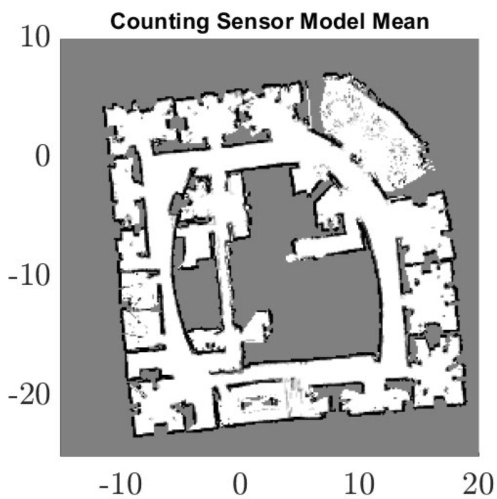
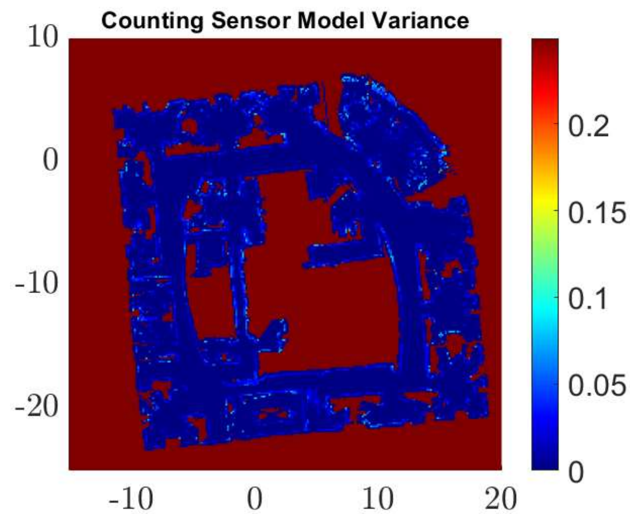
Saptadeep Debnath
EECS568 Problem Set 3

Task 1. Counting Sensor Model

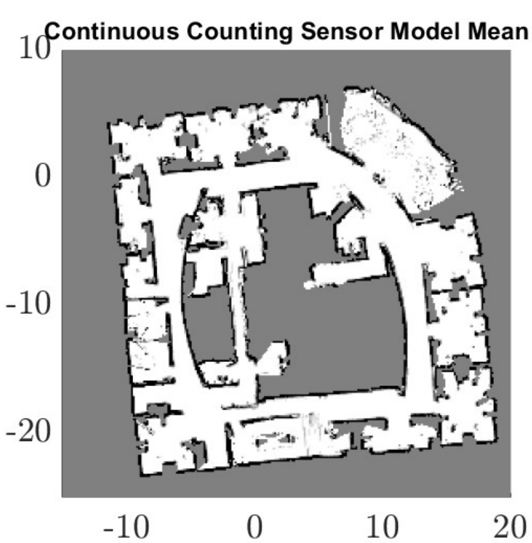
The following grid map and its associated variance map are computed using the counting sensor model with a grid_size of 0.135 m.

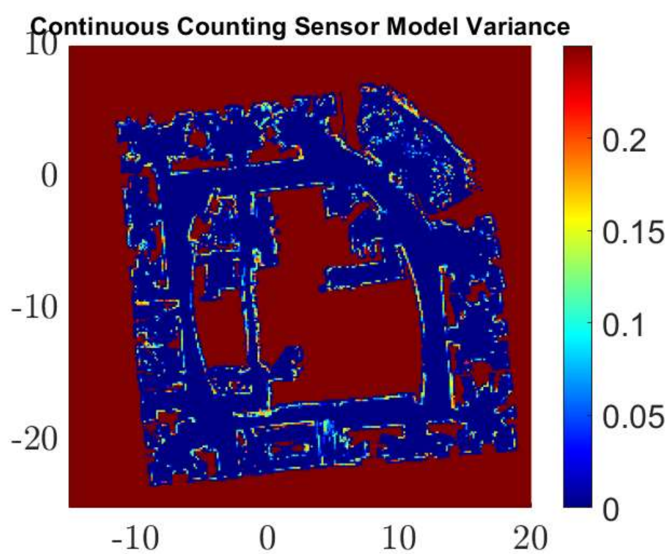




Task 2. Continuous Counting Sensor Model

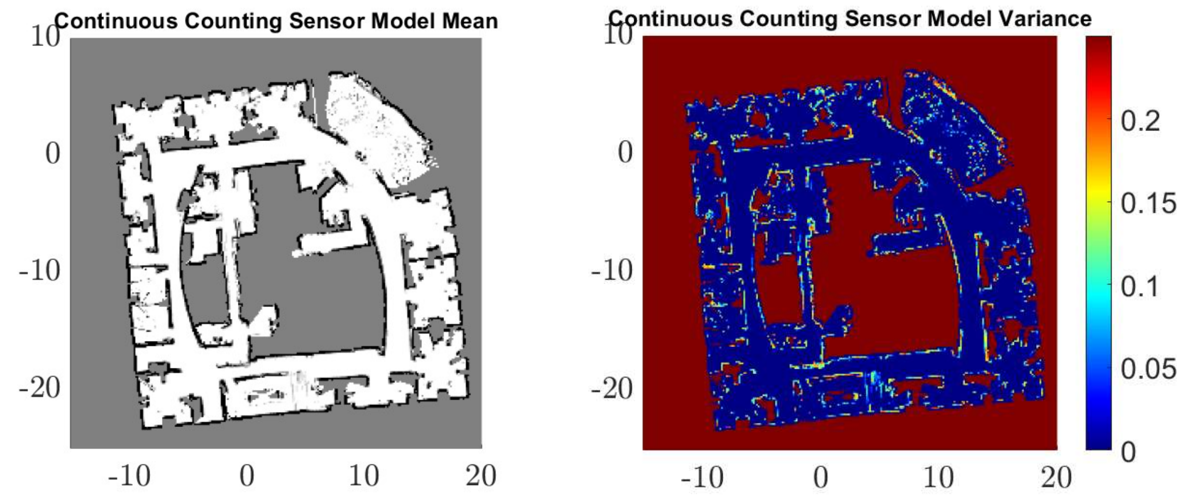
A. The following grid map and its associated variance map are computed using the continuous counting sensor model with a grid_size of 0.135 m.



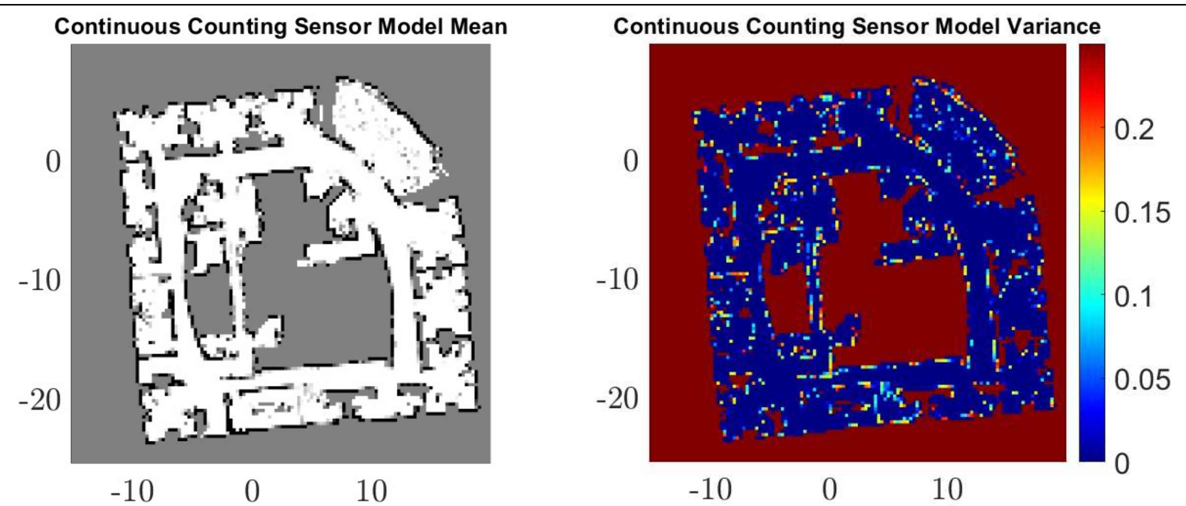


B. Following are the grid maps and variance maps for grid_size = [0.135, 0.270, 0.5]

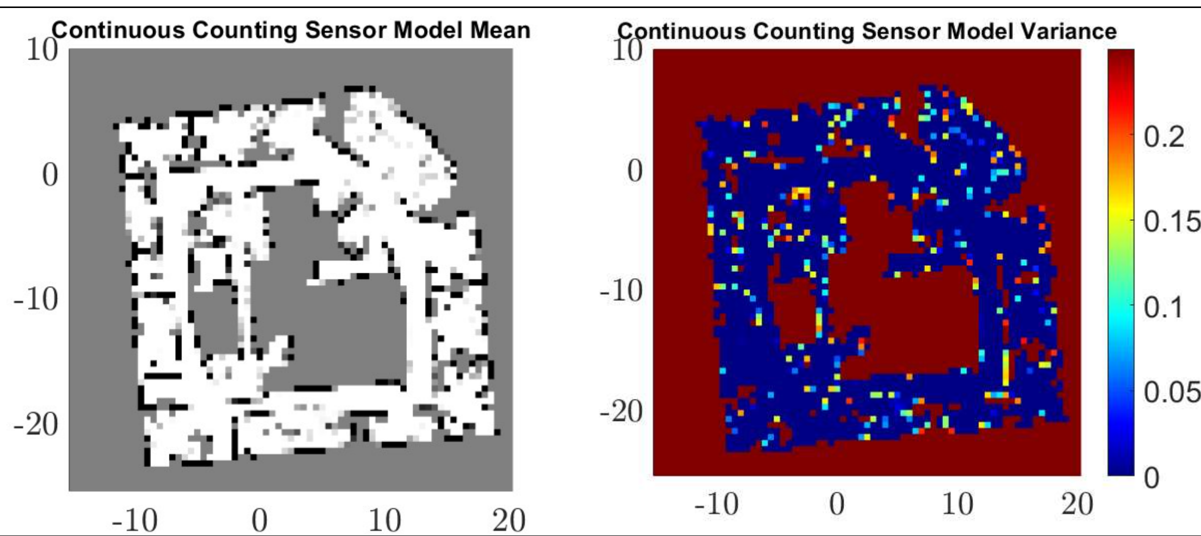
Grid size = 0.135



Grid size = 0.270



Grid size = 0.5

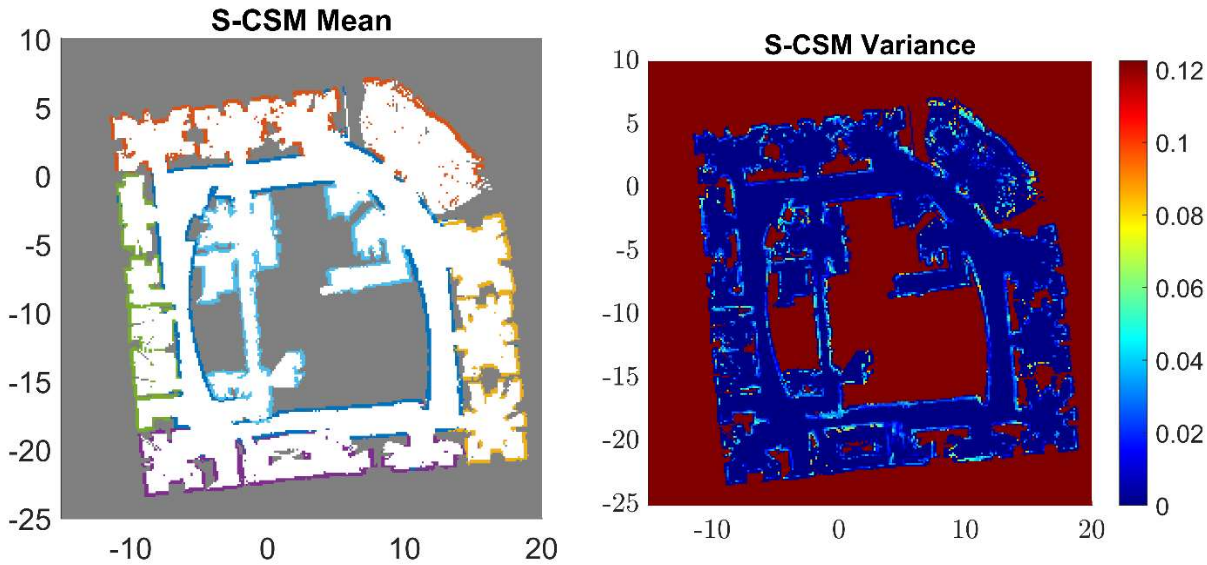


By reducing the grid size, the resolution of the maps decreases. There are two major observations; first, the computation time reduces and secondly the amount of information from the maps generated decreases. It can be said conclusively that having a smaller grid-size increases the resolution of the map and thus include much more information about the map than otherwise. Also, it is observed that the computation time for generating the map is inverse to the grid-size, i.e. increasing the grid-size of the map decreases the computation time.

C. On a much broader view it can be seen that the mean map of the discrete counting sensor model and the continuous counting sensor model is similar with almost the same features being detected. Although on a closer inspection it is observed that the continuous counting sensor model generates a much smoother map. One of the reasons is that the query point used is not a single point (which is the centroid in the case of discrete CSM) but rather a set of points being generated using a user defined kernel. In the experimentations, 4 points were queried for interpolation in the kernel. Thus, it can be inferred that with the right choice of the hyperparameters and the number of interpolation points, the ragged nature of the map generated by the discrete model can be smoothened.

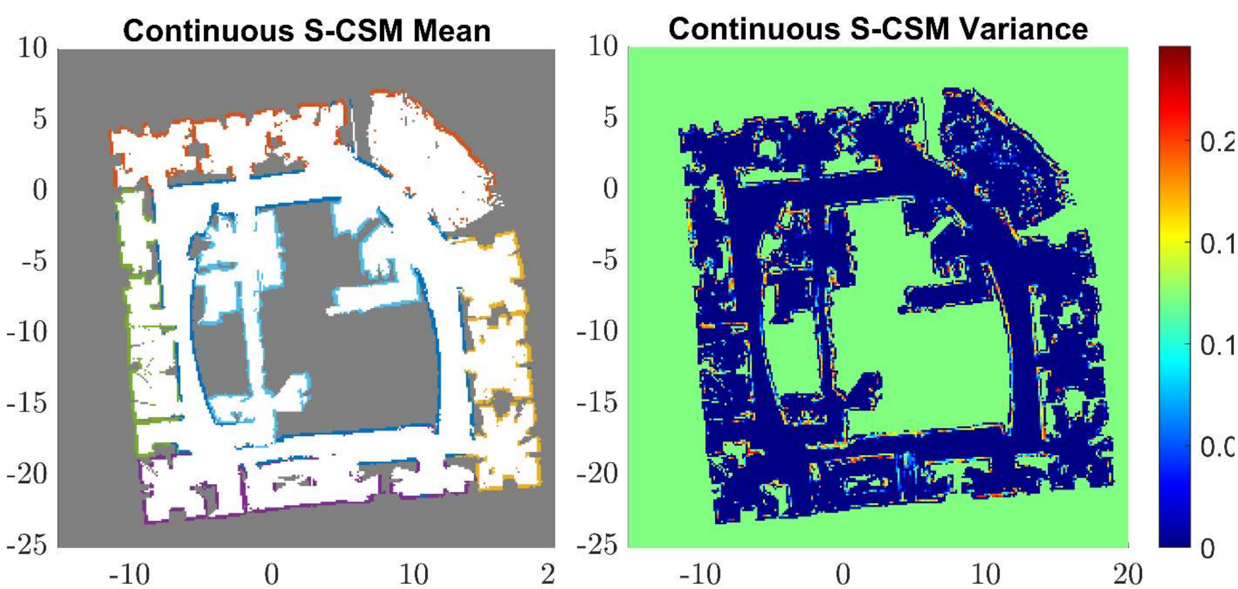
Task 3. Semantic Counting Sensor Model

The following grid map and its associated variance map are computed using the counting sensor model with a grid_size of 0.135 m.



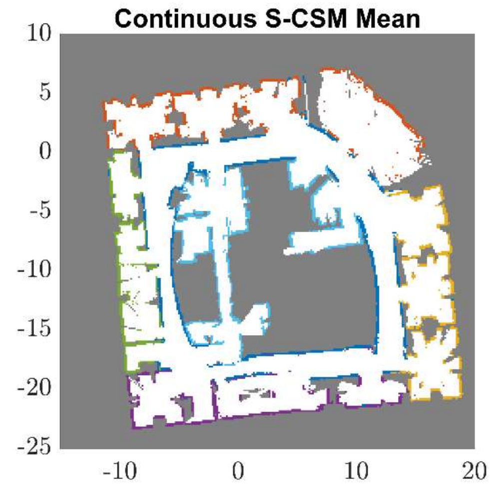
Task 4. Continuous Semantic Counting Sensor Model

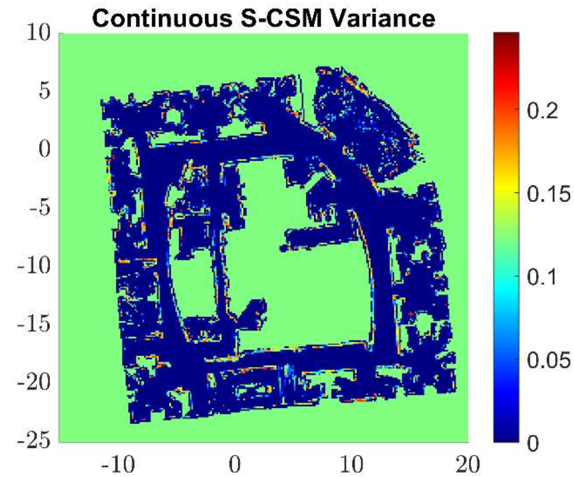
A. The following grid map and its associated variance map are computed using the continuous counting sensor model with a grid_size of 0.135 m.



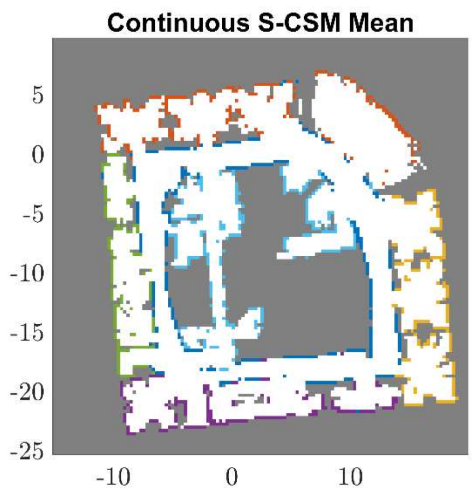
B. Following are the grid maps and variance maps for grid_size = [0.135, 0.270, 0.5]

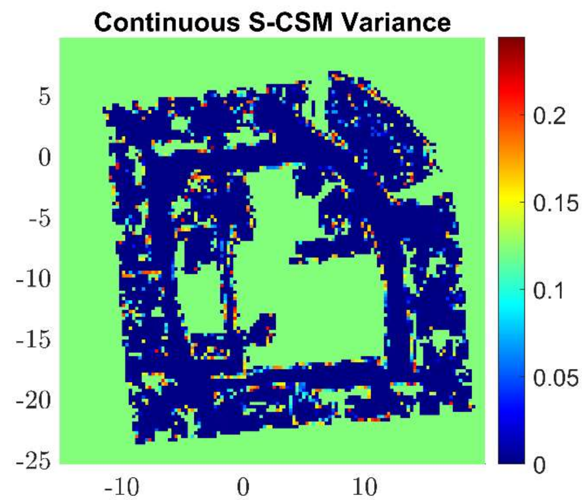
Grid size = 0.135



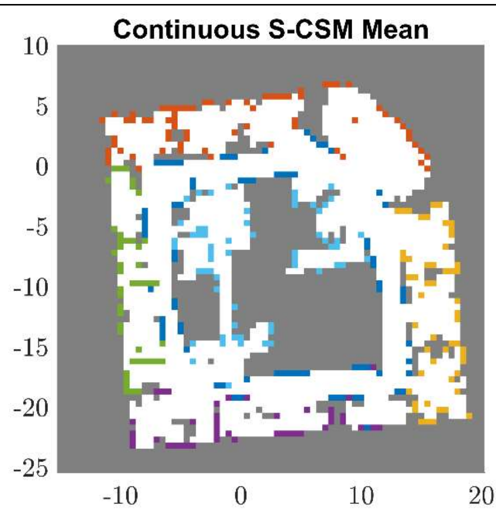


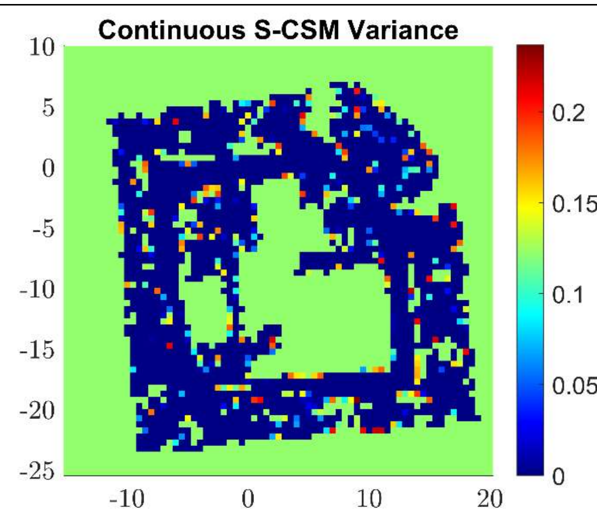
Grid size = 0.270





Grid size = 0.5





It is seen that by reducing the grid size, the resolution of the maps decreases. There are two major observations; first, the computation time reduces and secondly the amount of information from the maps generated decreases. It can be said conclusively that having a smaller grid-size increases the resolution of the map and thus include much more information about the map than otherwise. Also, it is observed that the computation time for generating the map is inverse to the grid-size, i.e. increasing the grid-size of the map decreases the computation time as is seen in the plots shown above.

C. On the first look it can be seen that the mean map of the discrete S-CSM and the continuous S-CSM is similar with almost the same features being detected. Although on a closer inspection it is observed that the continuous S-CSM generates a much smoother map. One of the reasons is that the query point used is not a single point (which is the centroid in the case of discrete S-CSM) but rather a set of points being generated using a user defined kernel. In the experimentations, 4 points were queried for interpolation in the kernel. Thus, it can be inferred that with the right choice of the hyperparameters and the number of interpolation points, the ragged nature of the map generated by the discrete model can be smoothened.

   The choice for implementation of one of the four algorithms (discrete CSM, continuous CSM, discrete S-CSM and continuous S-CSM) discussed in the assignment is totally subjective and task specific. First, the discrete models (in case of CSM and S-CSM) tends to generate a map in much lesser time than the continuous algorithm. But there is a trade-off in the information being generated, which is less in the case of discrete maps as the maps being generated are much ragged than the one generated using the continuous models. Furthermore, while the counting sensor model incorporates just two classes (free or occupied), the semantic sensor model is generated using multiple classes (which in the case of task 3 and 4 are six in total plus the free space). Use of multiple classes inherently increases the information being computed by the model for the generated map, which can further be used in a more descriptive manner in a high-level decision-making process for a robot/machine. A trade-off for higher information in a map is always the computation time for generating the map, which in case of S-CSM maps is higher than the CSM maps. As discussed before, the choice of algorithm to be used on a robotic platform is solely decided by the use and implementation of the map being generated. Dependencies discussed are computation power (inversely related to computation time) and the need of information in a map. In conclusion, for applications that can handle some uncertainties and has a low computing power, a continuous counting sensor model is preferred, whereas in an application which demands a higher need of information to complete the tasks, a continuous semantic map would be preferred.