Design Idea Contract:
Search & Rescue Robotic Quadruped

SACRAMENTO STATE

9/30/2019

Team 9

Alfred Martinez III, Kristian Ornelas, Edgar Granados, Marcus Huston

Professor Tatro – Professor Levine

Elevator Pitch:

We are designing the power and control systems for a robotic quadruped that will be able to operate semi-autonomously to aid in search and rescue operations.

Executive Summary:

This document outlines the design idea of our search and rescue robotic dog. The established requirements and features are Static and Dynamic Stability, Remote Camera Feed and Control, and ability to recognize its environment. To this aim, a comprehensive list of parts, software, sensors, and metrics has been laid out for the group to coordinate its efforts in the future. Some key components include having a working PID, Compliant Leg functioning by New Years, setting up a 3D animation of the robot's limbs using Inertial Measurement Units by the end of October, and having a GUI for robot controls and camera feed by the end of November. These are still rough estimates but meeting this list of criteria will help verify that the project is on its course to completion by May of next year.

Search & Rescue Robotic Quadruped

Alfred Martinez III, Kristian Ornelas, Edgar Granados, Marcus Huston
Department of Electrical & Electronic Engineering, Computer Engineering Program, CSU Sacramento
6000 J Street, Sacramento, CA, USA

***Abstract*— This document is a breakdown of the features required in the search and rescue robotic dog. Working with a team of Mechanical Engineers that will be constructing the physical components of the body and legs, this team will focus on giving the robot its brain and power source. The project requirements include: Static and Dynamic Stability, High Torque / High Speed Motors, External Visual Sensors, and an efficient form of communication between all components like a biological spinal column. These are all fundamental components to robotics, and they will each be used and tested in this experiment.**

***Index Terms*— Robotics, Quadruped, Search and Rescue, Disaster Worker, Robot, Open Source**

I. Introduction

This document will act as a project proposal for our design idea and describe the project in considerable detail such as the necessary hardware and software required for the control and power systems, as well as the key features of the robot. It will also provide the way that this idea addresses the problem as described in, "Societal Issue: Disaster Worker Safety." The content of this document will be used as a contract and the success of our project will be graded in reference to said, contract.

II. Design Idea Description

The Search & Rescue Robotic Quadruped is a four-legged robot that will have the option to operate by a user with instructions and operate semi-autonomously. Each leg of the robot will have three actuators providing 3 degrees of freedom (DOF) per leg. Since the robot contains four points of contact reaching static stability will be trivial if the center of gravity is within the polygon of contact points. Figures 1 – 3 show the CAD configuration from the open source design. Please note that this robot design is licensed under GNU General Public License (GPL3).

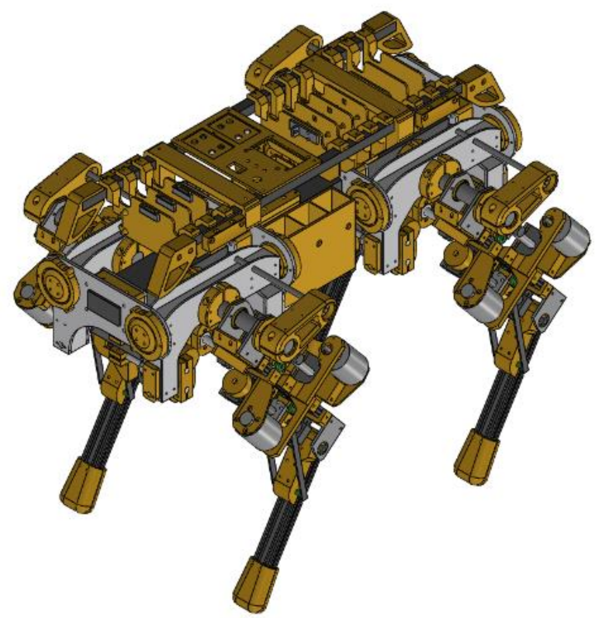

Figure 1: CAD Draft (does not reflect current or future revisions)
Source: http://www.xrobots.co.uk/open-dog-the-open-source-robot/

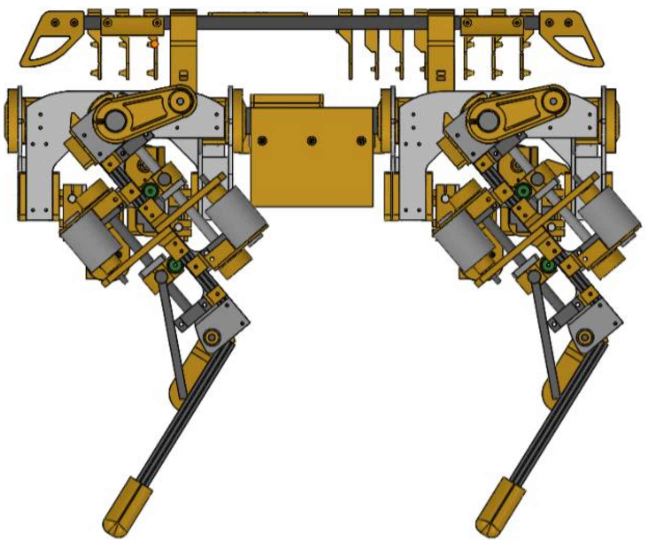

Figure 2: Quadruped Side View (does not reflect current or future revisions)
Source: http://www.xrobots.co.uk/open-dog-the-open-source-robot/

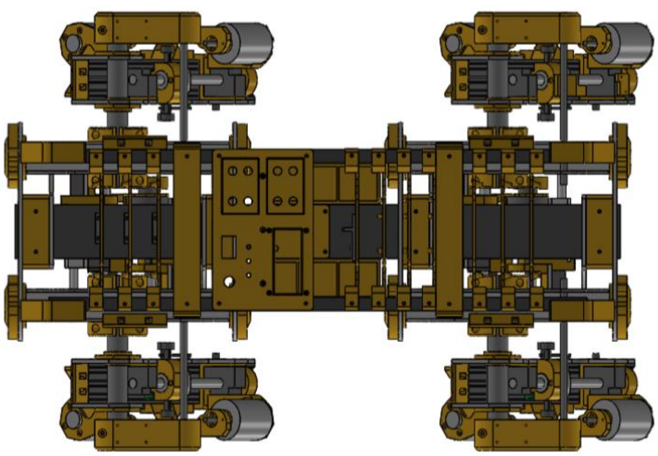

Figure 3: Quadruped Under Belly (does not reflect current or future revisions)
Source: http://www.xrobots.co.uk/open-dog-the-open-source-robot/

III. Addressing the Problem

The engineer is a glorified problem-solver and is required to design solutions to problems that others may be incapable of solving. Since the purpose of this design is to solve a societal issue, this section will re-address what the problem is, why it matters and discuss how the robot will fulfill its purpose.

A. What the problem is

With the amount of disasters growing every year, the amount of search and rescue teams are also growing and are put into more danger than ever. Search and Rescue Workers, Disaster Relief Workers, and Firefighters are all typically put into highly dangerous situations which prevents them from helping victims as thoroughly as they would otherwise like to. With the growing rates of both natural and unnatural disasters and the emphasis on understanding the dangers rescuers are placed into, we have deemed this as a societal problem in which we want to take measures to prevent bodily harm to both rescuers and victims.

B. How does this solve the problem?

With the creation of a semi-autonomous robotic quadruped, search and rescue teams will be able to deploy the quadruped and send them into the dangerous situations and be able to get video surveillance of what is happening. This will help tell how dangerous the situation is, help save time of search parties in dangerous situations, and help in the aid of rescuing. The idea of a semi-autonomous robotic quadruped will help save lives of victims and search and rescue teams that put their lives in danger every day.

IV. Idea Uniqueness

A. Other Possible Solutions

All of the following are ideas that our team discussed as possible solutions for our societal problem. One of the possible solutions that our team discussed was a semi-autonomous drone. The idea would be the same in which you have a camera on the drone, and you can fly it around to help search for lost victims. The issue that we found for a drone in search and rescue was that it would be hard to use in challenging geographical conditions like through a forest or within a collapsed household. Another idea that we researched was a small plane with lidar and/or sensors that would be able to map out a big area at one time. This seemed like a good idea because it can survey a big amount of land in a small amount of time, but the issues we ran into was trying to survey land such as a forest were most of the land underneath was covered from the air. The last idea that we researched was a tank like robot.

The benefits of a tank like robot was that it can stay low on the land under the trees and be able to search for lost victims. The issues that we saw in using a tank or wheeled robot was that it would be a challenge to get it over any obstacles. The wheeled robot would not be able to jump or go over challenging terrain like a collapsed house. After reviewing these possibilities, we chose to do a semi-autonomous quadruped robot.

B. *Why This Idea*

After weighing the different options and possibilities as well as their pros and cons, we decided to choose a semi-autonomous quadruped robot. The idea to make it a quadruped robot instead of a wheeled robot because it gives us the advantage of being able to get over obstacles. The next benefit is that the quadruped will be on the ground for search and rescue instead of the air which gives a better view of the actual surroundings and does not have the disadvantage of only being able to use it in specific terrain. This quadruped can also be very versatile in which it can be used and/or modified for varying situations. Building a semi-autonomous quadruped can be used in multiple lines of work such as military, firefighting, search and rescue, etc. The use of building this type of quadruped means that the possibilities are endless of what is possible for it to do. Therefore, we decided to design and create a semi-autonomous quadruped because we believe it is the best option with more pros then other robotics and the possibilities are really endless of what it can be modified/coded to do.

V. Required Features & Measurable Metrics

This section will go over the required features of the design such as the necessary actuators, MCU's, motor controllers, and compilers/IDEs. For us to determine if the feature has been implemented, measurable metrics will be added so that the results can be compared.

1. *<u>Accurate Motor Position / Encoder Control</u>*

a. *Purpose / Goal*

Since an obvious feature of the quadruped is to be able walk, the robot will need actuators in order to complete linear motion.

b. *Hardware*

Motors (12)

Legged robots can move linearly with either linear or angular/revolute actuation but the most common is revolute actuation. The robot will contain 3 revolute actuators per leg in the form of DC motors. Figure X shows the chosen actuators for the design. Budget is an issue for this design so we will be using a ball screw in conjunction with the DC motor because gearboxes would over exceed our budget.

Figure 4: Turnigy Aerodrive SK3 (does not reflect current or future revisions)
Source: https://hobbyking.com/en_us/turnigy-aerodrive-sk3-6374-192kv-brushless-outrunner-motor.html?wrh_pdp=2

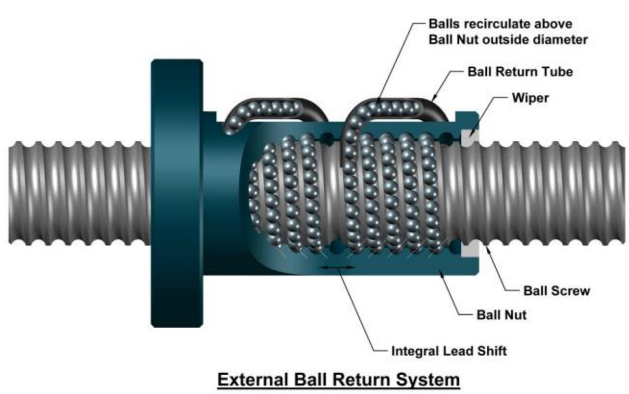

Figure 5: Typical Ball Screw Design Example
Source:https://johnsmachines.com/2016/05/23/lathe-conversion-to-cnc-3-ball-screws/

Motor Drivers (6)

DC motors also require motor controllers, otherwise known as motor drivers, in order to provide power to the leads accurately with the right polarity depending on the instructions sent to the motor controllers provided by the MCU. We chose to use these O-Drives because we couldn't find any other drives that would meet our specs and what we needed them to do. These were the best O-Drives that had the most features and made it easier/simpler to interface with the microcontrollers we are using.

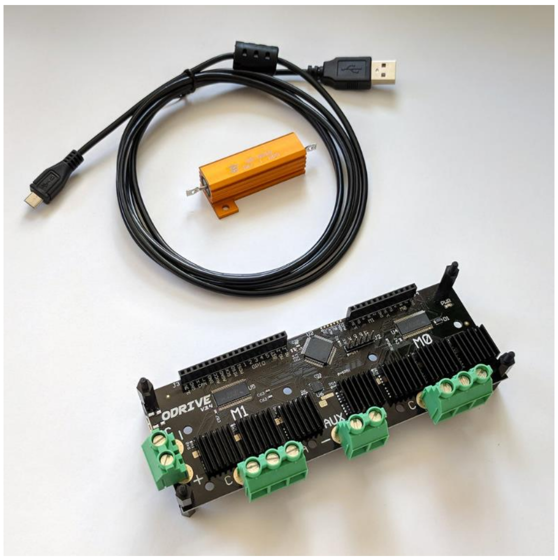

Figure 6: O-Drive V3.6 (does not reflect current or future revisions)
Source: https://odriverobotics.com/shop/odrive-v36

c. Software

The DC Motor itself does not required any software because the motor controller is the one distributing power. The motor controller, however, will require a compiler in order to flash it. As of right now we are still indeterminant of what IDE we will be using and in what programming language. Having said that, STM32CubeMX 5.3.0 does provide a simple interface of setting up the GPIO pins and clock speeds of various MCUs.

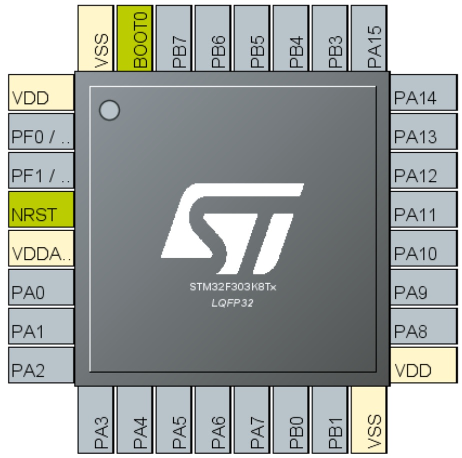

Figure 7: STM32CubeMX Pinout Initialization Interface
Source: STM32CubeMX 5.3.0

d. Sensors

The accurate operation of the motors does not require much sensors due to their simple design.

Encoders

A very common practice of determining the position of a motor is through the usage of a rotary encoder. There are various types of encoders and some DC motors even have built-in encoders. Luckily, there are motor controllers that provide the feedback of an encoder. We will, ideally, use a motor controller with an absolute encoder which not only provides the same information as an incremental encoder, but also the angular position and incremental changes of the motor shaft.

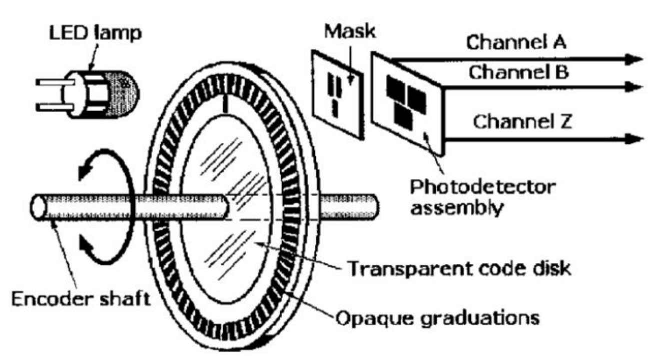

Figure 8: Incremental Encoder Example
Source: https Basic-elements-of-an-incremental-optical-rotary

encoder_fig37_245543196encoder_fig37_245543196

Voltage and Current Recorders

To ensure that the DC motors are operating to its full potential without severely decreasing its life, we will need to implement voltage and current recorders/sensors. One possible way of doing this would be to install voltage and current sensors between the motor controllers and the DC motors themselves but there are motor controllers that contain built-in voltage and current recorders. The O-Drive V3.6 seen in Figure X, for example, contains the necessary functions for us to determine the voltage and current levels.

e. Team Coordination (Who / Vital Skills)

The ability to accurately and precisely control the motors is what will allow the robot to walk. Due to the complexity of this design and our lack of experience with robotics and legged locomotion, this feature will require the entire team's effort. The skills needed varies from the ability to program in different languages to the ability of understanding kinematics and physics. To be able to properly control the robot's movement we will need a solid understanding of physic concepts such as force, torque, motor backlash, linear motion and angular motion.

f. Estimated Time to Completion

At this point of the project, determining the time of completion for this feature could vary greatly. Making the robot walk will more than likely be the most enduring task and could range from 50 - 500 hours to complete.

g. Measurable Metrics

The accurate motor positioning feature will be considered fully implemented by the following metrics: ability to rotate the motor to a predetermined position, ability of the robot to walk, and the ability of the motor to accurately respond to PID controls.

2. <u>*Static Stability (Frame / Mechanical)*</u>

a. Purpose / Goal

The first step in designing our quadrupedal robot will be to perform the necessary calculations and measurements for each mechanical body piece of the robot. In addition, the necessary CAD simulations will also need to be performed in order to determine correct body length measurements, forces, and material durability.

b. Hardware

Ball Screws / Pulleys (4)

The design of our robot that will need to ensure correct mobility, therefore, we will utilize Ball Screws and/or a pulley system. Ideally, we are trying to emulate the way a four-legged animal, such as a dog, moves. In order to accomplish this goal, we will need our limb designs to allow 3DOF. Each limb will need to incorporate a ball screw or pulley design and will need to have the correct anatomy to support 3DOF.

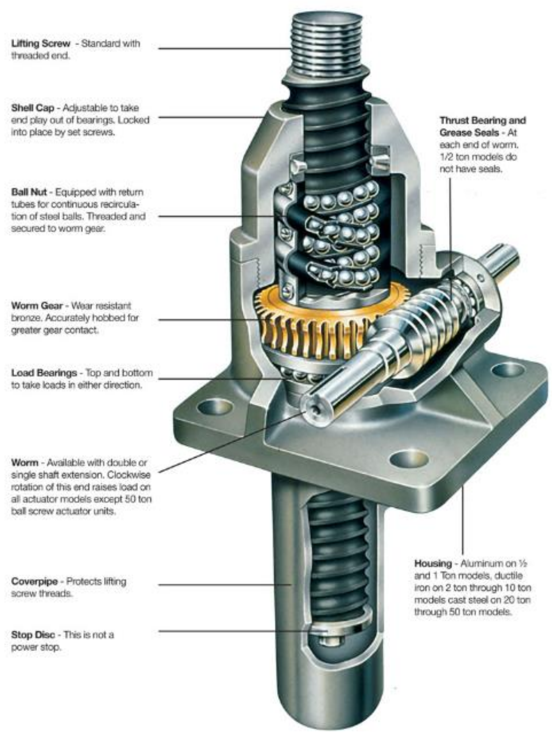

Figure 9: Ball Screw Actuator Diagram
Source: https://www.duffnorton.com/ball-screw-actuator-diagram

CNC Aluminum Alloy Frame

Just as the design of the robot's legs are important; the body of the robot and material used will also be important. The robot's body frame will house all of the electrical wiring connections to all other parts of the robot. It will contain the main MCU circuit, as well as the power distribution network to each electrically powered device. Therefore, it will critical to house these components in a sturdy and sizable frame that will be able to protect these parts from any damage.

3D Printed Parts

The parts that will act as the skeleton structure to our robot will be 3D printed. The desired measurements will need to be chosen and simulated on CAD software, so that we can verify that the design is feasible. Once the designs are discussed and agreed upon by the entire team, then we will move onto printing and testing the parts.

Figure 10: 3D Printing
Source:
https://www.safetyandhealthmagazine.com/articles/18295-d-printing-and-worker-safety

c. Software

Although no actual software will be written in this portion of the project, the team will use a variety of programs to that will deal with the static stability of our design. Specifically, AutoCAD will be a prime software tool used by the Mechanical Engineering team in order to test and verify the kinematics of our robot. SolidWorks is another important program that will also be used by the ME team to create 3D models of our designs and perform simulations on them.

d. Team Coordination

The ME team will be the ones who will possess the most significant skillset for this part of the project. They will run several simulations on the designs of our robot; in order to, verify the kinematics and weight distribution. Once, they have chosen a model, for our robot, the whole team will need agree on it, and the ME team will begin construction the frames and printing out the parts.

e. Estimated Time to Completion

The current time estimate for this section is to have a finished leg by December. The entire quadrupedal robot will be built and assembled through the duration of the entire Senior Design course.

f. Measurable Metrics

The measurable metrics for this portion of the project will be determined by measuring the physical parts of the robot such as the body frame and legs. If the printed parts match the desired measurements, then we can confirm that required metrics are met. Furthermore, once the robot if fully assembled, if the design is able to fully support itself without tipping over, then we can also confirm that the quadrupedal robot is statically stable.

3. *Dynamic Stability*

a. Purpose / Goal

For our quadrupedal robot to be reliable in real-world situations, it will need to make the necessary adjustments when traversing through a variety of environments. Ideally, we want our system to be able to control its outputs (voltage, current, motor speed etc.) by the inputs it receives. In other words, we are describing a closed loop system; in which a portion of the output is fed back to the input in order to perform the next calculations. There will be a variety of concepts we will need to utilize in order to develop the closed loop system for our quadrupedal robot.

b. Mathematical Model

In a real-world environment, there are random and noisy events that occur all the time. Our system will need to be able to filter out this noise and randomness, so that the data it collects is accurate and reliable. Therefore, we will need to implement techniques that will be able to deal with noise and provide accurate measurements. Luckily, there are variety of mathematical models that exist, that we can use in order to accomplish this.

One of the most common mathematical concepts used in control theory is the Kalman Filter.

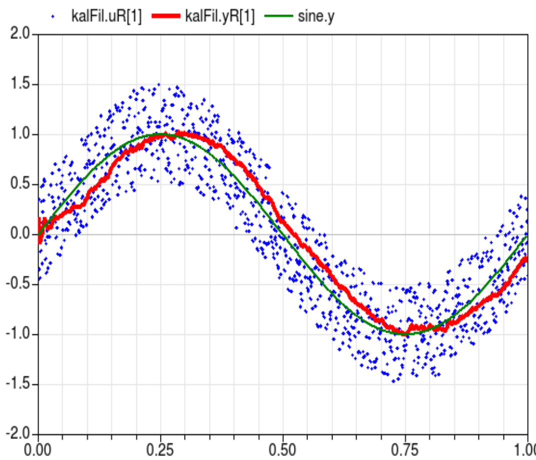

Figure 11: A plot of a sinusoidal input(green) and the Kalman filter estimation(red).
Source:
https://build.openmodelica.org/Docimentation/Buildings.Utilities.IO.Python27.Examples.KalmanFilter.html

The Kalman filter is an algorithm that provides an estimation of unknown variables through the observed measurements over time. There are variants of the filter; the Kalman filter which is used on linear systems and the Extended Kalman filter, which is used on non-linear systems. Since we want our robot to dynamically adapt its positioning based on any changes in the 3D environment; our system will be non-linear by nature. Thus, the Extended Kalman filter would be a much more beneficial tool to use for our system.
Another necessary model that may be utilized in our system is a PID Controller. A PID controller, which stands for proportional, integral, and derivative, is a closed loop control system that adjusts its output based on the comparison between the desired value and the actual value.

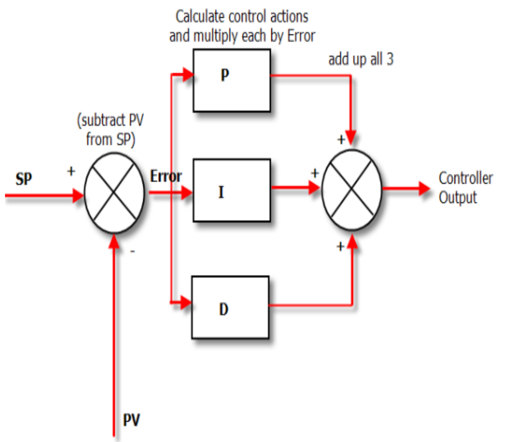

Figure 12: A simplified block diagram of a PID controller.
Source:
https://www.csimn.com/CSI_pages/PIDforDummies.html

For our application, the PID controller will be the simple method of controlling our motors, based on the data from our sensors and desired position.

c. Software

Most of the software that will be written for this portion of the project will deal with implementing the mathematical models discussed earlier in code. The software program will need to take readings from the sensors, encoders, accelerometers, etc. and use the algorithms to generate the required values for the PID controller; and lastly, communicate with the ODrive's to control the motors.

d. Team Coordination (Who / Vital Skills)

As this portion of the project is more software and coding intensive; the CpE members will play an important role in implementing these mathematical models in code. In addition, because the EEE members are better informed of the concepts of communication and feedback systems, they will also play an important role in explaining the concepts to the CpE team, so that the models can be implemented correctly.

e. Estimated Time to Completion

This will be the main foundation for our robot's control system. We will need to correctly implement these algorithms in code so that the proper output variables are transmitted to the encoders. Therefore, we will spend a big portion of our time writing and verifying that our mathematical models' function. In terms of estimated time, we believe this portion of the project should take us around 2-3 weeks to fully complete.

f. Measurable Metrics

The plan for testing our controller and filtering algorithms will be by providing the system a fixed input and comparing its output to our calculated output. For instance, in the case of the PID controller we can feed in a desired position we want and compare the movement of the robot to the expected result. In the case of the filtering algorithms, we can also do something similar. We can have an external device that provides that actual measurement of some variable such as acceleration, voltage, gravity, etc. and then compare it to our filtering system's output. If the values have minimal deviation than we can confirm that our estimating system functions correctly.

4. *<u>Cameras / 3D Rendering</u>*

a. Purpose / Goal

The purpose of adding Cameras and Lidar technology to the robot is to give the user a clear visual on the robot's perspective. The goal is to have an efficient feed rate of visual data sent from cameras attached to the robot to a remote computer, either a desktop GUI or one over the internet. There is still a lot of determination to be made as to which will give a faster feed rate, be more simplistic to implement, and, finally, cost effective with the current budget restraints.

b. Hardware

Raspberry Pi Camera

Implementing cameras is something already well established within the Raspberry Pi Communities across the web. This could give the team a quick start in sending and receiving live camera feeds, especially since the manufacturers of Raspberry Pi have a camera module made by them as well as a connector ribbon cable that connects directly to the device. The downfall of using this product is that it may be too low quality in terms of pixel density and/or streaming rate and streaming distance.

Figure 13: Raspberry Pi Camera Module
Source:
https://www.raspberrypi.org/products/camera-module-v2/

LIDAR Technology

LIDAR sensors are produced by several companies, each with developed firmware and communities that could be probed for advice. Thus far, the two main options are to use the Slamtec RPLIDAR - A1 which offers a highly accurate, two-dimensional, 360° mapping within a 12-meter range. To make it three-dimensional, a stepper motor could be used to adjust the angle of the disc sweep reading. It also comes with an adapter that converts the output pins into a micro-USB header allowing the device to be easily driven by a microcomputer.

Figure 14: Slamtec RPLIDAR A1 w/ Serial Pin to Micro-USB Converter

Source: https://www.adafruit.com/product

The second option being considered is to retrofit several Xbox Kinect devices. This option came about because Xbox Kinects can be acquired for a fraction of the cost of a new LIDAR system plus, they can map everything within a canonical shape in front of its lens. There is a small community of hackers that created a simple library for the devices which could help lower the entire cost of the robot. These devices are, however, bulkier and do not supply a 360° view.

Figure 15: Xbox Kinect Used in Human-Following Robot Project

Source: https://www.hackster.io/turtle-rover/human-following-robot-with-kinect-efb3cd

Neither option is final and the selection will be made as the project develops, but there will be a LIDAR device on the robot and the main goal is to use its data to map out terrain features and help the robot predict its course of motion before making its steps.

Wireless Signal Transfer Between Robot and Computer

The robot will require the ability to transfer its imagery data to a portal for the user to view as well as for the robot to utilize in its course planning. This will most likely be done through the Raspberry Pi's onboard Wi-Fi capabilities or an external USB Wi-Fi dongle that could speed the transfer rate.

c. Software

Linux / MATLAB Modeling of 3D Data

To have multiple cameras and/or multiple LIDAR sources all working together, there will need to be a consistent terminal on a windows desktop. The two primary concepts for this part include the Linux Web Server Library which could contain an online control panel for the robot commands with the camera feeds as outputs, or the MATLAB model which would be easier to use image and LIDAR data to send commands back to the robot as input data. More than likely, a combination of the two will be utilized.

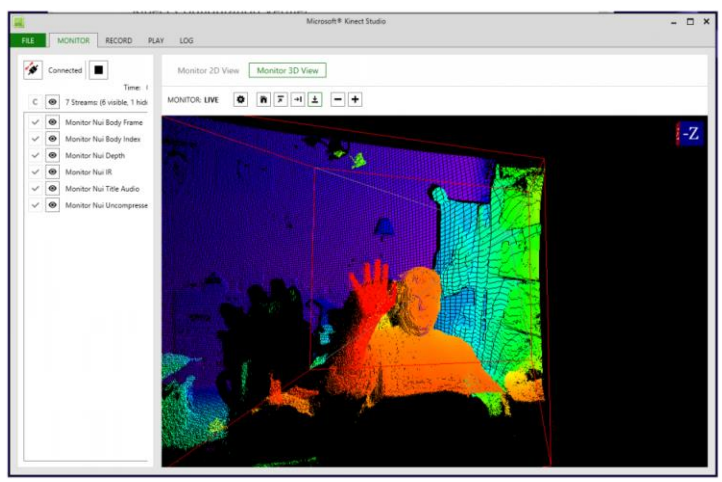

Figure 16: Xbox Kinect LIDAR Output
Source: https://thenewstack.io/kinect-for-app-development/

The Robot Operating System is a source of Linux libraries and other resources designed as a middleware that was put together to help developers share ideas and software in robotics. These libraries will be used to find ways to send the 3D imaging and camera feeds back to the robot as useful information for path mapping.

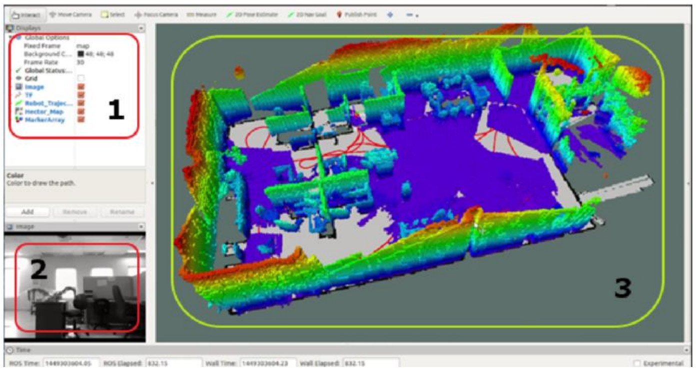

Figure 17: Robot Operating System using LIDAR and Camera Feeds
Source: https://www.researchgate.net/figure/RVIZ-node-panel-for-human-robot-visual-interface-on-ROS-ecosystem_fig7_305730015

Firmware from Manufacturers

The software supplied by the LIDAR Manufacturers will be very important when trying to convert the LIDAR input signals into output controls.

d. Team Coordination

Each team member has taken a class on microprocessors and therefore each have the same base level of knowledge in terms of setting up the software for the LIDAR and Cameras. The Electrical side of the group has had experience setting up cameras in Linux in a previous project which will become extremely useful.

e. Estimated Time to Completion

This component is expected to be under working conditions by mid-November since both LIDAR and Camera Modules can be acquired and tested for a reasonably low cost. They can also be implemented into a simulated program that will not actually drive the robot motors but will output the correct logical signals when certain terrain features are seen.

f. Measurable Metrics

The current test plan for the visual sensors is to build the HTML website that holds all the camera interfaces and the GUI for the robot controls. This would not require any real output meaning this step could be done well before a robot is built. Once this step is done, the next step would be to develop the logical feedback the robot would utilize from the different feeds. This logical analysis could be used to light up LEDs to identify the different feedback signals.

VI. Conclusion

To conclude, the quadrupedal robot will be a very ambitious and difficult project to accomplish. However, it will also be a great learning experience for the entire team and will help demonstrate every team member's skillset. The project will help us develop a lot of experience on project management, communication, team coordination, and product design. We will need to research a variety of different topics in order to design the quadrupedal robot. But in the end, the research and amount of work we put into this project, will provide us the experience and knowledge future employers may require for certain employment opportunities.

References

[1] Kalouche, Simon. "Design for 3D Agility and Virtual Compliance Using Proprioceptive Force Control in Dynamic Legged Robots." *The Robotics Institute Carnegie Mellon University*, Carnegie Mellon University, Aug. 2016, https://www.ri.cmu.edu/publications/design-for-3d-agility-and-virtual-compliance-using-proprioceptive-force-control-in-dynamic-legged-robots/.

[2] Boston Dynamics [Online]. Available: bostondynamics.com

[3] Introducing SpotMini. Boston Dynamics. https://www.youtube.com/watch?v=tf7IEVTDjng

[4] S. Seok, A. Wang, D. Otten, and S. Kim, Actuator design for high force proprioceptive control in fast

legged locomotion, 2012 IEEE/RSJ International Conference on Intelligent Robots and Systems, 2012.

[5] G. Kenneally, A. De, D. Koditschek. “Design Principles for a Family of Direct-Drive Legged Robots.” IEEE ROBOTICS AND AUTOMATION LETTERS, VOL. 1, NO. 2, JULY 2016.

[6] Huang, W., Kim, J., and Atkeson, C. (2013). Energy-based optimal step planning for humanoids. In 2013 IEEE International Conference on Robotics and Automation (ICRA), pages 3124–3129, Karlsruhe, Germany

[7] Kuindersma, S., Permenter, F., and Tedrake, R. (2014). An efficiently solvable quadratic program for stabilizing dynamic locomotion. In IEEE Intl. Conf. on Robotics and Automation (ICRA), Hong Kong, China.

[8] Marc Sons, Christoph Stiller, "Efficient Multi-Drive Map Optimization towards Life-long Localization using Surround View", *Intelligent Transportation Systems (ITSC) 2018 21st International Conference on*, pp. 2671-2677, 2018.

[9] David Wooden, Matthew Malchano, Kevin Blankespoor, Andrew Howard, Alfred Rizzi, Marc Raibert, "Autonomous Navigation for BigDog", *IEEE International Conference on Robotics and Automation*.

[10] Joel Chestnutt, *Navigation Planning for Legged Robots*.

[11] Dr. Asad Yousuf, Mr. William Lehman, Dr. Mohamad A. Mustafa, Dr. Mir M Hayder, "Introducing Kinematics with Robot Operating System (ROS)", *122nd ASEE Annual Conference & Exposition*.

[12] Kenta Takaya, Toshinori Asai, Valeri Kroumov, Florentin Smarandache, "Simulation Environment for Mobile Robots Testing Using ROS and Gazebo", *20th International Conference on System Theory Control and Computing (ICSTCC)*, 2016.

[13] Ilya Afanasyev, Artur Sagitov, Evgeni Magid, "ROS- Based SLAM for a Gazebo-Simulated Mobile Robot in Image-Based 3D Model of Indoor Environment", *International Conference on Advanced Concepts for Intelligent Vision Systems*, 2015.

Alfred Martinez

7248 Sunwood Way · Citrus Heights, CA 95621 · (916) 571 – 4991 · alfredmartinez555@gmail.com

Objective

To obtain an Electrical & Electronic Engineering related internship or position.

Education

Bachelor of Science, Electrical and Electronic Engineering
Concentration: Analog/Digital and Controls
California State University, Sacramento, CA, Expected: May 2020
GPA: 3.2

Related Coursework

Circuit/Network Analysis	Electronics	Transmission Line Theory
Microprocessors	PCB Design	Digital Circuit Design and Testing
Signals & Systems	Circuit Verification and Simulation	
Electromechanical Conversion	AutoCAD Design	

Technical Skills

Coding Languages: C++ / Verilog / Python / HTML / PHP / X86 Assembly

Engineering Tools: MATLAB / Altera Quartus / ModelSim / PSpice / Advanced Design System / FPGAs / Lab Bench Equipment

Desktop Applications: Microsoft Office Package / Visual Studios / Linux

Project Experience

- Worked with team to create a remotely monitors fish tank with completely automated cleaning and safety equipment to regulate tank conditions.
- LED Christmas Light Setup using Microcontroller with Audio Input and Fourier Spectrum Musical Display. "Dancing Christmas Lights"
- Line Following RC Car using Microcontroller

Work Experience

Officer Candidate, *USMC OCS PLC Program, Fully Trained*

- Intense Physical and Mental Training at USMC Officer Candidate School
- Small Unit Leadership Training
- High Stress Environment Decision Making
- Received College Credits in Leadership, Navigation, Weapons Handling

Affiliations

Member, *Institute of Electrical and Electronics Engineers, January 2018 - Present*

EDGAR GRANADOS ONATE

• (916) 793-5496 • edgargranados153@gmail.com • github.com/Edgar153

OBJECTIVE:

Actively seeking an internship in the areas of Hardware, Firmware, or Software Engineering.

EDUCATION:

Bachelor of Science, Computer Engineering *Expected:* December 2020
California State University, Sacramento
Overall GPA: 3.30 ***Major GPA:*** 3.34

WORK EXPERIENCE:

Software Development ***Freelance*** ***March 2019 - May 2019***

- Worked with a client to implement a software program that monitored user activity on a web forum and discord text channel. The program would automatically tweet user content from these forums onto the client's business twitter account. Twitter's Java and Python APIs were used to design and create the software.

Client Services Assistant ***Granados Gardening Service*** ***January 2015 – Present***

- Communicate with clients regarding services, quotes, and customer support for my father's business. Other responsibilities include planning out and designing schematics for landscaping projects requested by clients.

SKILLS-LANGUAGES, TOOLS, PLATFORMS:

C, Verilog, Python, JavaScript, Java, VHDL, x86 Assembly, ARM Assembly, HTML/CSS, Oracle SQL, PHP, Eclipse IDE, Xilinx Vivado Design Suite, Quartus Prime, OrCAD PSpice, Cadence Virtuoso, Attollic TrueStudio, STM32CUBEMX, Keil uVision 5 IDE, Git Version Control, DOS, Windows (XP, Vista, 8.1, 10), MS-DOS, UNIX, Linux (Ubuntu, Debian), VMWare

RELATED PROJECTS:

Senior Design Project:

- *Semi-Autonomous Quadrupedal Robot*: Currently involved in designing and building a Semi-Autonomous Quadrupedal Robot with 7 other team members. The team consists of 4 Mechanical Engineer (ME), 2 Electrical Engineer (EE), and 2 Computer Engineer (CpE) students. Directly assisting with designing the Control System for the robot and implementing the ME team's kinematic and compliance models in code. More information can be found at my GitHub profile.

Computer Interfacing Projects

- *Web Controlled Solar Tracker with Automation and Feedback Capabilities*: Designed and created, with a group member, a web controlled solar tracker capable of automatically detecting the most suitable position for solar energy. The main components utilized to create the solar tracker were a Raspberry Pi 3, STM32 Nucleo Board, Servo Motors, and LDR sensors.
- *UART Communication:* Wrote a program in Python that established UART Communication between a Raspberry Pi 3 and a STM32 micro controller. The micro controller would transmit sensor data to the Pi; and the Pi would update a web page with the transmitted data every 300 ms using JavaScript.

Java Projects

- *Real-Time Cryptocurrency Monitoring System:* Implemented a cryptocurrency monitoring program using Java Sockets and the java.net package. The program would retrieve information about cryptocurrency coins from several finance websites and display them onto a console window. The program was utilized by 16+ users.
- *Client Billing System:* Created and coded a GUI program, using the java.swing package, for my father's Gardening business. The program allowed users to add/delete client profiles, input client information, and provided the user with an automated invoice-making service that printed out invoices.

Computer Hardware Designs

- *Direct Mapped Cache Design*: In Verilog, designed and simulated a cache controller module that utilized the direct mapping scheme to store data onto cache blocks. The controller would be able to interface between a CPU and Main Memory to perform read or write operations.
- *PCI Bus Arbiter:* In Verilog, designed and simulated a PCI Bus Arbiter that performed bus arbitration among multiple master devices on a PCI Bus. The bus arbiter utilized the Round-Robin Priority Scheme to designate the PCI Bus to the appropriate master device.
- *Multi-cycle Datapath Model*: Designed and simulated a multi-cycle data path that performed either the RTN $R \leftarrow A + B + C - D$ or the RTN $R \leftarrow A - B + C + D$. A control unit (FSM) was also created to provide the proper control signals to the data path.

AWARDS/CLUBS:

Deans Honor List ***Spring 2017 – Spring 2019***
Engineering and Computer Science Scholarship ***Fall 2019***
Web Development Club, *Member* ***Fall 2018 - Present***
ACM, *Member* ***Spring 2019 - Present***
SHPE, *Member* ***Fall 2019 - Present***

Kristian Ornelas

1929 Oliveglen Court · Fairfield, CA 94534 · (707) 386-0338 · krisornelas85@gmail.com

OBJECTIVE

To obtain an Electrical & Electronic Engineering related internship or co-op position

EDUCATION

Bachelor of Science, Electrical and Electronic Engineering
Concentration: Analog/Digital and Controls
California State University, Sacramento, CA, Expected: May 2020
GPA: 3.2

Related Coursework

Circuit/Network Analysis	Electronics	Transmission Line Theory
Microprocessors	PCB Design	Digital Circuit Design and Testing
Signals & Systems	Circuit Verification and Simulation	
Electromechanical Conversion		

Technical Skills

Coding Languages:	Verilog, C++, C, Python
Engineering Tools:	Altera Quartus, ModelSim, PSpice, Advanced Design System, Oscilloscope, Multimeter, Signal Generator, FPGA
Desktop Applications:	Microsoft Word, Excel, PowerPoint, Visio, Visual Studio

PROJECT EXPERIENCE

- Designed a full 4-bit adder in Verilog, verified using a combination of the ModelSim simulator, individually assembled test-bench, and a FPGA
- Developed a state machine in Quartus using Verilog built to detect a pre-determined sequence of bits
- Created a NOR gate version of the D Flip-Flop in Quartus using data flow modeling techniques
- Constructed a series RC circuit with a team of two students, to analyze passive low and high pass filters with an oscilloscope and multimeter
- Successfully designed and drafted a PCB patch antenna in a group of four using the ADS software to impedance match the transmission line consisted of microstrips
- Computed a Pig Latin translator in C++ within the Visual Studio IDE utilizing the user’s input
- Coded a Parallax microcontroller in C to blink multiple LEDs and signal a piezo speaker when a pushbutton was pressed using three functions and a multicore approach

WORK EXPERIENCE

Dangerous Goods Specialist Lead, FedEx Express, Pacheco, CA July 2015 – Nov 2017

- Effectively trained and managed six high performing team members in auditing and data entry
- Decreased company spending by developing an efficient auditing process for maximum productivity and efficiency
- Assisted 3 – 10 customers per week in correcting hazardous material errors that did not comply with federal and international regulations
- Inspected 20 – 70 pieces of hazardous material per shift with four team members before the daily deadline

AFFILIATIONS

Member, Society of Hispanic Professional Engineers, 2018 – Present
Member, Institute of Electrical and Electronics Engineers, 2018 - Present

Marcus Huston

8146 Big Sky Drive, Antelope, CA 95843 | (916) 616-7927 | marcus.huston96@gmail.com | Computer Engineering Student

Education

Bachelor of Science in Computer Engineering — Spring 2020(est.)
Minors: Applied Mathematics & Studio Art — Overall GPA: 3.20 / 4.00
California State University, Sacramento

Member of Tau Beta Pi – Engineering Honors Society - achieved the top 12.5% of your Junior class or 20% of your Senior class. Tau Beta Pi is the only engineering honor society representing the entire engineering profession.

Professional Profile

I am an innovative individual looking to collaborate in diverse environments in order to immerse / enhance my knowledge, problem-solving skills, and project management experience to challenge me to grow and learn new languages / emerging technologies.

Skills Summary

- **Java, C, Python, x86 Assembly, Verilog, Microsoft Office and Adobe Suite.**
- **Experience working with Oscilloscopes, Microcontrollers, and FPGA.**
- **Good analytical, communication and technical writing skills**

Relevant Courses

CMOS and VLSI   **Database Management Systems**   **Operating System Principles**   **Advanced Math Science & Engineering**

Computer Networks & Internets	Advanced Computer Organization	
Probability & Random Signals	Computer Hardware Design	Electronics
Data Structures & Algorithm Analysis	Advanced Logic Design	Computer Interfacing
Discrete Structures	System Programming Unix	Network Analysis Signals & Systems

Work Experience

Law Office of Marcus, Regalado, & Marcus, LLP
August 2014 – Present

- Internal and external communication
- Data entry / Calendar statutes
- Client intake process coordinator
- Utilization review manager
- Assisting the attorneys/paralegals
- Assists in the development of project scope and project management documentation using MS Office.
- Trained incoming employees in preparation for their job
- Reports on analytics and project progress
- Installed software and hardware on employee machines

Project / Leadership Experience

Hornet Hyperloop
International Student competition organized by SpaceX and the Boring Company.
Controls Team

- Designed, analyzed, and debugged various software and systems
- Optimized design using simulations and analysis
- Use of CAN bus communications for main pod controls as well as data acquisition
- Ability to work with other engineers, collaborate, and test ideas
- Ability to solve technical problems
- Code: C Programming Language

American Sign Language Glove
Student project to create a bridge between ASL and English by converting signed data and displaying it as letters.
October 2018 – December 2018

- Organized and directed weekly team meetings and optimized group effectiveness.
- Created schematics to optimize design and transition into simulation and analysis
- Integrated embedded systems to communicate and increase speed
- Ability to quickly adapt, debug, and solve technical problems
- Code: C Programming Language
- Hardware: Raspberry Pi, Analog to Digital Converter, Accelerometer, Flex Sensors, etc.

Magnetic Levitation Quadcopter Drone
Student research project to design, create, and build a drone that levitates based on rpm against the magnetic fields
March 2019 – Present

- Troubleshooting skills
- Performed background research and study for the solidification processing of materials in magnetic fields.
- Researched and analyzed to decrease friction
- Designed and analyzed a structure capable of holding neodymium N52 grade magnets for solidification process.
- Code: C Programming Language

Appendix

A. Project Budget

Part	Quantity	Price	Purpose
DC Motors	12	$85.85	Actuators for linear motion
Motor Controllers	6	$129.00	Control actuators for linear motion
360-degree Lidar	1	$120 - $200	Detect robot surroundings
Gyroscope/Accelerometer/Magnetometer	TBD	$34.95	Determine robots orientation
Raspberry Pi 4	1	$55	Control various peripherals
Raspberry Pi Camera Module	1	$29.95	Display robot POV
	Total Cost	$2044.10 - $2124.10	

Table 1: Bill of Materials (does not include parts already owned and parts supplied by the Mechanical Engineering team)

C. PUNCH LIST

Feature	Measurable Metric
Accurate Motor Position & Encoder Control	- Ability to rotate the motor to a predetermined position - Ability of the robot to walk - Ability of the motor to accurately respond to PID controls
Static Stability	- Ability to maintain upright position incase power failure to motors or peripheral (Avoid Fall Damage) - Maintain three points of contact when not receiving command or not moving
Dynamic Stability	- Ability to balance its weight through a large range of motion - Ability to translate forward, back, left, right, and diagonally - Ability to self-correct when pushed or over uneven terrain
Camera & 3-D Rendering	- Ability to record and transmit video feed to desktop - Ability to record and transmit LIDAR data to desktop - Ability to utilize LIDAR / Imagery to determine course of action for terrain

Table 2: Punch List of features and their corresponding metrics