Team 19 : Construction Marking Robot

Design Review I

Team Members: Justin Gibbs, Kelsey Howard, Brandon Roberts, Derrick Portis, and Christian Baez

Sponsor: Mark Winger, PSBI

Advisors: Dr. Collins, Dr. Gupta

Date: February 18, 2016

PSBI

Presentation Outline

- Overview
- Methodology
- Updates
  - Mechanical
  - Computer/Electrical
- Budget
- Planning for the Future

Overview

Project Scope

- The scope of this project is to implement a "proof of concept" marking robot which can:
  - Receive a CAD file of a floorplan and mark it out on concrete
  - Do so within ½" accuracy
  - Navigate autonomously and avoid obstacles
  - Generate an error report

Need Statement

"The ***construction industry*** is in need of a means of **increasing efficiency and productivity** as well as **reducing the amount of time and error** that goes into laying out floor plans ***manually.***"

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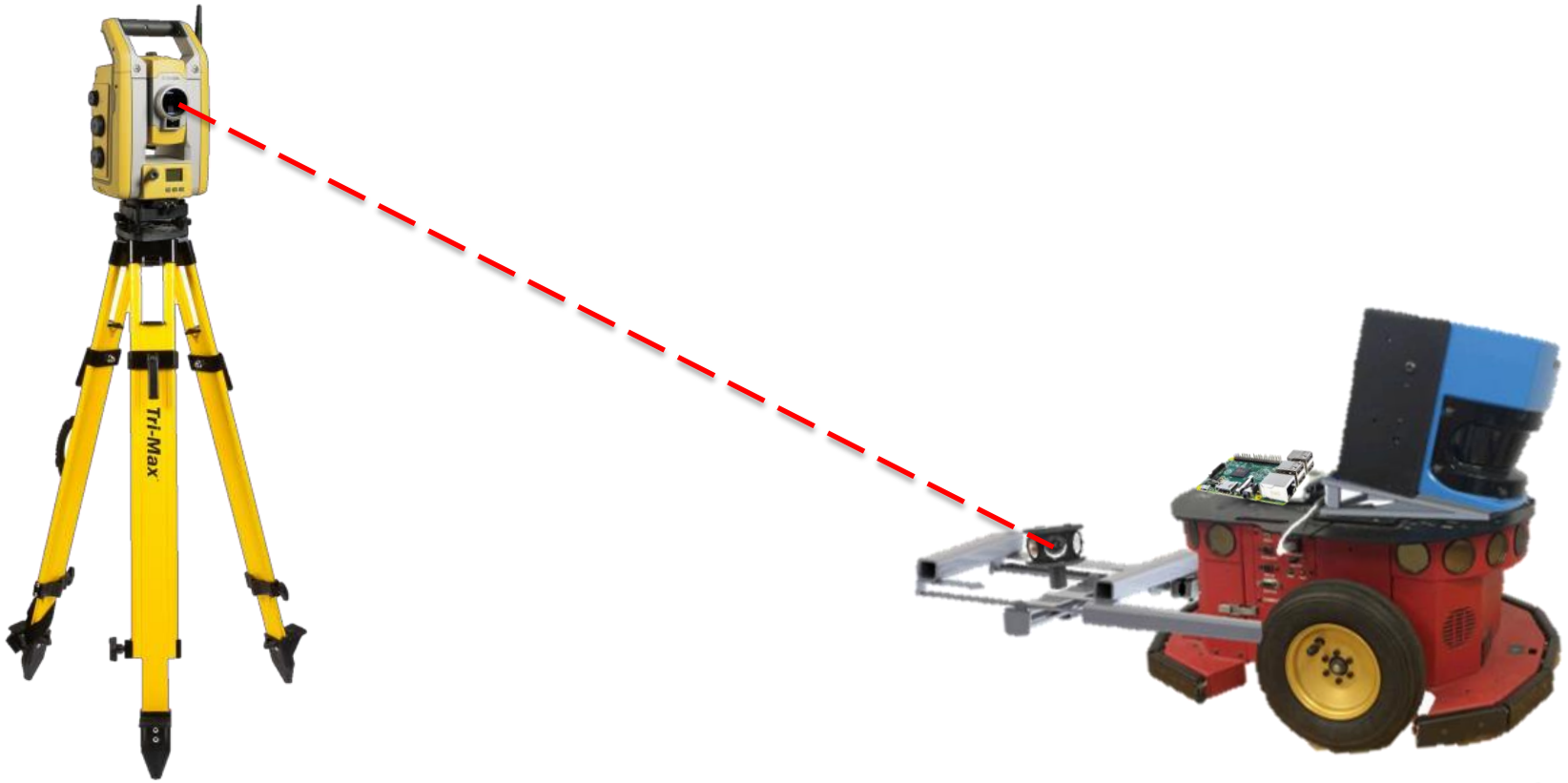
Goal Statement

"Implement a '**proof of concept**' high **precision marking robot** that will lay out the preliminary ***floor plan of a construction site,*** increasing **efficiency and productivity** of the layout process."

Methodology

Methodology



Methodology

Robotic Total Station

- Used for localization
- Contains CAD file of layout in internal memory
- Tracks prism to know robots location in real time
- Verifies points are being marked accurately

Methodology

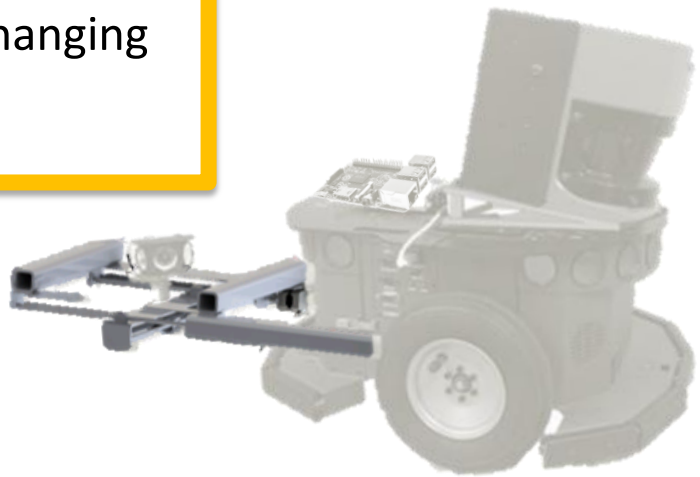
Pioneer 2DX

- Differentially steered robot
- Used as platform for marking mechanism and LiDar system

Methodology

Gantry System

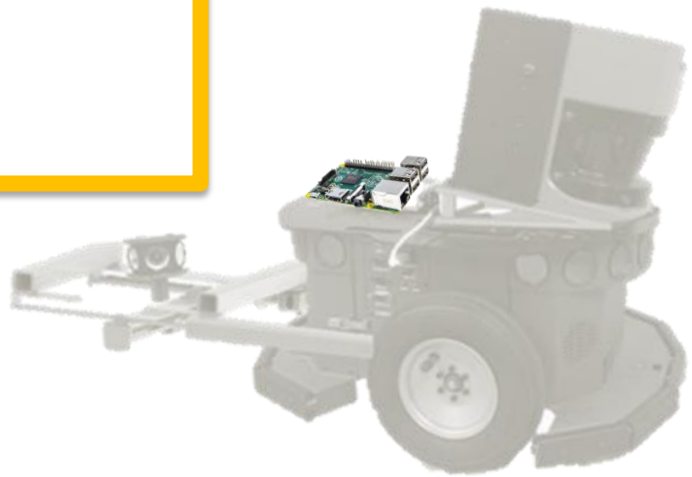
- Two linear guide rails
- Design strengths:
  - Accurate marker placement
  - Draw various shapes with ease
  - Modular mounting design to allow for easily changing out marker holders



Methodology

Raspberry Pi

- Enables communication between different subsystems
- Stores txt file to compare to RTS real time coordinates
- Communicates with Arduino to control gantry



Methodology

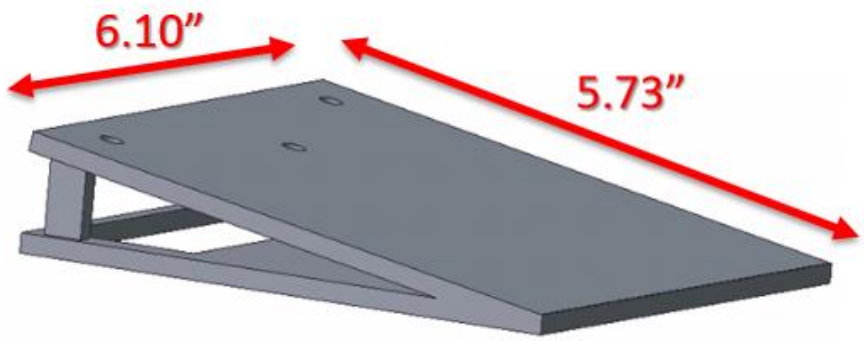
Sick LMS 200

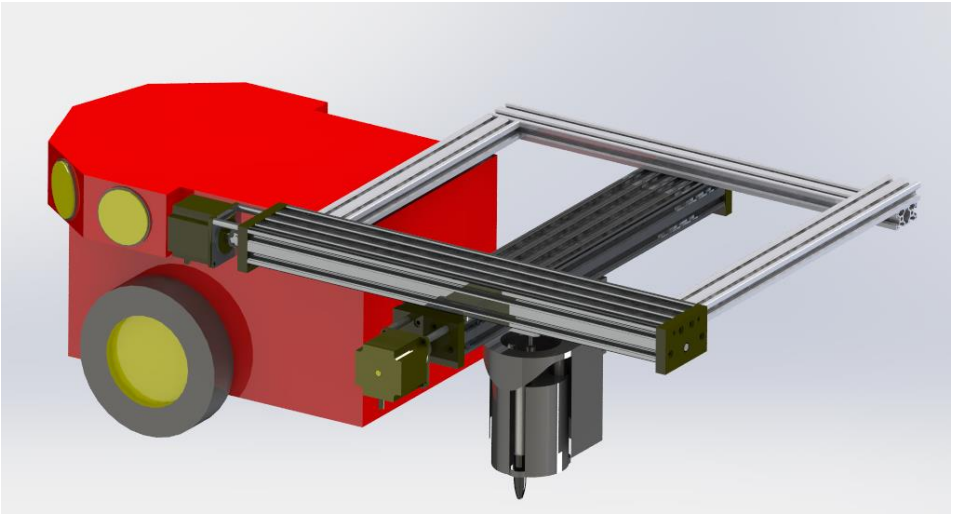
- Used for obstacle detection
- Uses laser to detect distances of oncoming obstacles
- Placed on angled mount to scan for obstacles on ground

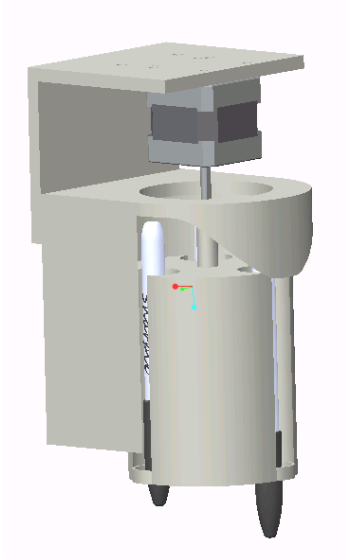
Project Updates

Mechanical Updates

- LiDar Mount
- Marker Holder
- Gantry

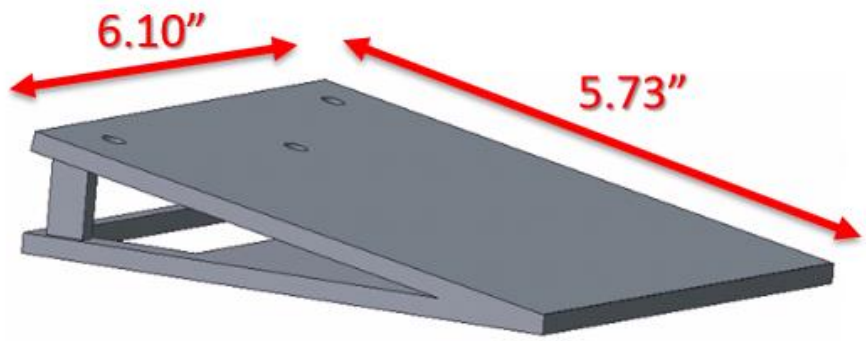


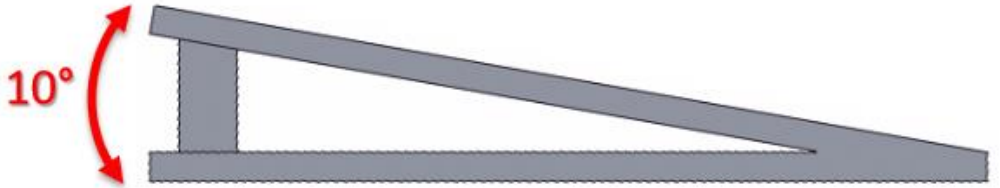


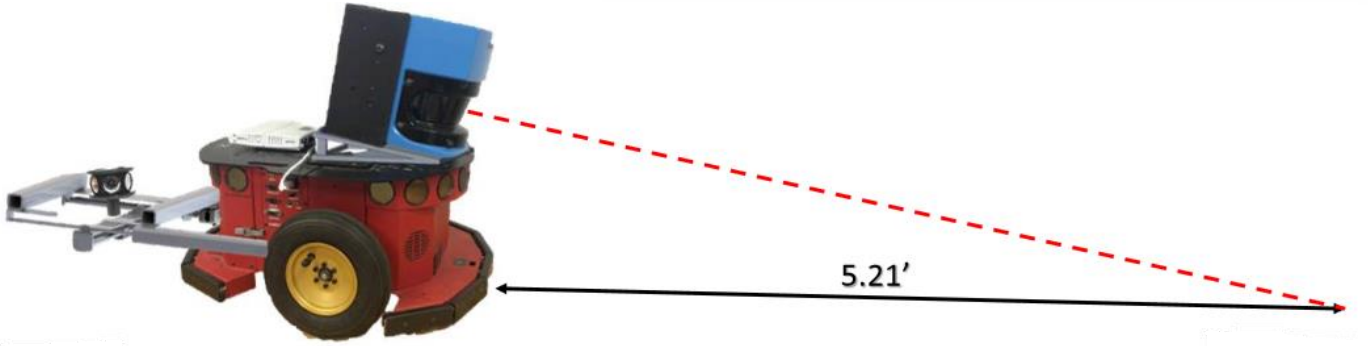


Mechanical Updates

- LiDar Mount
  - ✓Design finalized
  - ✓Material selected
  - ❑Manufactured
- Marker Holder
- Gantry

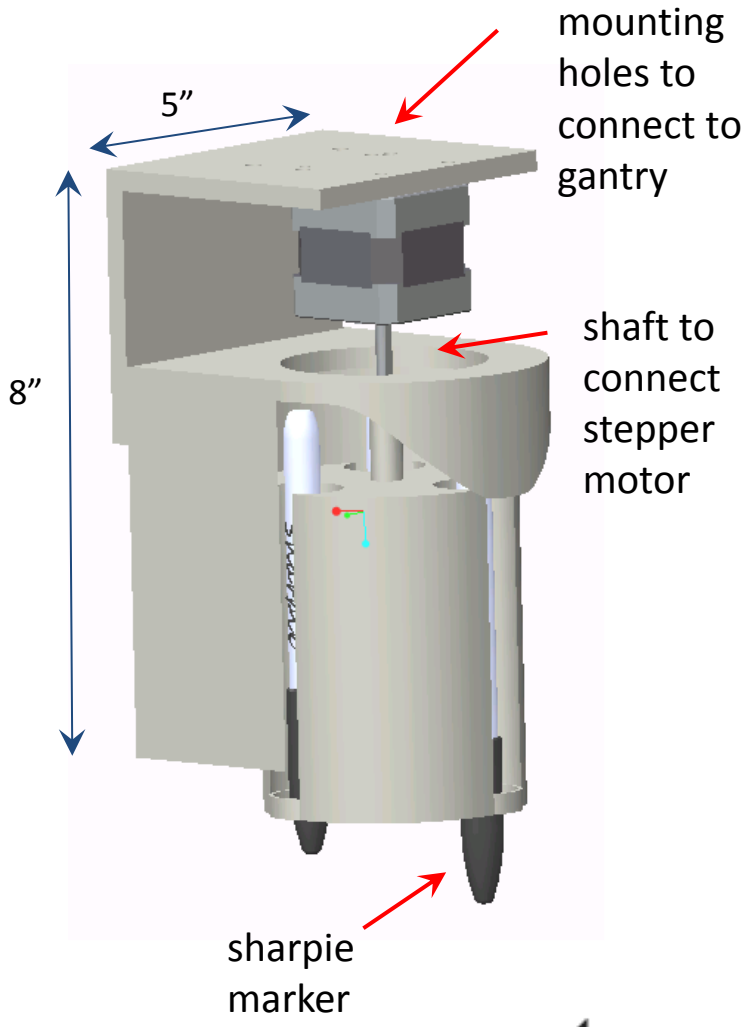






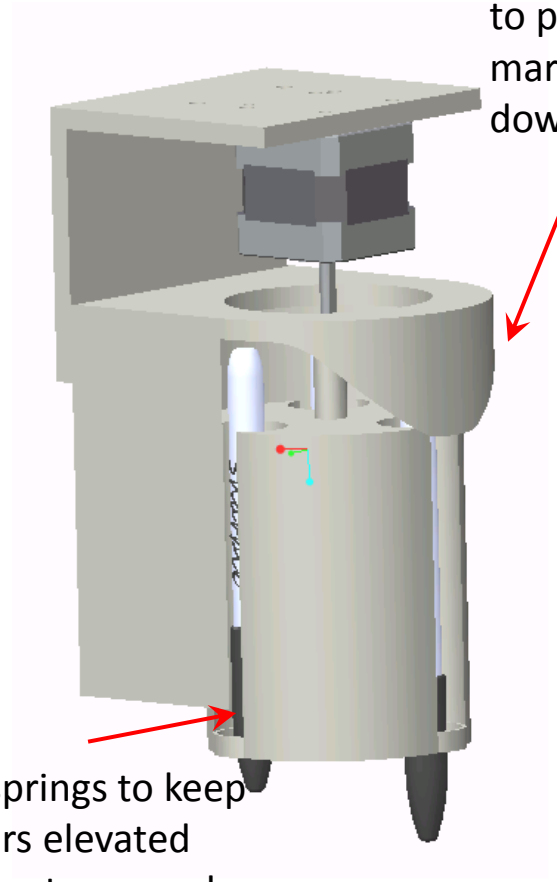
Marker Holder

- LiDar Mount
- Marker Holder
  - Provide the connection between the robot and the RTS with the ground
  - Will be mounted to the gantry
  - Holds up to 3 different colors for different subsystems of the floorplan
- Gantry



Marker Holder

- LiDar Mount
- Marker Holder
  - Revolver style movement powered by a NEMA 17 stepper motor
  - Spins in intervals of 60 degrees to initiate marking, not marking, and color changes
- Gantry



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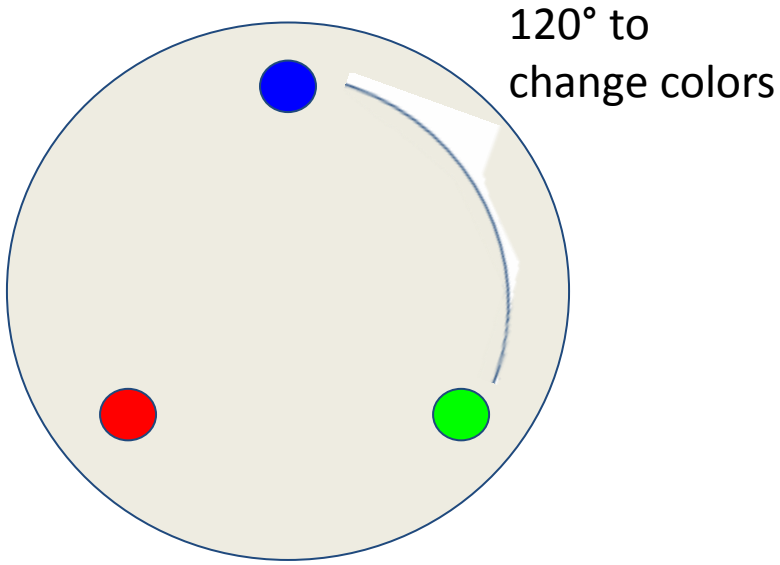

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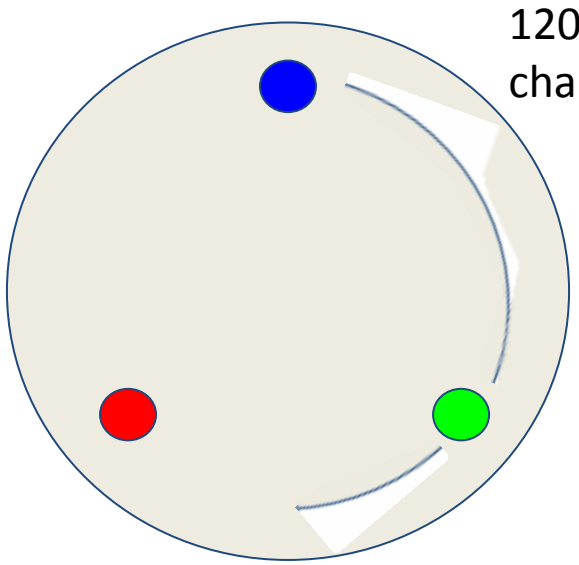
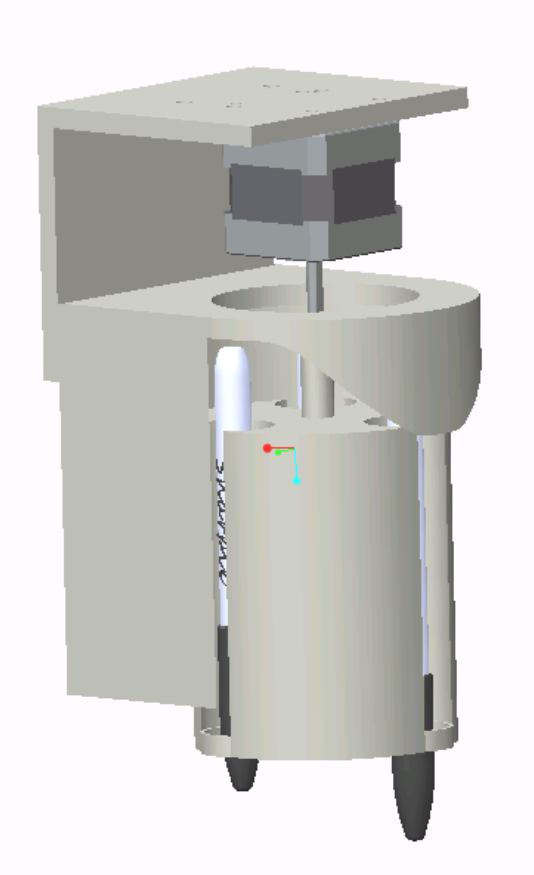


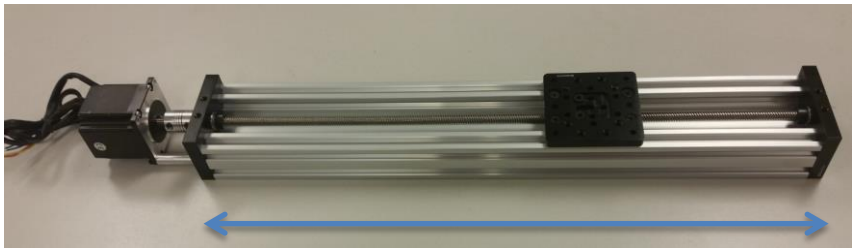
Mechanical Updates

- LiDar Mount
- Marker Holder
  - ✓Finalized design
  - ✓Motor selection
  - ✓Material Selection
  - ❑Manufacture
  - ❑Install
- Gantry



Mechanical Updates

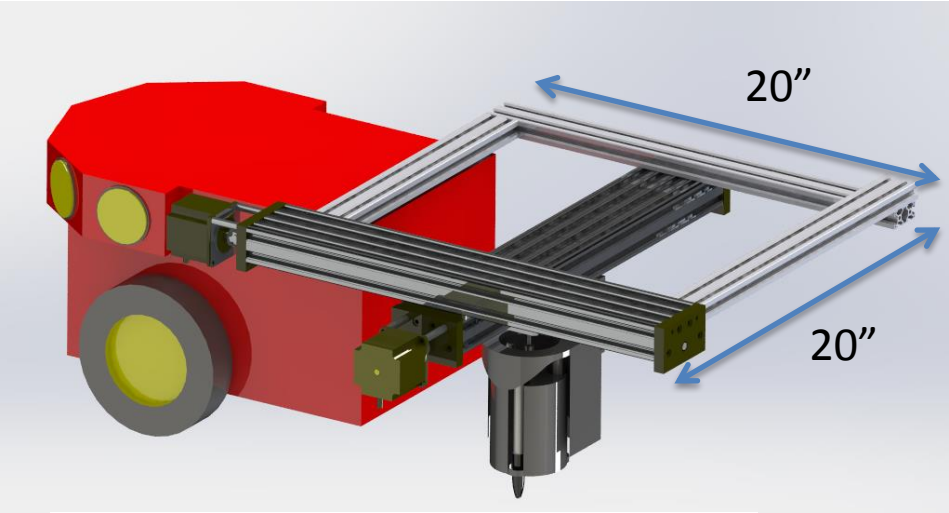
- LiDar Mount
- Marker Holder
- Gantry: Linear Actuators
  - lead screw driven by a stepper motor, guided by linear rails
  - Purchased and assembled
  - Will be mounted together to form the gantry

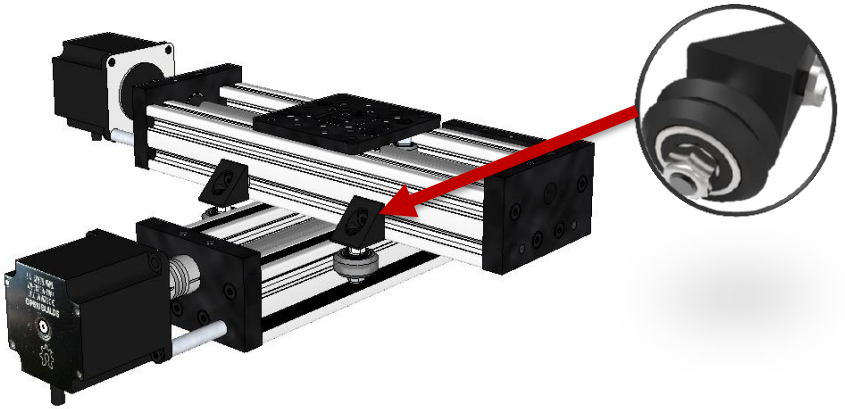


20”

Gantry Assembly and Mounting

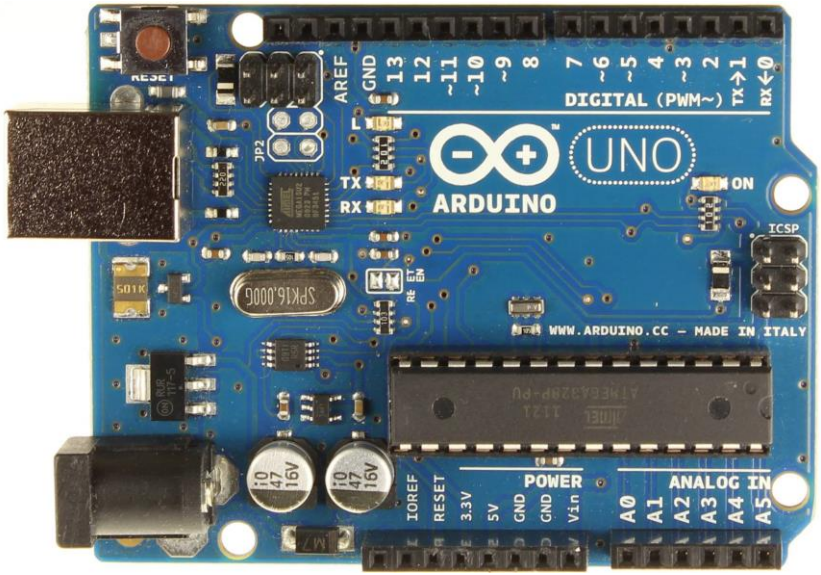
- Linear Actuators mounted together with wheeled corner connectors
- Double-wide extruded rails added for support
- Mounted to back of robot
- Will be modified to include caster wheel for support





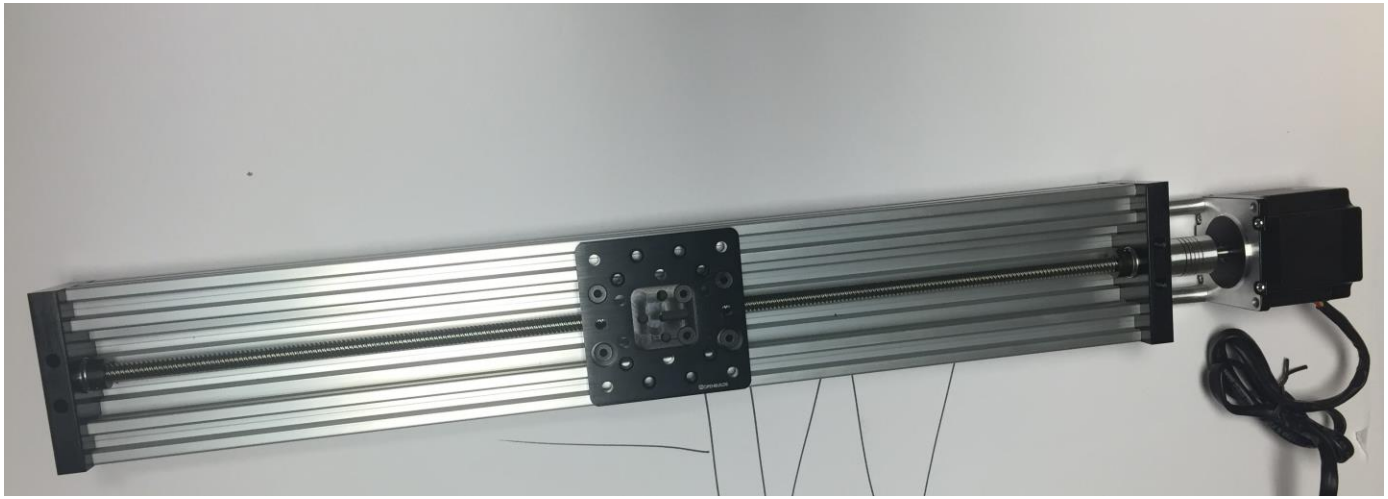
Gantry - Computer/Electrical Updates

- Coding Plans for Gantry System
  - Gantry system will be operated using the Arduino Uno Microcontroller



Gantry - Computer/Electrical Updates

- Coding Plans for Gantry System
  - Center linear guide rails on start up



Gantry - Computer/Electrical Updates

- Coding Plans for Gantry System
  - Determine the distance the marker has to shift
  - Convert distance in terms of steps
  - Each step turns the stepper motor 1.8°
  - 13,000 steps → 5cm

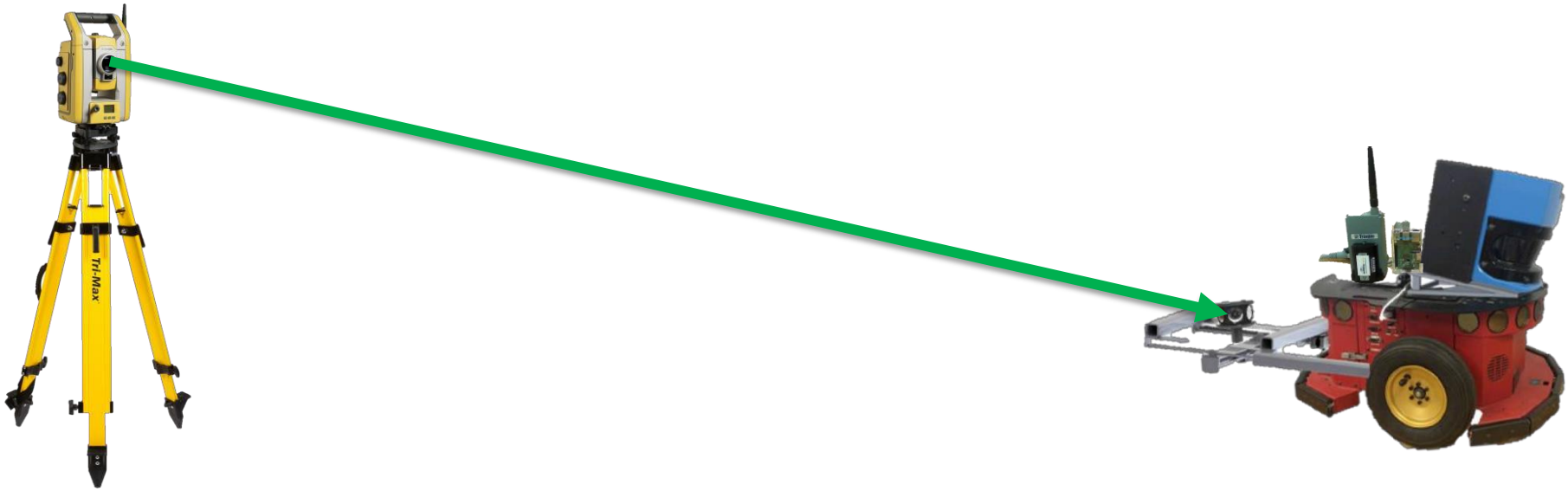
Gantry - Computer/Electrical Updates

- Coding Plans for Gantry System
  - If the gantry can no longer shift in a given direction due to range limitations
  - Robot will stop marking and realign so that the linear rails are centered again before continuing
  - A soft stop will be implemented in our code to ensure equipment does not get damaged by trying to shift the gantry too far in any direction

Coding the Stepper Motors

Computer/Electrical Updates - RTS

- RTS will track the prism mounted on the robot
- Prism will be directly above the gantry system
- RTS will then transmit the location data of the prism to Trimble's 2.4 GHz external radio



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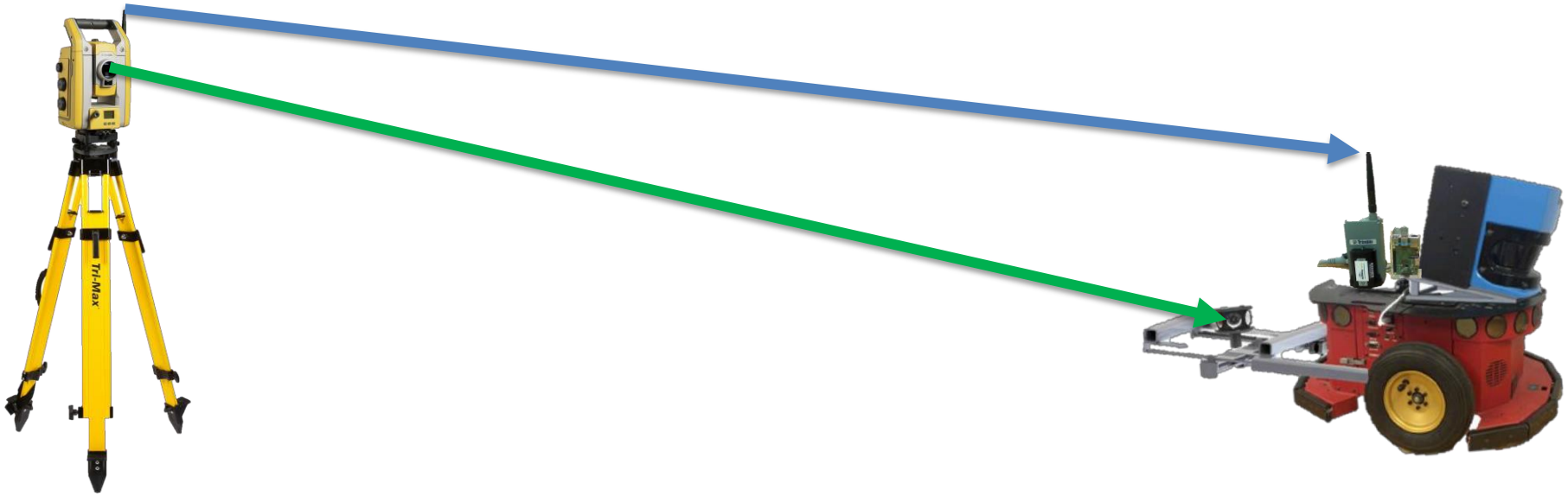
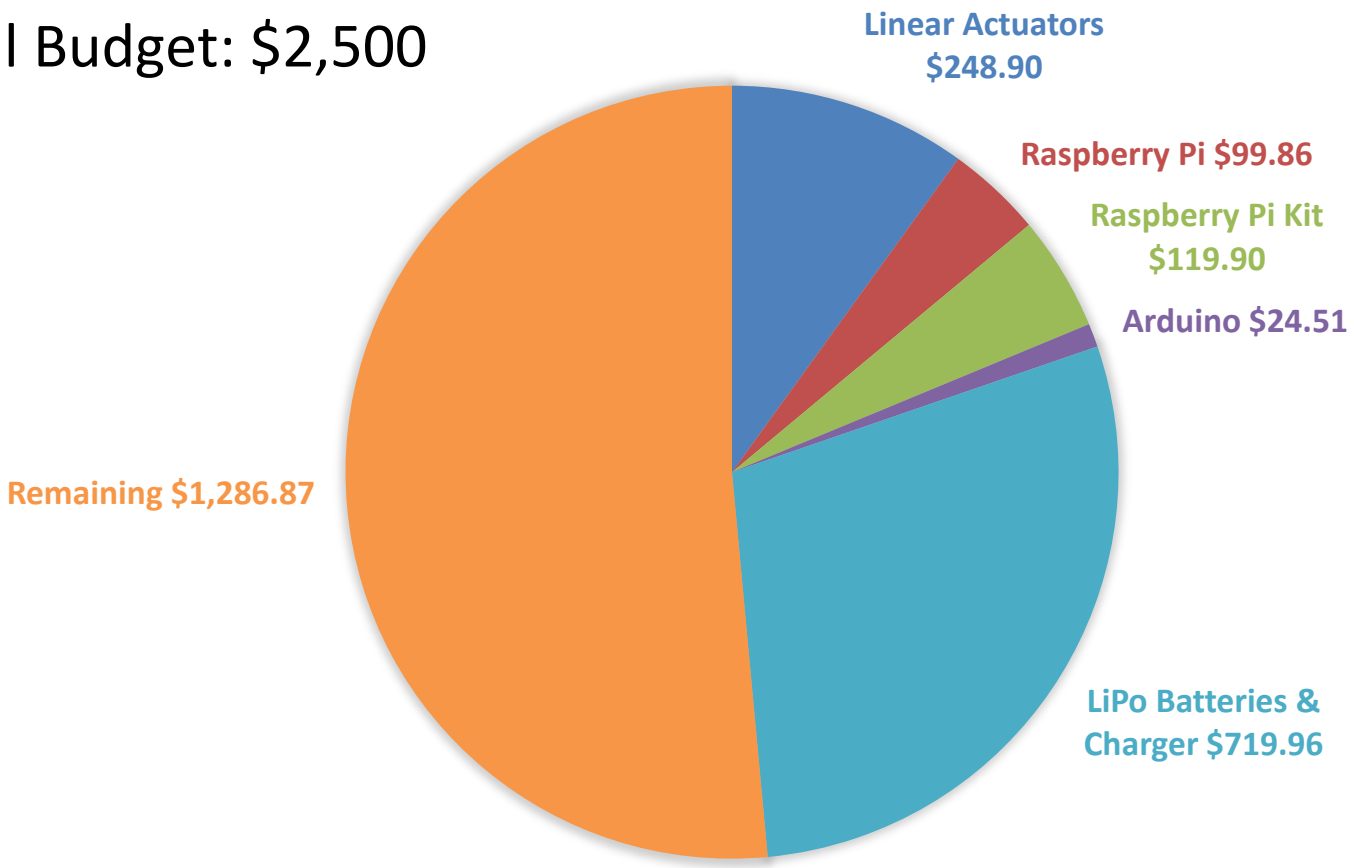


External Radio

- Radio will be connected to the Raspberry Pi via a serial to USB converter
- This system will be mounted on the robot
- The Pi will then send this data to the robot for positional checks
  as the robot travels to coordinates

Budget TBD by 12pm

Total Budget: $2,500



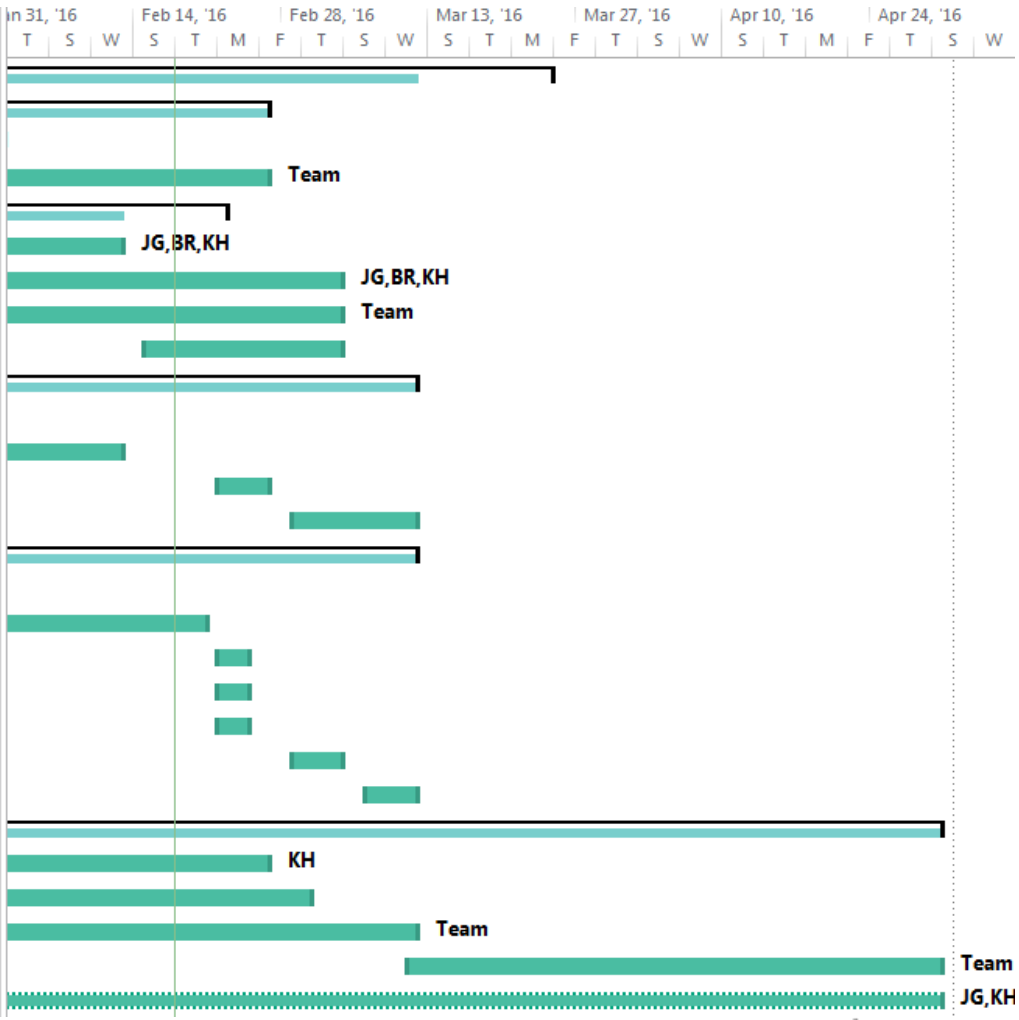
Planning for the Future

Future Planning

- Gantry System
  - Finalize support bracket design
  - Ordering support brackets
  - Fully assemble
    - Support brackets
    - Marker holder
    - Attach to Pioneer

Future Planning

Task Name	Duration	Start	Finish
Gantry System	**106 days**	**Fri 10/30/15**	**Thu 3/24/16**
Determine Final Concept	**87 days**	**Fri 10/30/15**	**Fri 2/26/16**
Determine Movement Methods	5 days	Mon 1/18/16	Fri 1/22/16
Finalize Design	26 days	Fri 1/22/16	Fri 2/26/16
Make CAD Drawings	**61 days**	**Mon 11/30/15**	**Mon 2/22/16**
Find Exact Dimensions	10 days	Mon 2/1/16	Fri 2/12/16
Select Components/Part Sourcing	45 days	Mon 1/4/16	Fri 3/4/16
Create Bill of Materials	45 days	Mon 1/4/16	Fri 3/4/16
FEA	15 days	Mon 2/15/16	Fri 3/4/16
LiDar Mount	**85 days**	**Mon 11/16/15**	**Fri 3/11/16**
Initial Designs	5 days	Mon 1/18/16	Fri 1/22/16
Finalize Design	16 days	Fri 1/22/16	Fri 2/12/16
Manufacture	5 days	Mon 2/22/16	Fri 2/26/16
Install on Robot	10 days	Mon 2/29/16	Fri 3/11/16
Marker Holder	**40 days**	**Mon 1/18/16**	**Fri 3/11/16**
Initial Designs	5 days	Mon 1/18/16	Fri 1/22/16
Finalize Design	22 days	Fri 1/22/16	Sat 2/20/16
Purchase Printing Material	3 days	Mon 2/22/16	Wed 2/24/16
Source Springs	3 days	Mon 2/22/16	Wed 2/24/16
Consult with printer shop	3 days	Mon 2/22/16	Wed 2/24/16
Manufacture	5 days	Mon 2/29/16	Fri 3/4/16
Install on Robot	5 days	Mon 3/7/16	Fri 3/11/16
Verification and Testing	**86 days**	**Mon 1/4/16**	**Sat 4/30/16**
Order Parts	40 days	Mon 1/4/16	Fri 2/26/16
Test Parts Seperately	22 days	Mon 2/1/16	Tue 3/1/16
Build Mechanism	30 days	Mon 2/1/16	Fri 3/11/16
Testing (On and Off Site)	37 days	Fri 3/11/16	Sat 4/30/16
Documentation of Activities	86 days	Mon 1/4/16	Sat 4/30/16

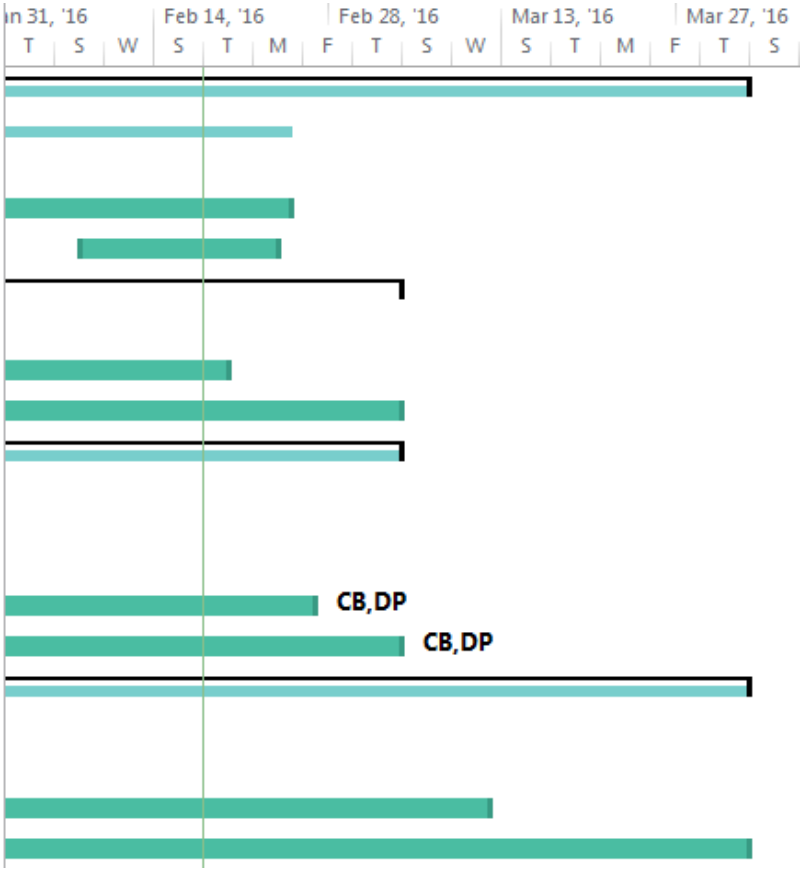


Future Planning

- Programming
  - Make robot move according to a txt file
  - Work on radio communication with RTS and receiver
  - Continue testing gantry movement in X and Y directions

Future Planning

Task Name	Duration	Start	Finish
Programming	**149 days**	**Wed 9/9/15**	**Fri 4/1/16**
Locomotion	**105 days**	**Wed 9/9/15**	**Sat 1/30/16**
QnX Code Research	49 days	Wed 9/9/15	Fri 11/13/15
Make Robot Move	38 days	Mon 1/4/16	Wed 2/24/16
Make Gantry Move	12 days	Mon 2/8/16	Tue 2/23/16
Microprocessor	**93 days**	**Thu 10/29/15**	**Fri 3/4/16**
Research Options	38 days	Thu 10/29/15	Fri 12/18/15
Raspbery Pi Work	74 days	Tue 11/10/15	Fri 2/19/16
Communication with Pioneer	45 days	Mon 1/4/16	Fri 3/4/16
Extraction of CAD Data	**129 days**	**Wed 9/9/15**	**Fri 3/4/16**
Find Software changing CAD to coordinates	43 days	Wed 9/9/15	Thu 11/5/15
MATLAB program for txt file	13 days	Thu 11/5/15	Mon 11/23/15
Task Assignments	83 days	Wed 11/4/15	Fri 2/26/16
Path Planning	45 days	Mon 1/4/16	Fri 3/4/16
Integration with Robotic Total Station	**149 days**	**Wed 9/9/15**	**Fri 4/1/16**
Research	54 days	Wed 9/9/15	Fri 11/20/15
Gather API			
Communication Code	40 days	Mon 1/18/16	Fri 3/11/16
Testing and Integration	65 days	Mon 1/4/16	Fri 4/1/16



Questions?