Moonrockers

Senior Design Final Documentation

Moonrockers

Alexander Muchow

December 11, 2015

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Overview Statements

0.1 Mission Statement

The mission of this team is to implement software into the Moonrockers robot, both telelcommunications and autonomous. We plan to implement computer vision based algorithms to determine location based a image at a fixed point. From there, we will begin to implement the autonomy algorithms in which the robot will complete the tasks of our competition.

Document Preparation and Updates

Current Version [1.3.0]

Prepared By:
Alexander Muchow

Revision History

Date	***Author***	***Version***	***Comments***
09/21/15	*Alexander Muchow*	*1.0.0*	*Initial version*
10/08/15	*Alexander Muchow*	*1.1.0*	*Added in Sprint 1 Report*
11/05/15	*Alexander Muchow*	*1.2.0*	*Added in Sprint 2 Report*
12/04/15	*Alexander Muchow*	*1.3.0*	*Added in Sprint 3 Report*

1

Overview and concept of operations

The overview should take the form of an executive summary. Give the reader a feel for the purpose of the document, what is contained in the document, and an idea of the purpose for the system or product.

1.1 Scope

This document will cover the methods of development, as well as algorithms and systems, of the moonrockers team. It will discuss the major components we will be developing, as well as their roles.

1.2 Deliverables

The client has requested improvements to their telecommunication code, as well as to begin working on the autonomy portion of the robot.

1.3 Purpose

The purpose of this system is to be able to control the robot which the team has build. The robot's goal is to go and mine regolith, in order to return it to a collection bin. The team would prefer to do this autonomously as it would gain a significant amount of additional points in the competition.

1.3.1 Vision based location

This component will playa major role in this system because it will determine where the robot is located within the competition pit. We plan to do this via attaching an AR tag to the collection bin in which we deposit our material, and then mount one or more cameras onto our robot. The cameras will use an algorithm to determine the distance and orientation in which they are located relative to the AR tag. This is important, as we are driving on a sandlike material, and typical odometry will not be nearly as effective as this vision based system.

1.3.2 Location based Decision Making

This will allow us to make decisions based on where we are within the competition pit, for instance is we are too close to a certain wall, we will turn away from it, or if we are to the mining portion of the pit, we will begin mining. The first component is very important for this one because we will need to be able to tell where we are relative to the collection bin in order to do this.

1.3.3 Telecommunication

This is another very important part of the robot's system, as it allows a user to directly control the robot. There is currently software in place for this, but it requires many improvements and also the ability to override the autonomous system if the need were to arise.

1.4 Systems Goals

The goals for this system to acheive are being able to perform in the competition pit autonomously to acheive some of the points available, as well as be able to receive points for mining material.

1.5 System Overview and Diagram

The major system components will interact in the manner seen in the diagram below. As you can see, our ODroid XU4 is running ROS, which will support both the Vision based location node and the decision making portion of the system. It will pass messages from the vision based location system to the decision making system, and then that will tell the Odroid what to tell the PCDuino to tell the robot.

At the same time, you can see the manual control via a windows PC . Currently the windows PC and the PCDuino connect to the same network and then form a TCP server to transmit information from the controller to the robot.

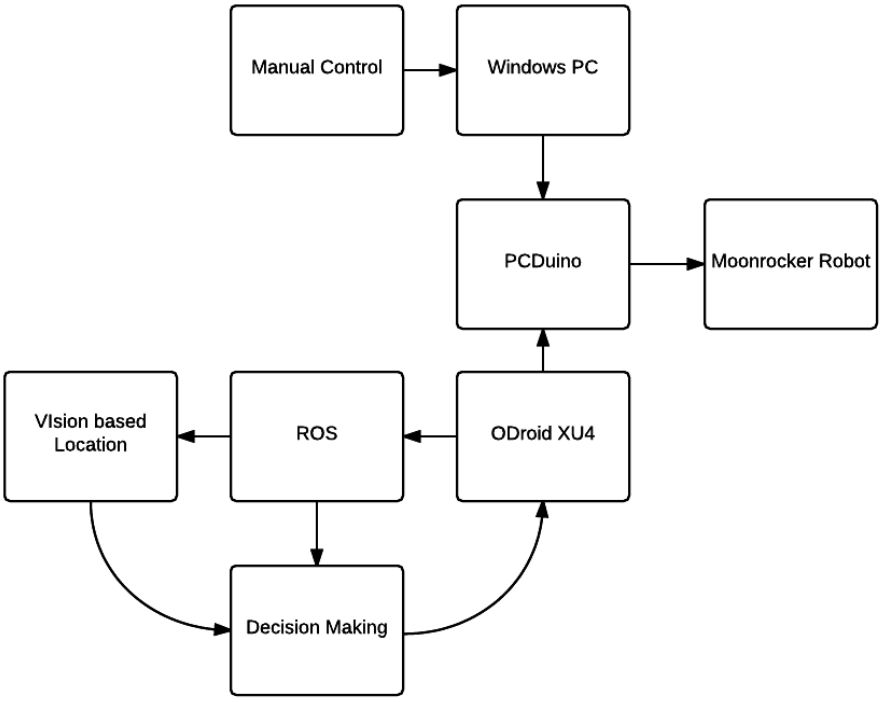

Figure 1.1: System Diagram

1.6 Technologies Overview

The technologies used to develop this system are the PCDuino, ODroid XU4, and ROS.

We chose to use the ODroid XU4 because it has 2 quad core processors which will be able to sufficiently handle the vision system, as well as the decision making system.

We chose to use ROS because it will help integrate the sensors in our system with the controls.

We chose to use the PCDuino because it was already integrated into our robotics system from the last year and currently runs out manual control systems.

2

Project Overview

2.1 Team Members and Roles

Autonomy
Alex Muchow, Computer Science
Devin Kroeber, Electrical Engineering

Moonrockers System
Daniel Hodges, Mechanical Engineering
q Samiel Hill, Mechanical Engineering
Jacob Green, Mechanical Engineering

Icy Regolith
Erik Figuracion, Mechanical Engineering
Mathew Gordon, Mechanical Engineering
Jonathan Stelzle, Mechanical Engineering

2.2 Project Management Approach

For this project we will be managing through the Agile methodology. The length of each sprint will be two weeks long, and there will be a week in between for review and a report. The product backlog is currently in trello, but as there has been a lot of overhead work, the backlog remains as it originally stood. Trello will be used to update progress on each backlog item, and to address items being done during each sprint., as well as bug tickets.

2.3 Phase Overview

Phase 1: 0.1

- AR Tag designed
- ASUS Xtion location relative to AR tag
- Find a location to mount the camera sensor on the robot.

Phase 2: 0.5

- Robot able to center itself at the AR tag from any start location and orientation
- Find a way to mount the AR tag at the dump station

Phase 3: 1.0

- Robot successfully able to travel the distance from the dump station, over the obstacle course to the mining site, and travel back.
- Robot able to perform a mining routing
- Robot able to performing dumping at the AR tagged dumping station after navigating back

Phase 4: 1.1

- Manual override

2.4 Terminology and Acronyms

Regolith - Black Point-1(BP-1), or simulant for mars soil.
Icy Regolith - Simulant for larger pieces of martian soil, in our competition it is gravel.
NRMC - NASA Robotic Mining Competition.
ROS - Robot Operating System

3

User Stories, Requirements,Backlog and Deliverables

3.1 Overview

This section of the report will contain all of my user stories and discuss the entirety of the backlog and requirements

3.1.1 Scope

This portion will cover each user story in depth. The tests for each of those stories will be covered in the testing section of the design document.

3.1.2 Purpose of the System

The purpose of this system is to autonomously run the Moonrockers robot at the NRMC.

3.2 Stakeholder Information

The stakeholders in this competition are myself and the moonrockers team.

This section would provide the basic description of all of the stakeholders for the project. Who has an interest in the successful and/or unsuccessful completion of this project?

3.2.1 Customer or End User (Product Owner)

The Product Owner is the moonrockers team. They will oversee the product and prioritize things in the backlog. They will interact with me throughout the project to drive it forward.

3.2.2 Management or Instructor (Scrum Master)

There will be no scrum master in this project.

3.2.3 Developers –Testers

I will be the one testing, designing, and developing.

3.3 Requirements and Design Constraints

The requirements for this project is that I develop and autonomous system to control the robot during the competition. The robot needs to navigate from its starting position, over the obstacle section, to the mining section of the pit. From there it needs to mine in the pit, and then backtrack through the obstacle section and deposit what it has mined in the collection bin, and repeat for the entire 10 minute run. As far as

3.3.1 System Requirements

The system must run on and ODroid and fit inside of the current electronics box.

3.3.2 Network Requirements

We currently use a router to transmit data from one device to another.

3.3.3 Development Environment Requirements

Must run in Ubuntu 14.04

3.3.4 Project Management Methodology

There will be two meetings a week. One with the advisors, and one with the remainder of the team. We will discuss the backlog during each meeting and also discuss progress made. There will be a total of six sprints throughout this project and the team will have access to the sprint and product backlogs if desired. Each sprint will last two weeks and there will be a review week after each sprint. There are no restrictions on source control as it will be hosted on github and only have one developer committing to the repository.

3.4 User Stories

3.4.1 User Story #1

As a robot, I want to be autonomous.

3.4.1.a User Story #1 Breakdown

The project as a whole requires the robot to be autonomous, and will perform various tasks in the competition pit.

3.4.2 User Story #2

As a robot, I want to be able to see the collection bin and determine my location from it.

3.4.2.a User Story #2 Breakdown

We will need to base our location off of an AR tag attached that will be attached to the collection bin. We have received code from Daniel Nix from his project he did last year in senior design. We will be using this code to implement our vision system.

3.4.3 User Story #3

As a robot, I want to be able to navigate to a predefined location within the competition pi

3.4.3.a User Story #3 Breakdown

We will need to be able to navigate to predefined locations, as we we will need to move from the starting location to the mining section. This will require knowing where we are in the pit.

3.4.4 User Story #4

As a robot I want to mine in a predefined area.

3.4.4.a User Story #4 Breakdown

Once the robot reaches a certain area, it will need to begin mining. This will require sending a signal to the robot to begin mining once it reaches that area.

3.4.5 User Story #5

As a robot, I want to return to the collector bin and deposit what i've mined.

3.4.5.a User Story #5 Breakdown

The robot will need to return over the obstacle section to the collector bin and dump what it has mined. This will use the previous user story and expand on it by backing up to the collector bin and then activating the dump routine.

3.5 Research Results

Up to this point a lot was researched for the robot. It was decided to use an ODroid XU4 for the processing, as well as use ROS for programming the system.

4

Design and Implementation

This section will go over all of the design and implementation details of the system. There are three main components to our project. They are the vision system, the decision making system, and the telecommunication system.

The vision system will allow the robot to be able to tell where it is within the competition pit. This is necessary due to the terrain being very sandy, thus causing typicaly methods of odometry to be uneffective.

The decision making system will allow the robot to make decisions when in the competition pit. This will be the brain of the robot and will tell all of the working parts what to do. We will have various logic setup for all of the areas of the pit, as well as data being stored as to wether or not it has been mining for a long enough to take its collected material back to dump, if it's stuck.

4.1 Vision based location

4.1.1 Technologies Used

For this component, we will be using a rgb camera, as well as an ODroid XU4, and it will be supported by ROS. We will be mounting the camera on the back of the robot, and this will allow us to back up to the collection bin with precision. We are also using an AR tag that will be attached to the collector bin.

4.1.2 Component Overview

As far as features of this component goes, it will allow a user, the robot in this case, to point a camera at the AR tag and be able to know how far away it is, and what angle you are viewing it from.

4.1.3 Phase Overview

This is an extension of the Phase Overview above, but specific to this component. It is meant to be basically a brief list with space for marking the phase status.

4.1.4 Design Details

Will be documented once code is up and running.

4.2 Decision making system

4.2.1 Technologies Used

This component will use the visual location component, and then also be running on the ODroid XU4 via ROS.

4.2.2 Component Overview

The features of this system will include:

- Ability to navigate from the starting location to the mining area
- The ability to mine in the mining area after determining that it is in the mining area
- The ability to back up to the collector bin after mining
- The ability to get the robot unstuck if it has not moved within a certain amount of time
- The ability to not run into walls

4.2.3 Design Details

Will be further documented after vision system is implemented.

4.3 Telecommunication

4.3.1 Technologies Used

This component uses a computer running windows, a router, an xbox controller, and a PCDuino.

4.3.2 Component Overview

The features of the telecommunication system is mainly just controlling the robot from the xbox controller.

4.3.3 Data Flow Diagram

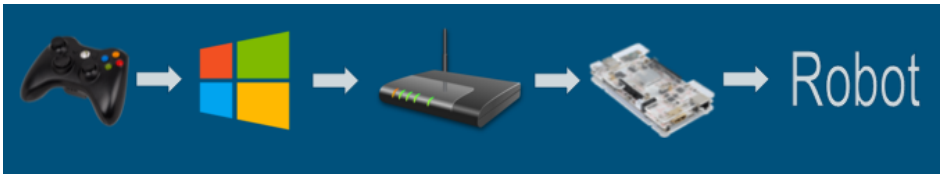

Figure 4.1: System Diagram

4.3.4 Design Details

Currently, this system is working by interacting the windows pc with the pcduino via a TCP server set up on the network that they are both connected to. The windows program repeatedly loops and takes in the xbox controllers input and then sends over an array to the PCDuino, which maps each array variable to a pin which is connected to a working part of the robot. We currently have our drive motors mapped to the control sticks on the robot, as well as forward and reverse for our conveyor system mapped to the Y and Right Bumper buttons, and the dumping mechanism mapped to the Left Bumper and B buttons.

5

System and Unit Testing

This section describes the approach taken with regard to system and unit testing.

5.1 Overview

For a lot of our testing, we will be performing live tests on the robot once the code is on there. We will be testing on the replica collection bin that we have in our lab during the winter, and then we will be testing out on the sand volleyball court once the weather gets nicer.

5.2 Test Setup and Execution

5.2.1 Test #1

As a robot, I want to be autonomous.

5.2.1.a Test #1 Breakdown

We will be setting up a simulated competition pit in the sand volleyball court once each individual section has been tested.

5.2.2 Test #2

As a robot, I want to be able to see the collection bin and determine my location from it.

5.2.2.a Test #2 Breakdown

We will be walking the camera around our lab and testing the vision algorithms to be sure they are functioning properly.

5.2.3 Test #3

As a robot, I want to be able to navigate to a predefined location within the competition pit

5.2.3.a Test #3 Breakdown

We will be running the robot around the lab and setting up locations where it will travel from and to.

5.2.4 Test #4

As a robot I want to mine in a predefined area.

5.2.4.a Test #4 Breakdown

We will be using the previous test to take us to a location and then make sure it will mine once it gets there.

5.2.5 Test #5

As a robot, I want to return to the collector bin and deposit what i've mined.

5.2.5.a Test #5 Breakdown

We will be starting the robot at some distance from the collector bin, and then having it travel back to the collector bin, orient itself to be facing away from it, back up, and then dump into the collector bin.

6

Development Environment

6.1 Development IDE and Tools

There were no IDE's used for this project, we only used vim to do the file editing in ubuntu.

6.2 Source Control

For this project, we used git via github for source control. We set it up on our ODroid and our PCDuino and have two repository's, one for telecommunication and one for autonomy. A developer connects to it by pulling down the repository and loggin in via their credentials that have access to the repository.

6.3 Dependencies

ROS Indigo

ODroid XU4 running Ubuntu 14.04

6.4 Build Environment

There will be build scripts once we are in that stage of the project.

7

Release – Setup – Deployment

Will be placed in document second semester

7.1 Deployment Information and Dependencies

7.2 Setup Information

7.3 System Versioning Information

8

User Documentation

Will be placed in document second semester

8.1 User Guide

8.2 Installation Guide

8.3 Programmer Manual

9

Class Index

9.1 Class List

Here are the classes, structs, unions and interfaces with brief descriptions

10

Class Documentation

Will be discussed as the software is further developed

SDSMT SENIOR DESIGN
SOFTWARE DEVELOPMENT AGREEMENT

This Software Development Agreement (the "Agreement") is made between the SDSMT Computer Science Senior Design Team Moonrockers ("Student Group"), consisting of team members Alexander Muchow ("Student Names"), and Sponsor Moonrockers ("Company Name"), with address: _____.

[Note: Bracketed material is included to suggest content that will vary with each agreement. I STRONGLY SUGGEST THAT THE INSTRUCTOR LOOK AT THE COMPLETED AGREEMENT BEFORE YOU SIGN IT!!]

1 RECITALS

1. Sponsor desires Senior Design Team to develop software [for use in Sponsor's simulation platform for optical fiber transmissions of digitized video signals] (the "Field").
2. Senior Design Teams willing to develop such Software.

NOW, THEREFORE, in consideration of the mutual covenants and promises herein contained, the Team and Sponsor agree as follows:

2 EFFECTIVE DATE

This Agreement shall be effective as of 9/14/2015 (the "Effective Date").

3 DEFINITIONS

1. "Software" shall mean [the computer programs in machine readable object code form and any subsequent error corrections or updates supplied to Sponsor by Senior Design Team pursuant to this Agreement.] [Depending on the particulars of each agreement, any or all of the following may need to be specified. If they are relevant, they should be used throughout, modifying the standard form as appropriate.]
2. "Acceptance Criteria" means the written technical and operational performance and functional criteria and documentation standards set out in the [project plan.]
3. "Acceptance Date" means [the date for each Milestone when all Deliverables included in that Milestone have been accepted by Sponsor in accordance with the Acceptance Criteria and this Agreement.]
4. "Deliverable" means a deliverable specified in the [project plan.]
5. "Delivery Date" shall mean, [with respect to a particular Milestone,] the date on which University has delivered to Sponsor all of the Deliverables [for that Milestone] in accordance with [the project plan and] this Agreement.

6. "Documentation" means the documents, manuals and written materials (including end-user manuals) referenced, indicated or described in [the project plan] or otherwise developed pursuant to this Agreement.
7. "Milestone" means the completion and delivery of all of the Deliverables or other events which are included or described in [the project plan] scheduled for delivery and/or completion on a given target date; a Milestone will not be considered completed until the Acceptance Date has occurred with respect to all of the Deliverables for that Milestone.

4 DEVELOPMENT OF SOFTWARE

1. Senior Design Team will use its best efforts to develop the Software described in [the project plan.] The Software development will be under the direction of or his/her successors as mutually agreed to by the parties ("Team Lead") and will be conducted by the Team Lead. The Team will deliver the Software to the satisfaction of the course instructor that reasonable effort has been made to address the needs of the client. The Team understands that failure to deliver the Software is grounds for failing the course.
2. Sponsor understands that the Senior Design course's mission is education and advancement of knowledge, and, consequently, the development of Software must further that mission. The Senior Design Course does not guarantee specific results or any results, and the Software will be developed only on a best efforts basis. The Software is considered PROOF OF CONCEPT only and is NOT intended for commercial, medical, mission critical or industrial applications.
3. The Senior Design instructor will act as mediator between Sponsor and Team; and resolve any conflicts that may arise.

5 COMPENSATION

[This is entirely subject to negotiation. Normally NO COMPENSATION occurs in a Senior Design Project. On occasion an intern status and wage is appropriate.]

6 CONSULTATION AND REPORTS

1. Sponsor's designated representative for consultation and communications with the Team Lead shall be Moonrockers or such other person as Sponsor may from time to time designate to the Team Lead ("Designated Representative").
2. During the Term of the Agreement, Sponsor's representatives may consult informally with course instructor regarding the project, both personally and by telephone. Access to work carried on in University facilities, if any, in the course of this Agreement shall be entirely under the control of University personnel but shall be made available on a reasonable basis.
3. The Team Lead will submit written progress reports. At the conclusion of this Agreement, the Team Lead shall submit a comprehensive final report in the form of the formal course documentation at the conclusion of the Senior Design II course.

7 CONFIDENTIAL INFORMATION

1. The parties may wish, from time to time, in connection with work contemplated under this Agreement, to disclose confidential information to each other ("Confidential Information"). Each party will use reasonable efforts to prevent the disclosure of any of the other party's Confidential Information to third parties for

a period of three (3) years after the termination of this Agreement, provided that the recipient party's obligation shall not apply to information that:

(a) is not disclosed in writing or reduced to writing and so marked with an appropriate confidentiality legend within thirty (30) days of disclosure;

(b) is already in the recipient party's possession at the time of disclosure thereof;

(c) is or later becomes part of the public domain through no fault of the recipient party;

(d) is received from a third party having no obligations of confidentiality to the disclosing party;

(e) is independently developed by the recipient party; or

(f) is required by law or regulation to be disclosed.

2. In the event that information is required to be disclosed pursuant to subsection (6), the party required to make disclosure shall notify the other to allow that party to assert whatever exclusions or exemptions may be available to it under such law or regulation.

8 INTELLECTUAL PROPERTY RIGHTS

[Negotiated on a case-by-case basis. This must address who owns the algorithms and who owns the source code. For example: All deliverables become property of the Sponsor. Roughly: If the idea originates with the sponsor, or if a sponsor pays you to develop an idea, then they have legitimate claim to the IP. If the idea originates from the University (through faculty or staff) then the University has legitimate claim. If the idea is yours (student) and you develop it without external compensation then you have legitimate claim.]

9 WARRANTIES

The Senior Design Team represents and warrants to Sponsor that:

1. the Software is the original work of the Senior Design Team in each and all aspects;
2. the Software and its use do not infringe any copyright or trade secret rights of any third party.

No agreements will be made beyond items (1) and (2).

10 INDEMNITY

1. Sponsor is responsible for claims and damages, losses or expenses held against the Sponsor. [Sponsor may have something to add here.]
2. Sponsor shall indemnify and hold harmless the Senior Design Team, its affiliated companies and the officers, agents, directors and employees of the same from any and all claims and damages, losses or expenses, including attorney's fees, caused by any negligent act of Sponsor or any of Sponsor's agents, employees, subcontractors, or suppliers.
3. NEITHER PARTY TO THIS AGREEMENT NOR THEIR AFFILIATED COMPANIES, NOR THE OFFICERS, AGENTS, STUDENTS AND EMPLOYEES OF ANY OF THE FOREGOING, SHALL BE LIABLE TO ANY OTHER PARTY HERETO IN ANY ACTION OR CLAIM FOR CONSEQUENTIAL OR SPECIAL DAMAGES, LOSS OF PROFITS, LOSS OF OPPORTUNITY, LOSS OF PRODUCT OR LOSS OF USE, WHETHER THE ACTION IN WHICH RECOVERY OF DAMAGES IS SOUGHT IS BASED ON CONTRACT TORT (INCLUDING SOLE, CONCURRENT OR OTHER NEGLIGENCE AND STRICT

LIABILITY), STATUTE OR OTHERWISE. TO THE EXTENT PERMITTED BY LAW, ANY STATUTORY REMEDIES WHICH ARE INCONSISTENT WITH THE PROVISIONS OF THESE TERMS ARE WAIVED.

11 INDEPENDENT CONTRACTOR

For the purposes of this Agreement and all services to be provided hereunder, the parties shall be, and shall be deemed to be, independent contractors and not agents or employees of the other party. Neither party shall have authority to make any statements, representations or commitments of any kind, or to take any action which shall be binding on the other party, except as may be expressly provided for herein or authorized in writing.

12 TERM AND TERMINATION

1. This Agreement shall commence on the Effective Date and extend until the end of classes of the second semester of Senior Design (CSC 467), unless sooner terminated in accordance with the provisions of this Section ("Term").
2. This Agreement may be terminated by the written agreement of both parties.
3. In the event that either party shall be in default of its materials obligations under this Agreement and shall fail to remedy such default within thirty (30) days after receipt of written notice thereof, this Agreement shall terminate upon expiration of the thirty (30) day period.
4. Any provisions of this Agreement which by their nature extend beyond termination shall survive such termination.

13 ATTACHMENTS

Attachments A and B are incorporated and made a part of this Agreement for all purposes.

14 GENERAL

1. This Agreement constitutes the entire and only agreement between the parties relating to the Senior Design Course, and all prior negotiations, representations, agreements and understandings are superseded hereby. No agreements altering or supplementing the terms hereof may be made except by means of a written document signed by the duly authorized representatives of the parties.
2. This Agreement shall be governed by, construed, and enforced in accordance with the internal laws of the State of South Dakota.

15 SIGNATURES

Alexander Muchow

Replace with name of student #1 — Date

Replace with name of student #2 — Date

Replace with name of student #3 — Date

Devin Kroeber

Replace with name of sponsor's representative — Date

A

Product Description

Write a description of the product to be developed. Use sectioning commands as neccessary.

NOTE: *This is part of the contract.*

B

Sprint Reports

1 Sprint Report #1

Sprint Report #1

Team Overview

Name

Moonrockers

Team Members

Alex Muchow

Project Title

NASA Robotic Mining Competition

Customer Overview

Customer Description

Moonrockers is a competitive team that participates in the NASA Robotic Mining Competition each year. The goal of this competition is for teams to build robots that could theoretically perform mining on Mars.

Customer Problem

Currently, the team uses telecommuncations via a TCP server on a PCduino to control the robot from an xbox controller, but one of the major factors in scoring for this competition is autonomy. Autonomy has not been the focus of the team in the past, but as there is a currently functioning robot that will be iterated upon rather than rebuilt; the team has opted to focus on autonomy this year.

Customer Needs

- Camera sensor implemented into current design,
- Autonomy to be implemented using computer vision with the assistance of an AR tag,
- An override option to regain telecommunication control while the robot is running autonomously.

2 Sprint Report #2

Sprint Report #2

This sprint report is to inform you of the backlog completed during Sprint 2. During this sprint, our team continued to meet bi-weekly to discuss our plans in further detail as well as to work on a few adjustments to our robot. One of the small accomplishments of this sprint was an adjustment to the telecommunication code. The team requested a mining mode for the robot to allow it to drive slower while mining. This update worked with with all sides of our telecommunication code. We had to map a new button on our controller, as well as update our code on our PCDuino to receive the new signal from the xbox controller. Our motor controller code needed to be updated as well, and some rewiring was required on those motor controllers in order to allow another signal to be sent to it.

We also continued to work on our visual odometry. During this sprint, it was found out that the Landing Pad senior design time has an AR Tag visual odometry package written in ROS. We plan our working with the Landing Pad team to obtain this and begin working with and learning ROS.

The team also ordered an Odroid XU4 during this sprint, which we plan on using to run our autonomy code, as the PCDuino was ruled out as an effective device to do so.

Deliverables:
Began to learn ROS, as well as decided on all of the hardware required for the project.

3 Sprint Report #3

Sprint Report #3

This sprint report is to inform you of the backlog completed during Sprint 3. During this sprint, our team continued to meet bi-weekly to discuss our plans in further detail as well as to work on a few adjustments to our robot. The majority of this sprint was spent continuing to learn ROS.

One of the requirements for our competition is that we volunteer as a team and do STEM outreach. We went and demoed our robot at the First Lego League competition at our school and spoke with the kids at the competition about robotics and let them drive the robot a bit. We will also be helping out at the Vex Robotics competition on 12/12/15 at one of the local high schools.

We obtained visual odometry code from Daniel Nix during this sprint. After speaking with him about code written last year, he volunteered some that he had written to do the same thing that our team desired and needed. This will be worked with over Christmas break.

My main focus of this sprint was to continue learning ROS. We obtained the ODroid XU4 at the beginning and I installed Ubuntu 14.04 on it and also installed ROS and continued to work through the tutorials and the book reccomended to me by a classmate.

Deliverables: Continuing to learn ROS, getting the ODroid XU4 and setting it up, and obtaining the computer vision code.

C

Industrial Experience and Resumes

1 Resumes

1.1 Alex Muchow

Alexander Muchow

501 East Saint Joseph St. RH554 Rapid City, South Dakota 57701

Alexander.Muchow@mines.sdsmt.edu 612-618-8559

Objective

Obtain a full time position in the field of software development beginning in May 2016.

Education

South Dakota School of Mines & Technology

- B.S. Computer Science May 2016
- Current GPA: 2.7

Programming

- Languages: C++, PHP, Java, Python, C#, MySQL, HTML, CSS, JavaScript, JQuery, and ARM Assembly.
- Notable Courses: Computer Vision, Artificial Intelligence, Software Engineering, and Mobile Computing.

Work Experience

Software Development Intern Perfect Memorials LLC, Eden Prairie, Minnesota May 2014 – Present

- Software Development using PHP, MySQL, HTML, CSS, JavaScript, and JQuery. Maintained and extended legacy code.
- Working with international developers to drive feature requests to implementation. This includes reviewing code and occasionally addressing critical code errors that were pushed to production.
- Developed software to assist with Physical Inventory. This was focused on improving the process of taking inventory. We outlined our requirements and put them into sprints in order to get the minimum viable product.
- Rebuilt a website that was broken during a server move. This included updating outdated code, improving efficiency in the code, improving the user interface, and adding features to the site.
- Working with a database, running various queries for business reports, as well as extending the database for projects.
- Currently developing a digital signage system on the Raspberry Pi 2, from which an individual will be able to manage all of the Pi's from a web interface to control what will be shown on them.

Residential Assistant Residence Life: South Dakota School of Mines & Technology August 2014 – Present

- Using communication and leadership skills to assist students in their transition to college.
- Coordinating with other Resident Assistants to plan and host activities to engage our students.

Microsoft Student Partner Microsoft: South Dakota School of Mines & Technology September 2013 – Present

- Coordinating with Microsoft Employees and other Microsoft Student Partners from around the country to plan and host events to promote Microsoft, both locally and remotely.
- Instructing students on how to develop apps for Windows 8, Windows Phone, and to develop with IoT hardware.
- Attended //BUILD 2015 and learned about Microsoft's technologies and how to develop for them.

Volunteer Work

Orphanage in Zacatecas, Mexico February 2011 – Present

- Experiencing a different cultural perspective firsthand, while working with a missionary to meet needs around an orphanage and church.

Hour of Code January 2015

- Coordinating and hosting an Hour of Code event at my hometown high school. Hour of Code includes teaching younger students how to do basic programming and generally teaching them about the field of Computer Science.

Activities

Finance Committee Student Senate April 2013 – Present

- Committee Chair April 2014 – April 2015
- Allocating $1.5 million to various school entities and student organizations annually.
- Communication with student organizations in regards to their finances as well as meeting with them to discuss the annual requests.

Vice President Mines Gaming Network January 2013 – May 2015

Secretary Student Program Board January 2014 – February 2015

D

Acknowledgment

Thanks

E

Supporting Materials

This document will contain several appendices used as a way to separate out major component details, logic details, or tables of information. Use of this structure will help keep the document clean, readable, and organized.