Homework 4: Packaging Specifications and Design

Team Code Name: 2D-MPR **Group No. 12**

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NOTE: This is the first in a series of four "design component" homework assignments, each of which is to be completed by one team member. The body of the report should be 3-5 pages, **not** including this cover page, references, attachments or appendices.

Evaluation:

SCORE	DESCRIPTION
10	***Excellent*** *– among the best papers submitted for this assignment. Very few corrections needed for version submitted in Final Report.*
9	***Very good*** *– all requirements aptly met. Minor additions/corrections needed for version submitted in Final Report.*
8	***Good*** *– all requirements considered and addressed. Several noteworthy additions/corrections needed for version submitted in Final Report.*
7	***Average*** *– all requirements basically met, but some revisions in content should be made for the version submitted in the Final Report.*
6	***Marginal*** *– all requirements met at a nominal level. Significant revisions in content should be made for the version submitted in the Final Report.*
*	***Below the passing threshold*** *– major revisions required to meet report requirements at a nominal level.* ***Revise and resubmit.***

* *Resubmissions are due within* ***one week*** *of the date of return, and will be awarded a score of "6" provided all report requirements have been met at a nominal level.*

Comments:

Comments from the grader will be inserted here.

1.0 Introduction

The 2D-MPR is an autonomous robot designed to collect data required to map a room. In order to accomplish this, the robot, needs to be able to easily navigate around and know where it is moving as well. In order to accomplish the robot will have to be motorized, relatively low to the ground so that it can fit under some elements in rooms, such as tables. Since we will be using an Xbox Kinect for data collection, with a low lying mobile robot we can easily mount the Kinect and PCB to the top of the robot. With these three components, a mobile robot, an Xbox Kinect, and PCB, the 2D-MPR can be packaged into a working autonomous robot that can effectively navigate and map rooms.

2.0 Commercial Product Packaging

There are two commercial products that are similar to our project design both are used for automated vacuuming in houses. The first is an iRobot Roomba 610 Professional Series and second is Neato XV-11.

2.1 Product #1

iRobot Roomba 610 Professional Series

The packaging on the iRobot Roomba is a circular low height moving robot. On the top of the robot there are a series of buttons used for basic automated control; these buttons will send the robot out to clean. On the bottom are wheels designed to navigate carpet, hardwood floors, or tile. Also on the bottom side are bristles in order to sweep the floors. On the sides are sensors that can search for walls, objects that would obstruct its path, and virtual walls set up by the user. When it is finished cleaning or the battery runs low it will navigate back to its charging station to recharge.

The Roomba advantages lie in its complete autonomy. When set up, it can function completely without ever having to run it, or control it, yourself. Its sensors function very well and are very precise when close. It does a good job of vacuuming crumbs and other small pieces of dirt in the carpet. It maps based on determining where walls and virtual walls are and tracking where it has vacuumed so far. This makes the computation and the sensors on the Roomba pretty simplistic overall which helps for its longevity and reduces chance of malfunction.

Disadvantages with the Roomba start with the sensors. They are not very sensitive and mounted on the sides so long distance mapping is much more difficult. So the Roomba cannot really map rooms without first walking them out. So it may be able to figure out the overall room layout after its first vacuum pass but cannot chart before, and will not be able to easily account for furniture being moved. Also since it is so low to the ground, getting over certain terrain may be difficult or impossible.

In our design we really like the overall design of the Roomba, the minimum height and its movement is something that is perfect for our project. We plan to use the overall design very similarly but our Xbox Kinect will be top mounted making data collection more accurate. We will also need more computing power and obviously have no need for its vacuuming abilities.

2.2 Product #2

Neato XV-11

The packing on the XV-11 is very similar to that of the Roomba. Its structural design is a little more angular and less circular, it has one square side and the other is round. The top has an LCD screen with buttons to help configure the robot, it also has a laser range finder in order to map the room for a much greater distance than the Roomba. On the bottom it is pretty identical in that it has sweepers and wheels for movement. The XV-11 also is very low to the ground which makes it easy to navigate under things but still difficult to navigate over some larger objects. Once the vacuuming robot also uses a charging station in order to recharge when finished cleaning or out of batteries.

The biggest advantage the XV-11 has that the Roomba does not is that it can truly map and navigate a room. It scans the room with the laser range finder and determines the best and most efficient way to clean the room. This will obviously require more calculation which could lead to greater change of failure or programming bugs but based on reviews is not really a problem. It also determines where it is in the mapped room based on where it has moved based on its movement of its wheels. When cleaning the XV-11 also has a special approach to corners that cleans them more effectively.

The disadvantages for the XV-11 are almost completely the same as the Roomba. It’s low riding making it difficult to drive over larger objects. However unlike the Roomba, as mentioned before, it does map the room, so it can account for changes more quickly and more efficiently than the Roomba. With its different shape however it may be more difficult to navigate a room, causing the XV-11 to catch its rounded corners easier then the circular Roomba.

The XV-11’s greatest quality is its mapping ability, which we plan to mimic with our Kinect. Its laser range finder is also top mounted which is similar to where the Kinect will be mounted on our robot. So overall our shape will be similar to that of the Roomba but the functionality will be more similar to the XV-11, aside from the vacuuming capabilities obviously.

3.0 Project Packaging Specifications

The design of the 2D-MPR will use the iRobot Create as the base robot. It functions much like a cut down version of the Roomba. It comes with built in sensors for up close detection, motor and wheels for movement, and serial port in order to take full control of everything it is capable of. The PCB will be in the cargo bay of the iRobot and the Xbox Kinect will be mounted on the top. The PCB will interface the wireless device with the iRobot's and Kinect's functions and data, as well as the computations to map the room and basic navigation of it. Please see Appendix A for a CAD drawing of the 2D-MPR and Appendix B for other specifications.

4.0 PCB Footprint Layout

The major components selected include, an ARM processor and a wireless networking module, both of which are pretty straight forward and we decided to order pretty much what we needed in terms of computing power and speed. Both easily fit onto the iRobot so space is not really a major concern for our PCB. With the two components mentioned as well as connectors to the USB for Kinect and serial for the iRobot the overall size should be around XXXmm^2. Please see Appendix C for PCB footprint layout.

5.0 Summary

The packaging of the 2D-MPR will overall be small, lightweight, and simple but have the computing power, accurate long range (2m+) sensors, and the mobility to map and navigate a room. Its base design will be very similar to the Roomba 610 while having the sensing and computing capabilities of the XV-11. Using these two commercial products as a guild in the package design of our project we have settled on using the iRobot to provide the mobility and basic housing for the 2D-MPR. With top mounted Xbox Kinect sensor and a PCB with an ARM processor housed in the iRobot's bay the design should exceed the needs required to accomplish all the PSSC's.

List of References

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http://www.nxp.com/documents/data_sheet/LPC1758_56_54_52_51.pdf
[Accessed: Feb 9, 2011].

[4] Microsoft, Xbox Kinect,
http://www.xbox.com/en-US/kinect
[Accessed: Feb 10, 2011].

[5] iRobot Corporation, iRobot Roomba 610 Professional Series,
http://store.irobot.com/product/index.jsp?productId=3881237&cp=2804605.2501652&view=compare&s=D-StorePrice-IRBT&parentPage=family
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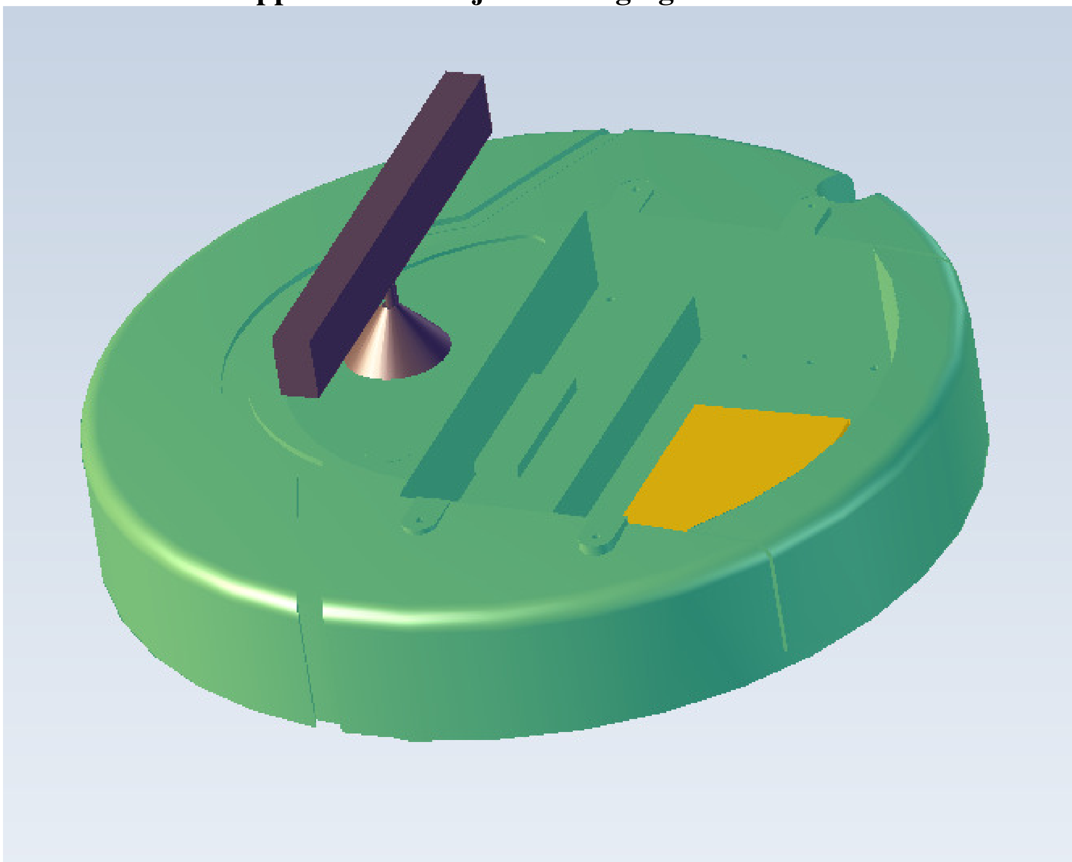
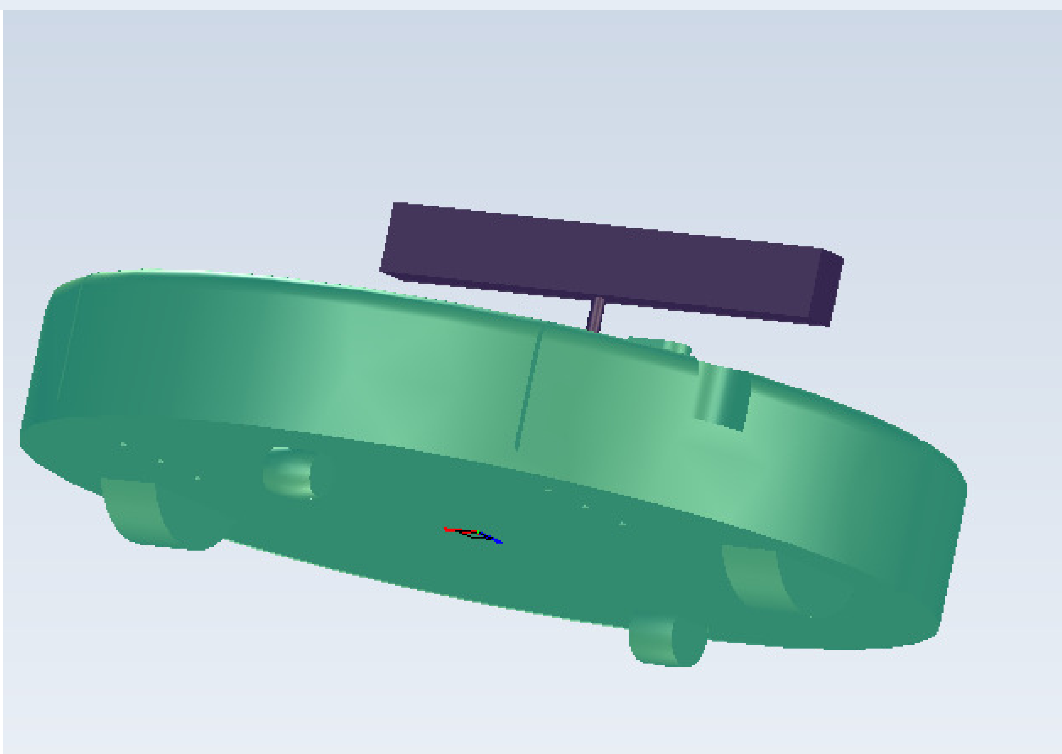
[6] Engadget, Neato XV-11 robotic vacuum review,
http://www.engadget.com/2010/08/24/neato-xv-11-robotic-vacuum-review/
[Accessed: Feb 10, 2011].

[7] Neato Robotics, Neato XV-11,
http://www.neatorobotics.com/
[Accessed: Feb 10, 2011].

IMPORTANT: Use standard IEEE format for references, and CITE ALL REFERENCES listed in the body of your report.

Appendix A: Project Packaging Illustrations





Appendix B: Project Packaging Specifications

Materials

Part	Description	Cost
iRobot	Open-source, mobile robotics platform	$175.00
Xbox Kinect	Vision sensor array	$150.00
LPC1758	ARM Cortex M3 Microcontroller	$24.26
LPC1343	ARM Cortex M3 Development Board	$39.95
WRL-08664	Drop-In Wireless Networking Module	$45.90
		$435.11

Estimated Weight: 7-8lbs

Appendix C: PCB Footprint Layout