



Figure 4: Another fix is to use an 8-connected grid. Now there is a diagonal line directly connecting (1,1) with (2,2).

paths: there might be just enough room between two obstacles for the robot to move from  $(x, y)$  to  $(x-1, y+1)$ , yet both node  $(x, y-1)$  and node  $(x-1, y)$  might be covered. To guarantee that no paths are missed, the grid spacing must be reduced to  $rVT/2$ . That is the largest  $si/c$  allowable that guarantees that if diagonally opposite nodes are covered, there is not enough room between them for the robot to safely pass.

If the grid is eight-connected (each node connected to its diagonal, as well as orthogonal, neighbors), the problem with diagonal paths disappears. As in the ID case, the grid spacing can be a full  $\lambda$ ; while guaranteeing that if there is a path it will be found.

## 4.2 Grid Search

Once the grid size has been fixed, the next step is to assign costs to paths on the grid and then to search for the best path along the grid from the start to the goal. "Best", in this case, has three conflicting requirements: shorter path length, greater margin away from obstacles, and less distance in uncharted areas. These three are explicitly balanced by the way path costs are calculated. A path's cost is the sum of the costs of the nodes through which it passes, each multiplied by the distance to the adjacent nodes. (In a 4-connected graph all lengths are the same, but in an 8-connected graph we have to distinguish between orthogonal and diagonal links.) The node costs consist of three parts to explicitly represent the three conflicting criteria.

1. Cost for distance. Each node starts out with a cost of one unit, for length traveled.
2. Cost for near objects. Each object near a node adds to that node's cost. The nearer the obstacle, the more cost it adds. The exact slope of the cost function will depend on the accuracy of the vehicle (a more accurate vehicle can afford to come closer to objects), and the vehicle's speed (a faster vehicle can afford to go farther out of its way), among other factors.