Walking Machine Proposal

Prepared For: San Diego State University

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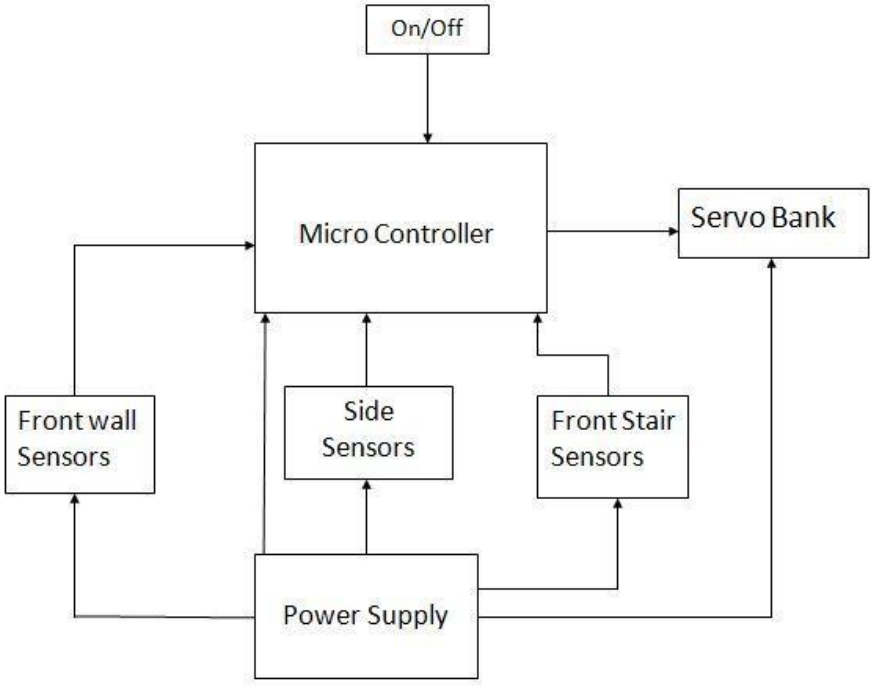
Introduction

Abstract: This proposal details the Rabbit Trails team's initial plan to create a walking robot. This document explains how we plan to design a machine to navigate autonomously, avoid obstacles, traverse a predefined set of stairs, and reach a predetermined destination. Our strategy is to build a custom chassis that will house an onboard power supply and microcontroller capable of powering servo motors and infrared sensors to identify its position and navigate toward the goal.

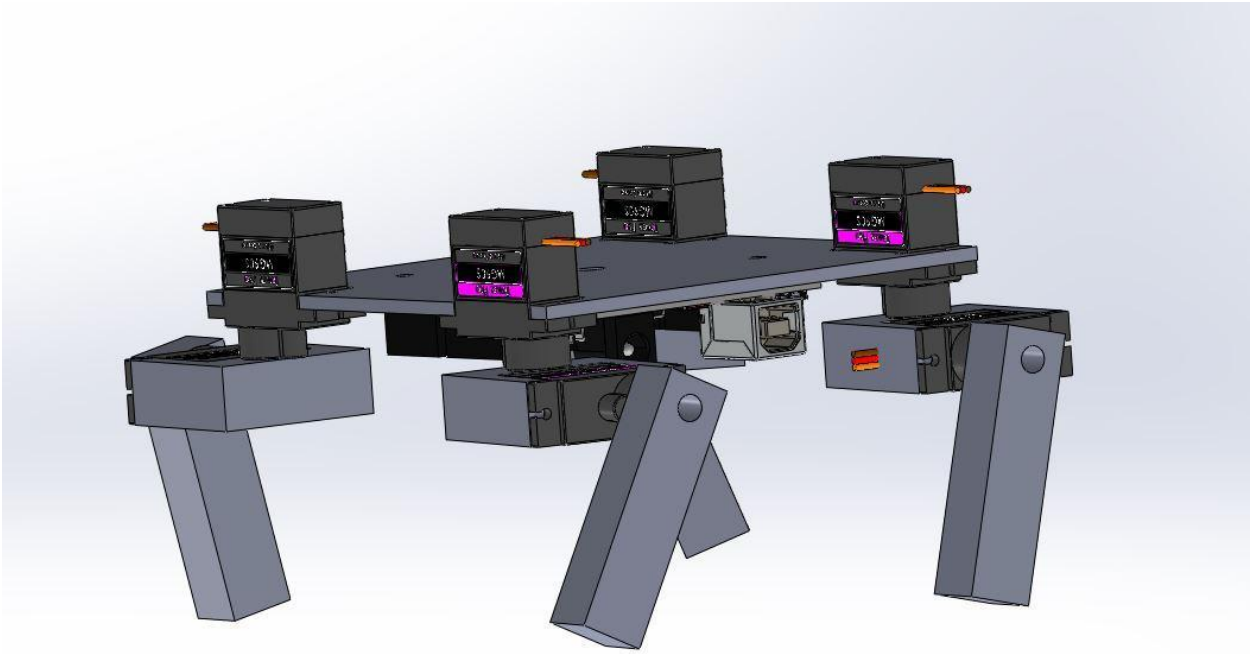
Project Description: Design a walking robot capable of avoiding obstacles of at least 2" in height, ascending and descending a total of exactly two stairs of 1" height, 2" depth, and 7" width. The robot must be able to fit inside a 7" cube. The robot may not receive any user input or control. The use of wheels is allowed but must not be the primary driver of motion. Two tests will be implemented to test success: A test with obstacles but no stairs and a test with obstacles including a set of unavoidable stairs. Robots will be scored based on their ability to successfully reach the goal, traverse the stairs, and complete the course quickly. This is a competition.

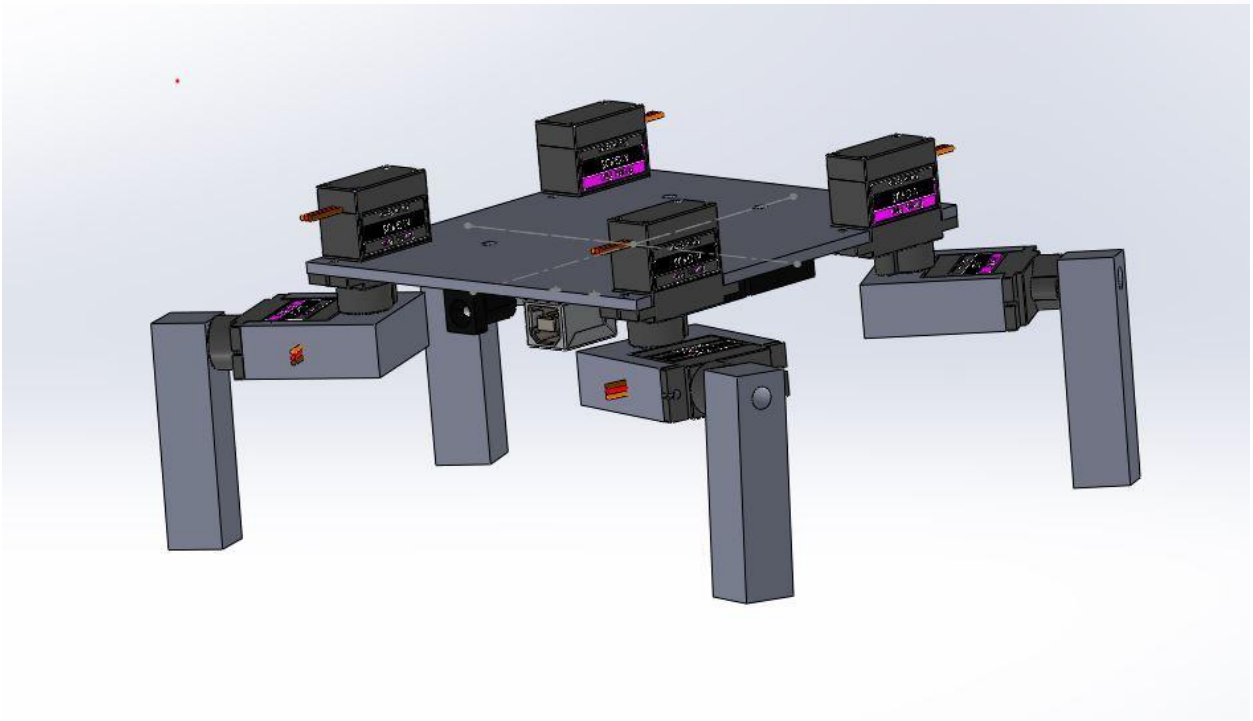
Design

Block Diagram:



Mock-Up Illustrations:





Performance Requirements: The performance requirements state that our robot must:

- Avoid obstacles of at least 2” in height
- Ascend and descend exactly two stairs of 1” height, 2” depth, and 7” width
- Fit within a 7” cube
- Operate autonomously
- Not use wheels as the primary driver of motion
- Complete the course as quickly as possible

Testing and Verification

Testing Procedures:

Servo Test
Servos will be tested in a custom designed servo test fixture. They will be tested for functionality and for calibration purposes. All servos will be serialized. The calibration done in this test will be used in Software Design to ensure that each leg moves predictably.

Sensor Test
Sensors will be tested in a custom designed sensor test fixture. They will be tested for functionality in the specified range of operation and for calibration purposes. All sensors will be serialized. The calibration done in this test will be used in Software Design to ensure that each sensor measures distance predictably.

Unpowered Walking Test
The first iteration of the chassis will be tested for the ability to walk. Servos will be replaced with dowel rods to allow free range of motion. Each leg will be meticulously moved mechanically by hand power. This test will ensure that the mechanical design allows the robot to walk, given appropriate electrical design and software.

Powered Walking Test
The second iteration of the chassis will be tested for the ability to walk. The robot will have all servos and the power supply installed. Software to make the robot walk will have been written. The servos will be tested to ensure they move with an appropriate walking cycle to create a stable forward walking motion. Reverse walking will be tested in the same fashion. Side to side walking will then be tested. Lastly, turning motions will be tested. This test will be done iteratively throughout the software design process to ensure that the most refined walking motion is achieved.

Obstacle Avoidance Test

The robot will be tested for the ability to identify an obstacle, find a way around the obstacle, and correct its walking course before colliding with the obstacle. We will set up various obstacles at various distances from the robot and observe how it attempts to maneuver out of situations. No distance will be considered too close or too far to place an obstacle during this test. A minimum of 12 different obstacle scenarios will be created by the test team and the robot will be tested in each.

Stair Identification Test

The robot will be tested for the ability to identify stairs. It will be tested for the ability to differentiate between a stair and an obstacle. The robot will take no corrective action to avoid an obstacle until it is determined that that obstacle is not a stair.

Stair Climb Test

The robot will be tested for the ability to climb stairs. Stair dimensions and quantity have been explicitly defined in the Project Description above. Once successfully identified, the robot will be hardcoded to move toward the stairs, stop at an appropriately close distance from the first stair, and begin to climb the stairs one leg at a time.

Stair Descent Test

The robot will be tested for the ability to descend stairs. Once successfully climbed, the robot will be hardcoded to descend the stairs, reposition all of its legs on the ground, and continue the mission.

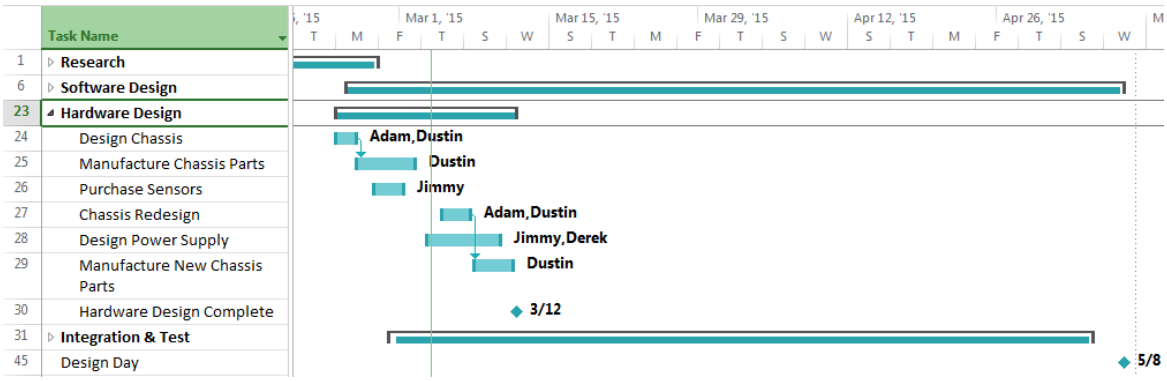
Course Completion Test

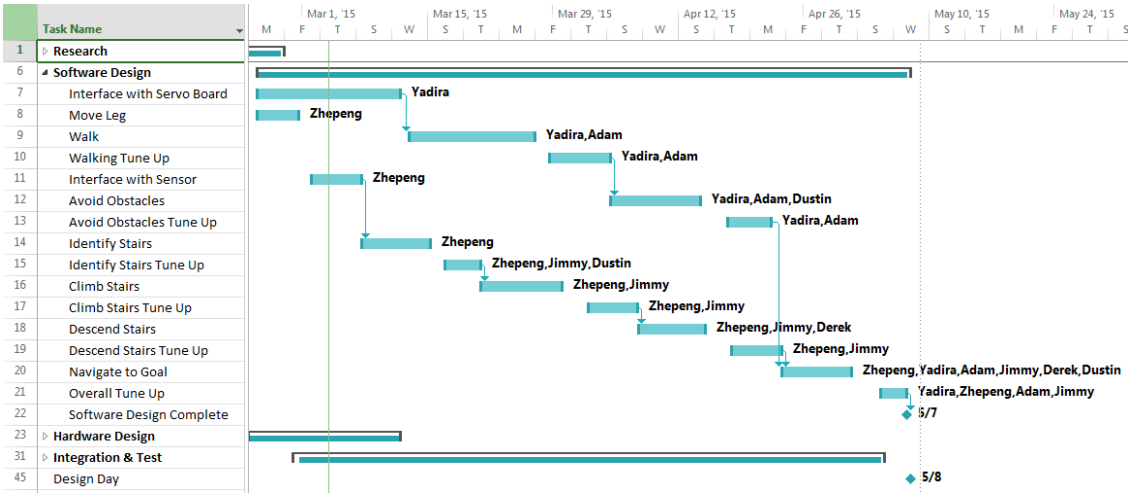
The robot will be tested for the ability to successfully navigate towards the goal. The robot will be tested for the ability to avoid obstacles in an intelligent manner. The robot will be tested to ensure that it continuously traverses new paths until the course is completed. Getting stuck at any point or endlessly walking in an unsuccessful pattern will be considered a failure.

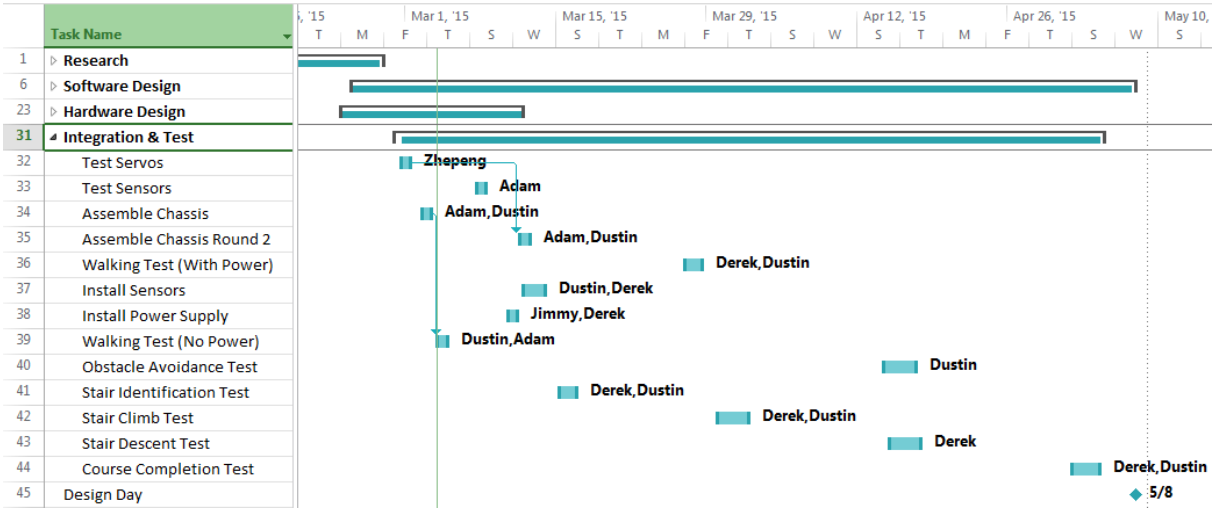
Benchmarks: Two tests will be implemented as benchmarks. We will set up a test with obstacles but no stairs and then a test with obstacles including a set of unavoidable stairs. We will evaluate our performance based on the robot's ability to successfully go around walls and its ability to ascend and descend stairs without falling. Ultimately, we will judge our performance based on the robots ability to reach the desired destination.

Project Management

Project Plan:







Milestones:

2/28/15	Motor Moves a Leg
3/7/15	Mechanical Design Complete

3/10/15	Power Supply Designed and Manufactured
3/11/15	Chassis Manufactured
3/13/15	Robot Assembly Complete
3/20/15	Stair Identification Algorithm Complete
4/4/15	Walking Algorithm Complete
4/7/15	Stair Climb Algorithm Complete
4/22/15	Obstacle Avoidance Algorithm Complete
4/23/15	Stair Descent Algorithm Complete
5/7/15	Software Design Complete

Budget

Cost Analysis:

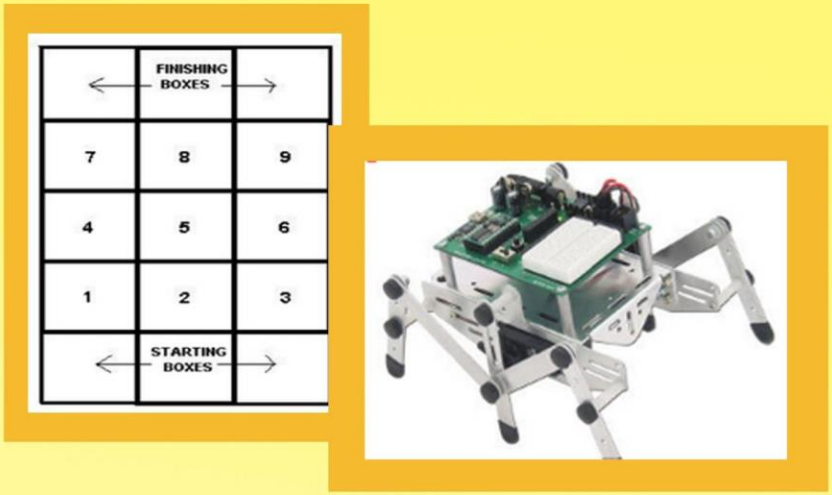
Total Budget	$300.00
Motors	$100.00
Infrared Sensors	$100.00
Microcontroller and Power Supply	$100.00

Promotional Flyer

RABBIT TRAILS

Bugs
The Walking Machine

The Goal: To design and build a small walking robot that can perform simple walking tasks



*The robot must not use any type of remote control at any time
*No wheels are allowed
*The robot must be a maximum of 7 inches cubed
*The ability to climb up stairs must be included

Join us May 8 2015 at SDSU senior design day for the demonstration of Bugs

Sponsored by

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Team Rabbit Trails

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