**Project Roomba**

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**1. Introduction**

Autonomous robots can take on many real-world roles, from domestic assistants to search and rescue and military applications. This project will simulate a robot traversing and mapping a hostile structure, tracking hostile entities without engaging them. This type of application is useful in military situations when prior knowledge about an enemy structure would aid in planning tactical maneuvers. This robot must be able to discreetly traverse and store relevant information concerning potential obstacles and pathways within the structure.

This utility is not new; in order for practically any autonomous robot to perform a function, it must have the ability to create and maintain accurate models of their environments and relative positions within them. This problem, which has been prevalent in robotics for decades, is often referred to as SLAM, or Simultaneous Localization and Mapping (Rogers III, 2013) (Corcoran, Bertolotto, & Leonard, 2014). The solution to this problem is dependent upon several factors, including the types of sensors the robot is using to obtain information about its environment, the limitations of those sensors, the physical limitations of the robot if it must traverse and actively explore to acquire information, what sort of map is required, etc. (Thrun, 1998)

Several types of sensors have been used, often several in conjunction, to help solve these problems when exploring an environment. Odometry readings, i.e., readings from internal sensors measuring distance traveled or the robot’s angular rotation, by themselves are often quite unreliable; external sensors are required to compensate for this inadequacy (Patki, 2011). A robot will typically use ocular (vision) sensors in addition to range sensors like sonar sensors and laser scanners (Lee, Cho, & Song, 2012). Sonar or auditory sensors can allow for a robot to evaluate and localize events such as humans talking or doors slamming, but they are difficult to calibrate such sensors to dynamically adjust for the robot’s own motion, as well as ambient sounds (Sasaki, Kagami, & Mizoguchi, 2009). Laser scanners are often much more precise, but they are often cost prohibitive. Another alternative is to simply use visual cues for all sensors and rely on a binary search pose estimation technique, which uses visual landmarks to iteratively converge towards the best estimation of the camera’s position relative to the points (Ross, Martchenko, & Devlin, 2013). This visual approach to the localization problem is both cost effective and subtle, something that would be required of a robot with real-world applications in the military, where discretion is of the utmost importance. One factor to consider, however, is the relatively enormous processing power required to store the images (Mendes, Coimbra, & Crisostomo, 2011) .

Once the sensors have detected information about the environment, the robot will need a way to process the objects discovered. These objects can be classified in a multi-level hypothesis hierarchy, much like the robotic butler HERB, which classifies objects as potential people or chairs (Srinvasa, et al., 2009). These objects representing potential humans and obstacles are sorted in a hierarchical tree for easy recall.

Landmarks can also be stored in a tree, allowing the grouping of landmarks to determine relationships and pathways between objects. Using this method is effective for memory storage, as smaller details (which are further down the tree) can potentially be pruned in the event that more memory is needed while still maintaining a broad view of the area, and the global map can be seen as a compilation of smaller, local maps of each room (Mair, et al., 2014).

These potential solutions, drawn from research involving several branches of robotics, have helped us form a basis for our solution to the problem of modeling a previously unknown area and storing the information in the most effective ways possible.

**2. Analysis**

 Project Roomba is a fully autonomous robot design for military use in reconnaissance by traversing hostile structures to generate a map and provide enemy numbers. It primarily consists of three systems: visual scanner (simulated input), coordinate mapping and overarching driver (simulated transversal). After being deployed to the structure, it will begin by attempting to scan through any crevasse of opportunity to evaluate its intended destination for hostile entities. When able, it will enter the new room and repeat this process as it discovers pathways.

The scanning process will record all doorways, windows, objects and entities within the space. These have their locations recorded and are assigned unique IDs as needed, then the information is transcribed through the coordinate system to be stored in the robot’s database in the form of a multi-linked Binary Tree. Since it is designed to avoid engaging an enemy, if discovered it will attempt to retreat through a previously recorded pathway until it is able to resume the mission or return to the operator. If it becomes compromised, there is a fail-safe system in place to erase the software and trigger a self-destruct mechanism.

Upon returning from a successful traversal, the robot's operator is provided an interface to review the information. It can be graphically presented as individual rooms, individual floors, or the entire structure. Each option will also provide the number of living entities encountered and if they appeared to be armed. The maps presented will be comprised of characters with a reference key provided and can be output to a text file.

**Project Roomba Schedule**

Friday, October 20

* Jesse – References, abstract design
* Deanna – Introduction, References
* Kyle – References, abstract design

Friday, November 10

* Jesse – work on user interface, work on Implementation for paper
* Deanna – work on objects in building, work on conclusion for paper
* Kyle – work on generating building, work on design and results for paper

Wednesday, November 29 - Friday, December 1

* Everyone have their sections done to combine and fix bugs

Wednesday, December 6

* Everyone have their part of the paper done and come together to fix paper errors

**3. Design**

**4. Implementation**

**5. Code**

**6. Results**

**7. Conclusion**

# 8. References

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