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VERSION HISTORY

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<td>Courtney Kinnard</td>
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APPROVALS

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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
## Schedule/Milestones

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<tr>
<td>Add &quot;snap-and-go&quot; camera</td>
<td>Install software libraries</td>
<td>Motion control software</td>
<td>Order hardware</td>
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<tr>
<td>Process field of vision</td>
<td>Obstacle avoidance software</td>
<td>Create hardware design</td>
<td>Select libraries</td>
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<tr>
<td>Identify target</td>
<td>Software libraries</td>
<td>Prep testing environment</td>
<td>Write documentation</td>
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<tr>
<td>Navigate to target</td>
<td>Assemble body with sensors</td>
<td>Write tutorial</td>
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<td>Test all functions</td>
<td>Create manual</td>
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<td>Prepare demo in each phase</td>
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<td>Complete documentation</td>
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<td>Make code available</td>
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<td>Write use case tutorials</td>
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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:
- Motor Control: [https://www.adafruit.com/product/2348](https://www.adafruit.com/product/2348)
- PWM expander: [https://www.adafruit.com/product/815](https://www.adafruit.com/product/815)

Sensors:
- GPS: [https://www.adafruit.com/product/746](https://www.adafruit.com/product/746)
- Load cell to get the weight of objects: [https://www.sparkfun.com/products/13329](https://www.sparkfun.com/products/13329)

Tools:
- Pliers: [https://www.amazon.com/Kobalt-0464614-5-piece-Pliers-Set/ref=sr_1_10?ie=UTF8&qid=1516638540&sr=8-10&keywords=pliers+set](https://www.amazon.com/Kobalt-0464614-5-piece-Pliers-Set/ref=sr_1_10?ie=UTF8&qid=1516638540&sr=8-10&keywords=pliers+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:  
   (see attached)

   Mentor Name:  
   (see above)

   Mentor Signature:  
   (see attached)