Warehouses are increasingly being managed by automated systems. Robots move around inventory shelves so that stationary humans can pick items off of and place items onto shelves. Robots that take optimal paths can increase the rate of orders being filled and decrease the number of robots needed to manage a warehouse. Finding this solution is NP-hard as robots interact with each other.

Kiva systems, recently purchased by Amazon, was created for automated warehouse management. Their system allows for many robots and human pickers to be working at a time.

A* Search
- All edges have equal weights
- \( h(n) \) uses Manhattan distance to prioritize nodes
- Ties in \( f(n) \) also resolved with smallest Manhattan distance
- Reduces the randomness of nodes explored
- Admissibility of A* allows for the shortest path to be found

Collision Resolution
- The environment is carefully engineered to minimize the chances of collision
- Nodes are directionally connected
- a collision is resolved by one robot waiting in its current position
- The order that collisions are detected is changed to resolve circular deadlocks

Example Warehouse given by Kiva Systems

Robot used by Kiva Systems

Warehouse with robots moving and shelves containing items

Collision Resolution

Head on collision that cannot be resolved by waiting

Circular deadlock that occurs if robot B is asked to wait. Can be resolved with A waiting

Future Work
For this project:
- Implement Jingjin’s path finding algorithm and compare running time on a queue of tasks
- Create a warehouse with less restrictive movements and more complex collision resolution
- Create a GUI tool that allows for easier warehouse creation
- Implement multiple shelves on a storage unit

For other projects:
- Senior Thesis next year under Ming Do
- Creating an android app that uses a stereo camera to determine depth of objects

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References
http://www.kivasystems.com
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