ModBot
Project Plan Document

Document Version: **2.0**

AUTHORS

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VERSION HISTORY

Date	Document Version	Document Revision History	Document Author/Reviser
January 24, 2018	1.0	Initial draft	Courtney Kinnard
January 31, 2018	2.0	Made changes to accommodate input from project mentor, Houssam Abbas.	Courtney Kinnard

APPROVALS

Date	Document Version	Approver Name and Title	Approver Signature
January 31, 2018	2.0	Houssam Abbas, project mentor	Houssam Abbas

TABLE OF CONTENTS

1. INTRODUCTION

The ModBot project seeks to design and develop a modular robot that fulfills multiple functionalities based upon the user's needs. This project was born out of research efforts from the University of Pennsylvania, and the hope is that over a period of years, a product will be available in stores in a "snap-and-go" configuration, where customers with no programming or robotics knowledge will have the ability to build their own robot to perform a variety of tasks.

Our project will be the first installment of this future vision and will focus on accomplishing two main tasks: perception and navigation. The goal for this project is to develop the robot to fit a single use case and developing differing functions to accomplish this use case to meet modularity requirements.

2. STATEMENT OF WORK

In scope:

- Sensing obstacles around the robot
- Robot range of motion
- Weigh objects placed on robot via load cell
- Attach camera
- Identify target destination
- Move to destination while avoiding obstacle collision
- Modularity of adding/taking away sensors

Out of scope:

- Attach a grabber for retrieving items
- Voice control
- Hand gestures to control motion

3. WORK REQUIREMENTS

Kickoff:

- Select libraries
- Order hardware components
- Complete documentation

Design Phase:

- Identify and prepare a controlled environment for testing
- Determine how the hardware pieces will fit together

Build/Implementation Phase:

- Assemble the robot body with base sensors (module 1)
- Install software libraries and packages
- Write software to control motion and detect and avoid obstacles
- Add the camera to the robot in a "snap-and-go" fashion (module 2)
- Program Pi to recognize attached camera and unlock access to camera functions
- Write software to process field of vision and determine distance to target
- Write software to navigate to target while avoiding obstacles using camera and sensor input
- Stretch goal: Add optical character recognition for the robot to identify its target for navigation

Training Phase:

- Test to ensure that the robot can perform its defined functions (both modules) in controlled environment
- Prepare demo for presentation, ensuring the robot passes its test cases in each stage of part addition

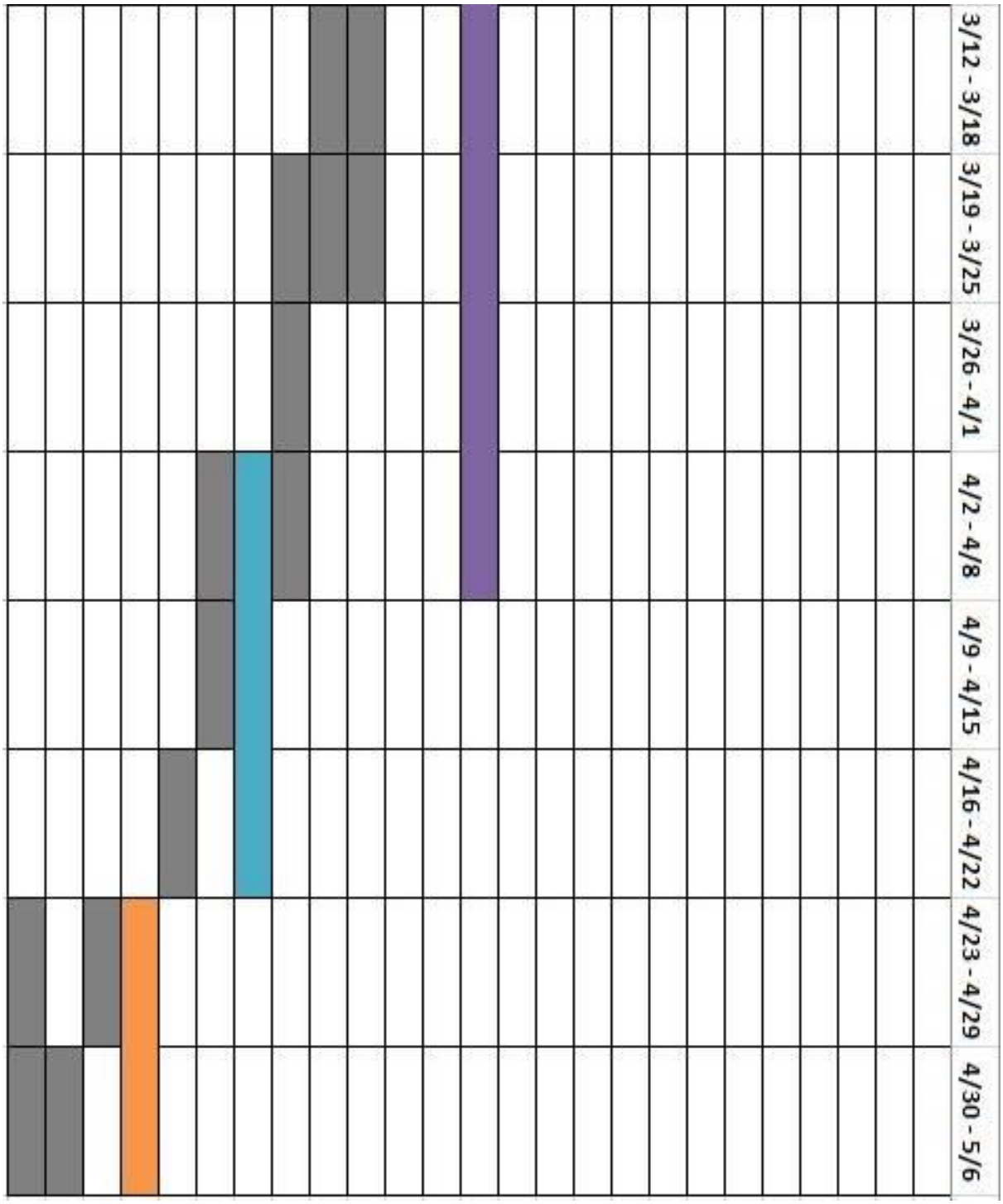
Handoff/Closure:

- All documentation completed and signed
- Code available via GitHub
- Written tutorials of each test case so they can be replicated properly
- Public project demonstration

4. SCHEDULE/MILESTONES

ModBot Project Schedule

		1/22 - 1/28	1/29 - 2/4	2/5 - 2/11	2/12 - 2/18	2/19 - 2/25	2/26 - 3/4	3/5 - 3/11
1. Kickoff								
	Order hardware							
	Select libraries							
	Write documentation							
2. Design								
	Prep testing environment							
	Create hardware design							
3. Build I								
	Assemble body with sensors							
	Install software libraries							
	Motion control software							
	Obstacle avoidance software							
4. Build II								
	Add "snap-and-go" camera							
	Unlock camera functions							
	Identify target							
	Process field of vision							
	Navigate to target							
5. Training								
	Test all functions							
	Prepare demo in eac h phase							
6. Handoff								
	Complete documentation							
	Make code available							
	Write use case tutorials							



Link to document:

ModBot Project Schedule.xlsx

5. ACCEPTANCE CRITERIA

Criteria:

- **Showcases modularity**
- **Performs trials with minimal errors or collisions**
- **Utilizes visual input to identify and navigate to target**

These criteria will be evaluated by the team, the course instructor, Bardh Hoxha, and the project sponsor, Houssam Abbas. The course instructor and the project sponsor are authorized to accept the work, and their concurrence will be the final say on the acceptance of the project.

6. RESOURCE REQUIREMENTS

Small-size robot components:

- Frame: http://www.robotshop.com/en/dfrobot-4wd-arduino-platform-encoders.html
- Motor Control: https://www.adafruit.com/product/2348
- Microcontroller: https://www.amazon.com/Raspberry-Pi-RASPBERRYPI3-MODB-1GB-Model-Motherboard/dp/B01CD5VC92
- Battery: https://www.robotshop.com/en/120v-2800mah-rechargeable-nimh-battery-pack.html
- Charger: https://www.robotshop.com/en/nimh-nicd-smart-charger-1025.html
- PWM expander: https://www.adafruit.com/product/815

Sensors:

- Night Vision Camera: https://www.amazon.com/Raspberry-Camera-Module-OV5647-Supports/dp/B01ICLLOZ8/ref=sr_1_3/133-9116198-4574465?ie=UTF8&qid=1512845609&sr=8-3&keywords=raspberry+pi+night+camera
- GPS: https://www.adafruit.com/product/746
- Sonar: https://www.amazon.com/HC-SR04-Ultrasonic-Distance-MEGA2560-ElecRight/dp/B01MA4O5G5/ref=sr_1_4?ie=UTF8&qid=1512873604&sr=8-4&keywords=HC-SR04
- Load cell to get the weight of objects: https://www.sparkfun.com/products/13329

Tools:

- Soldering Station: https://www.amazon.com/X-Tronic-3020-XTS-Digital-Display-Soldering/dp/B01DGZFSNE/ref=sr_1_3?ie=UTF8&qid=1516638407&sr=8-3&keywords=soldering+stations
- Pliers: https://www.amazon.com/Kobalt-0464614-5-piece-Pliers-Set/dp/B00GR98QOA/ref=sr_1_10?s=hi&ie=UTF8&qid=1516638540&sr=1-10&keywords=pliers+set
- Screw Driver: https://www.amazon.com/Syntus-Precision-Screwdriver-Electronics-Cellphone/dp/B071PB4RPV/ref=sr_1_9?s=hi&ie=UTF8&qid=1516638641&sr=1-9&keywords=electronics+screwdriver+set

Programming Language:

Python

Software Libraries:

RPi.GPIO (for control of motor and movement of robot)

YOLO – You Only Look Once (for navigation/mapping of environment)

SLAM (Simultaneous Location and Mapping)

7. RISKS

- Time constraints
- Learning curve in robotics development
- Working with sensitive parts
- Difficulty integrating sensors with the rest of the hardware
- Parts may not work as intended upon original purchase
- Software may not be compatible with certain hardware components
- Mapping techniques may be too processing-intensive
- Further modifications to the system to meet use case may result in subtle scope creep

8. ROLES AND RESPONSIBILITIES

J. Kole Cralley: Hardware SME / Developer

Vincent Davis: Lead Developer

Christian Garcia: Project Lead / Developer

Courtney Kinnard: Project Manager / Developer

Date:	1/31/2018
Approved by:	Houssam Abbas
Approver Signature:	(see attached)
Mentor Name:	(see above)
Mentor Signature:	