

- How does your system track the current directions and locations of the lawnmowers?

The system knows the initial condition of the lawnmowers. The mower-map will be updated when each lawnmower scans the environment or make a move. When the lawnmower moves, it will update the position (or coordinate) of the lawnmower in the map based on the direction it moves and whether the move is successfully. If the mower turning, the direction will be updated. Therefore, the system can track the current directions and locations of the lawnmowers based on the mower-map.

- How does your system track the locations of static obstacles like craters?

The simulation system will initialize a lawn map when it reads the information from the input file. It will mark the type of each grid on the lawn with the following: grass, empty, mower, crate, fence and charging station. The crate will mark the craters as “crate” in the corresponding position in the lawn map.

The mower can scan the environment when the area is unknown. If the scan discovers the craters in the surroundings, it will be marked in the mower-map. If the mower moves into an unknown location and crashes, the location it crashes can be either craters or fence (need further information to determine the exact type).

- How does your system track the how much of the grass has been cut so far, and which sections of the lawn still need to be cut?

The system tracks each motion of the mowers and update the map. The map consists of the following states: grass, empty, mower, crate, fence and charging station. Whenever the mower moves across a grass, it will cut the grass and update the total grass that has been cut. And the grid will now be marked as “empty” in the map. The grid that the mower that is current occupying will have no grass when the mower leaves. Therefore, it is clear in the map that which sections of the lawn still have grass, which is marked as “grass”.

- How does your system determine which mower should be checked/pollled for the next action?

The system will allow the mower to move sequentially base on their id if the mower is active. If the mower is disabled, it will be skipped. For example, there are three mowers: mower\_1, mower\_2 and mower\_3. First move mower\_1, then mower\_2, then mower\_3. The next move is mower\_1 again. Each time one mower moves, it will updates its information to the system and to the other mowers. Each motion should avoid hitting a crate, a fence or a mower.

- How does your system determine the next immediate move for each of the lawnmowers?

The mowers will scan and updates the mower-map when it takes an action. Each mower will initialize a mower-map and there is a shared knowledge base among all mowers. The mower-map can be updated with surrounding information when the mower scans. The next immediate move of the mower depends on the knowledge of the mower-map.

1. If the surrounding of the mower is known in the mower-map, the mower should be “greedy” and make a move that can cut maximum amount of grass. If there are several different directions that can cut maximum amount of grass, the mower should choose the direction without turning. If the mower cannot cut any grass (all surroundings are empty), the mower should move to the closest boundary of the known area (in the mower-map) to

perform scan to explore the new areas, or move to an closest location with grass marked in the mower-map (whichever is closer). This can be achieved using breath first search.

2. If the mower does not know its surroundings, it should first scan and then decide how to move in the next step to prevent crash.

- How does your system determine if the move request from a mower is completed successfully, or if it results in a crash?

The system tracks the locations if the craters, fences and the other mowers. If there are craters, fences or the other mowers in the moving path of the mower, the system will determine the move request is not successful. If it moves on to a crate or fence, the mower will be removed from the map. If it hits another mower, it will be immobilized temporally.

In principle, the mower should never move directly into an unexplored area, it must scan the unknown area first and then make a movement. This will ensure that the mower will never hit a crate or fence. However, it is possible that the mower will hit another mower.

- How does your system assemble the data needed to fulfill a scan request?

The simulation system will track the motion of each mower and update the lawn in real time. If the mower moves across a grid with grass, it will be marked as empty. If it hit a crate or fence, it will be removed from the map. If the mower stops at certain grid, it will be marked as mower. If it stops at a charging station, it will be fully charged, and the charging station will be marked as mower. In this way, the system knows the status of each mower and the lawn, it can accurately fulfill a scan request.

- How does your system keep track of the lawnmowers when they are temporarily or permanently immobilized?

The system knows the position and the amount of energy of each mower. If a mower hits a mower, it will be temporarily immobilized. If the mower has no energy left and is not current on a charging station, it will be permanently immobilized.

- How does your system determine when the simulation should be stopped? This must include the cases of a completed lawn and multiple failed lawnmowers.

The simulation system will stop in one of the following conditions.

- (1) All mowers have crashed or run out of energy. There is no active mower left in the map.
- (2) The maximum number of turns in permitted in the scenarios file is reached. The OsMowSis system will count how many turn the lawnmowers has made. The simulation will stop when the maximum allowed turnings are reached.
- (3) All grass has been cut. The OsMowSis system will keep track of how many grasses the mowers have cut. If all grass has been cut, the simulation will stop.

- How does your system track the “full map of knowledge” needed to accurately manage the simulation?

For each move operation of the lawnmower, the simulation system will update the lawn and the knowledge base of the mower (the mower-map) accordingly.

1. If the lawnmower moves across a grid with grass, it will be marked as empty in the map.
2. If the lawnmower hit a crate or fence, the lawnmower will be removed from the map.
3. If the lawnmower hits another lawnmower, it will be immobilized for the current step.
4. The grid that the lawnmower is current on will be marked as mower.
5. If the lawnmower run out of energy and is not on a charging state, it will be disabled on the map.
6. If the lawnmower stops at the charging station, its energy will be restored to maximum.

• How does your system assemble and take advantage of the “partial map” of collected knowledge from the different lawnmowers?

The mower-map can merge the “partial map” generated by different mowers in one of the following three situations.

- (1) when the mower hit other mower, they know the relative position of each other, and they can merge the map.
- (2) when the mower perform scan and find another mower, they know the relative position of each other, and they can merge the map.
- (3) when the mower finds a corner of the lawn, it knows its relative position to that corner. It can then see all the other mowers that also find that corner.