third-type sub-matrix, each of the at least one third-type sub-matrix being an intersection of two second-type square sub-matrices in such a way that rows of the third-type sub-matrix in the similarity matrix are the same as rows of one of the two second-type square sub-matrices in the similarity matrix and columns of the third-type sub-matrix in the similarity matrix are the same as columns of the other of the two second-type square sub-matrices in the similarity matrix; and

identify largest elements along main diagonal of the at least one third-type sub-matrix as the candidates for re-observed snapshots.

10. The apparatus of claim 9, wherein each similarity value within each of the plurality of first-type square sub-matrices is greater than a threshold value.

11. The apparatus of any one of claims 9-10, wherein each of the plurality of second-type square sub-matrices starts from a beginning of a first first-type square sub-matrix and ends at an end of a subsequent first-type square sub-matrix.

12. The apparatus of any one of claims 9-11, wherein the identifying of the at least one third-type sub-matrix comprises identifying similar second-type square sub-matrices by comparing patterns of the plurality of second-type square sub-matrices.

13. The apparatus of any one of claims 9-12, wherein the descriptor changes in proportion to changes of the observation.

14. The apparatus of any one of claims 9-13, wherein the descriptor is a list of eigenvalues of Laplace-Beltrami operator over a surface mesh generated from 3-dimensional point cloud data.

15. The apparatus of claim 14, wherein the 3-dimensional point cloud data is obtained by scanning visible subset of the volume.

16. The apparatus of any one of claims 9-15, wherein a similarity value is determined by comparing descriptors of two observations.

17. A non-transitory computer-readable medium storing computer executable code, comprising instructions for:

for each observation of subsets of a volume, calculating a descriptor that characterizes the observation;

determining a similarity value between any two descriptors to form a similarity matrix; and

identifying candidates for re-observed snapshots of the previously observed subsets of the volume based on the similarity matrix,

wherein the instructions for identifying of the candidates for re-observed snapshots comprise instructions for:

identifying a plurality of first-type square sub-matrices along main diagonal of the similarity matrix;

identifying a plurality of second-type square sub-matrices along the main diagonal of the similarity matrix as similar sequences, each of the plurality of second-type square sub-matrices containing multiple first-type square sub-matrices of the plurality of first-type square sub-matrices;

identifying at least one third-type sub-matrix, each of the at least one third-type sub-matrix being an intersection of two second-type square sub-matrices in such a way that rows of the third-type sub-matrix in the similarity matrix are the same as rows of one of the two second-type square sub-matrices in the similarity matrix and columns of the third-type sub-matrix in the similarity matrix are the same as columns of the other of the two second-type square sub-matrices in the similarity matrix; and

identifying largest elements along main diagonal of the at least one third-type sub-matrix as the candidates for re-observed snapshots.