Project Proposal

Department of Aerospace and Mechanical Engineering

EME85A - Team Winery Bot

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Abstract

In response to a Unitrans request for a bike storage system on buses, a front-attaching bike rack capable of carrying two bikes was designed. The design placed emphasis on durability and user-friendliness. It consisted of a steel frame, aluminum bar slots, a spring pin restraint for each wheel and a hinge joint at the end of each slot. The spring pin box allows for the user to simply place their bike on the rack and automatically lock in place. The rack was mid-range in price in comparison to competitors and has passed static and fatigue simulations, successfully achieving infinite life under normal operating conditions.

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1 Mission Statement

The Winery Floor Cleaning Robot team is tasked with developing an autonomous robot that can clean the crush pad area of the winery of grape skins, stems, and other debris with minimal water use. Currently the wine industry, uses approximately six volumes of water?almost entirely used for cleaning purposes?to produce one volume of wine. This project is sponsored by Dr. David E. Block of the Viticulture and Enology Department at UC Davis.

2 Identified Customer Needs

After speaking with Dr. Block about the current problems and discussing the pros and cons of the WEINBot created last year, the team developed the needs that needed to be met for the new robot. Since a large concern of current cleaning methods is the amount of water used, the robot should minimize the amount used to clean. It should also be fully autonomous, which includes finding its own charging station when the battery is low. It also includes being able to navigate obstacles and stay within designated areas. The robot must also be safe to operate when turning on and off and easy to clean.

3 Refined Target Specifications

These needs led to the development of some preliminary target specifications for the new robot. The new design will cut the ratio of water to wine to at least 3:1. It will have multiple sensors to gain information from each direction to provide safe 360^o automation. The insides and wiring of the robot will be covered with a casing to shield sensitive components as well as protect users from potentially dangerous electrical equipment. Brushes and waste baskets will be easily removable through use of bolts and snap fits for manual cleaning purposes and the robot itself will be able to clean the UC Davis winery crush pad, 800 square feet, in less than an hour on one battery charge. There are two options to solve these problems. The first is to use the existing WEINBot and modify it to meet the desired specifications. The second option is to design and construct a new prototype. If the WEINBot is modified, there are several key issues that need to be addressed in order for it to be used by the winery staff. The WEINBot must be made autonomous and run its movement and cleaning functions simultaneously. It must be reduced in size and the exposed battery terminals and electrical wiring must be covered., A new WEINbot design could potentially use the same idea of the original, but reduce the scale of the components. The problem with this, however, will be to optimize the size and efficiency. A larger robot can clean a larger area and carry a heavier load, but its bulkiness makes it hard to use and inefficient in power. A new WEINbot structure could use the same dynamic cleaning system as the original, but have better space optimization.

4 External Concepts and Existing Solutions

The main problem with the current robot is that it is lacking the proper software to run functions simultaneously and autonomously. The current robot is also using complex circuitry and wiring that is difficult to follow and decipher without previous documentation. This includes multiple wires and power sources that were previously disconnected and without knowing exactly where they go, it is dangerous to operate. As a group, it was decided that designing a microcontroller system from scratch would provide a better learning experience because of the potential problems of failures that might be encountered instead of trying to slowly follow each wire that was previously used. Since the previous robot did not have an automation system in the first place, it makes sense to design a new one from scratch. Most of the hardware for the robot will remain the same, however, everything will be unplugged and rewired from the beginning.

After studying the previous robot, it was found that the system used a single LIDAR sensor and a strain gauge on the front. The microcontroller it used was the Beaglebone Black along with various relays and other subcomponents. Further research of automated vacuum cleaners in general showed interesting features. A Roomba has a single sensor in the center of the robot detecting obstacles. Other autonomous objects like the Google Car has multiple sensors placed at a height above it in order to generate data on the surroundings.

5 Initial Design Concepts

Using these external concepts as guides, more internal concepts were generated. The goal involved finding the correct microcontroller and sensor for the job as well as developing ways of mapping for the WEINbot. Microcontrollers that were considered included the Arduino MEGA, TI CC3200, and the Beaglebone Black. These microcontrollers would then be connected to different methods of environment sensing to determine position and obstacles. Potential ways of obstacle detection include LIDAR and SONAR. With recent technology advances, it may also be possible to take a picture and scan it for categorized objects that are obstacles. Sensor location for the robot was also considered. Having sensors at each side simultaneously gathering information would be much safer than a single sensor in the front, especially when turning. There were also many different methods of generating a path for the WEINbot. It is possible to just program the floor plan of the desired location to be cleaned into the robot and just have it follow a predetermined route every time. This, however, is not true automation and obstacles could still get in the way. Another way of automation was SLAM which maps obstacles in the environment as the robot travels.

6 Preliminary Planning and Scheduling

7 Preliminary budget

Qty	Cross-section	Length	Description	Price	Total
4	1x1x0.125	70	Square Tube (6063-T6 Aluminum)	0.37	103.6
3	1x1x0.125	41	Square Tube	0.26	31.98
4	1x1x0.125	36	Square Tube	0.26	37.44
4	1x1x0.125	11	Square Tube (6063-T6 aluminum)	0.37	16.28
4	6x0.5	12	Plate to support the bike	19.28	77.12
1	1.625x3	18	Spring box	89.7	89.7
4	0.5 diameter	2	Spring	3	12
1	0.5 diameter	12	Pin collets	4	4
1	12x1	24	Plate that connect the rack to the bus	220.55	220.55
Total Parts: 26			**648.67**		
RECOMMENDED MSRP			**1081.12**		

Table 1: Bill of Material

8 References

1. "CHAPTER 310.", 2014. *California Vehicle Code.* Assembly Bill No. 2707. Sacramento: California Legislative Counsel, 2014. Print.

2. Richard G. Budynas, J. Keith Nisbett 2011. *Shigley?s Mechanical Engineering Design.* The McGraw-Hill Companies, Inc. 1221 Avenue of the Americas, New York, NY 10020

3. Speedy Metals 1. *Wall Other Steel Square Tube.* Web. 1 Dec. 2015. http://www.speedymetals.com/pc-4783-8251-1-x-012-x-1-wall-square-steel-tubing.aspx.

4. SolidWorks essentials, 2015. *Concord, Mass.: SolidWorks Corporation.* http://help.solidworks.com/2015/English/SolidWorks/sldworks/c_introduction_toplevel_topic.htm.

A Apendix A: Figures

Type	Battery	Ultracapacitor
Power Density	Lower	Higher
Energy Density	Higher	Lower
Price	Depends, larger batteries can be very expensive	Relatively inexpensive
Lifetime	Hundreds to thousands of times before replacement	Can be used thousands to millions of times
Common Uses	Everyday electronics	Wind turbines, hybrid vehicles, electric motors

Table 2: Battery Considerations

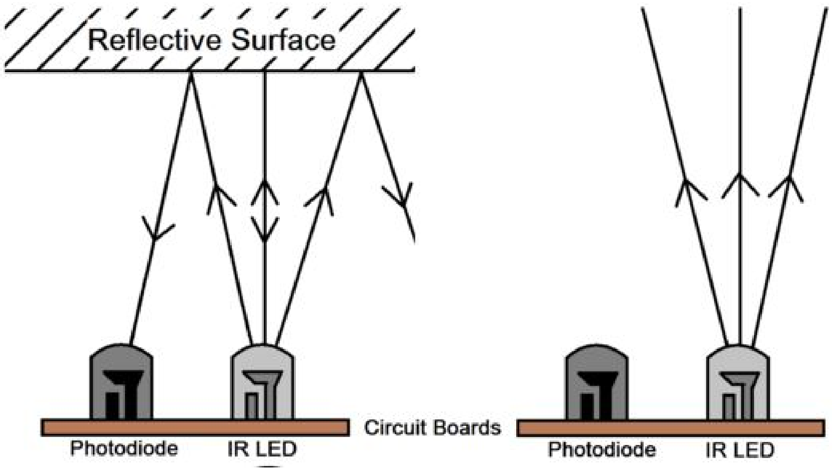

Figure A.1: Infrared Detector (www.maxembedded.com)

A APENDIX A: FIGURES

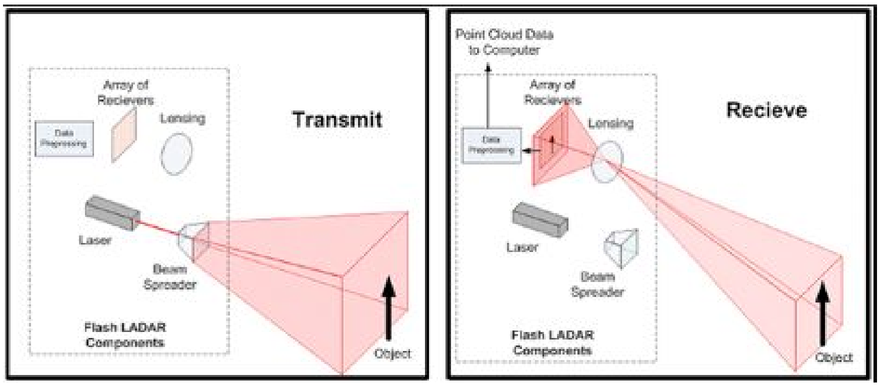

Figure A.2: LIDAR Scanning (www.advancedscientificconcepts.com)

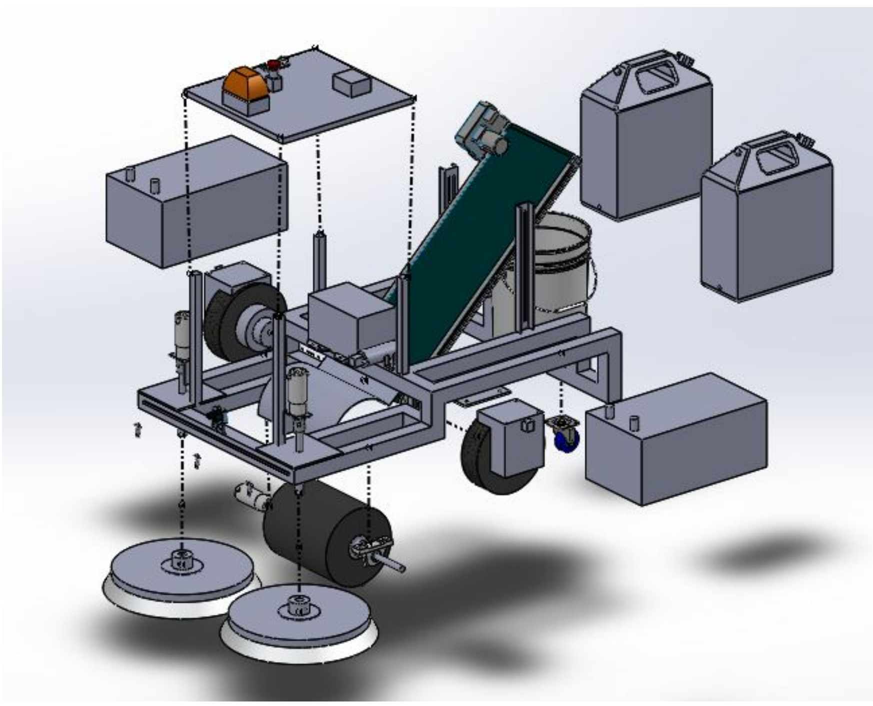

Figure A.3: WEINBot Assembly