Team 19 : Construction Marking Robot

Spring Update

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PSBI

Presentation Outline

- Overview
- Methodology
- Updates
  - Mechanical
    - Gantry
    - New components
  - Computer/Electrical
- Planning for the Future

Overview

Background

- Productivity in the Construction Industry has been low since the recession
- Mark Winger of PSBI's solution: including more technology
- One application:
  - Layout of floorplans onsite
    - Manual layout is inefficient and prone to high error propagation
    - Including a robot in this process could save the industry time and money by working more efficiently and accurately

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."

Objectives

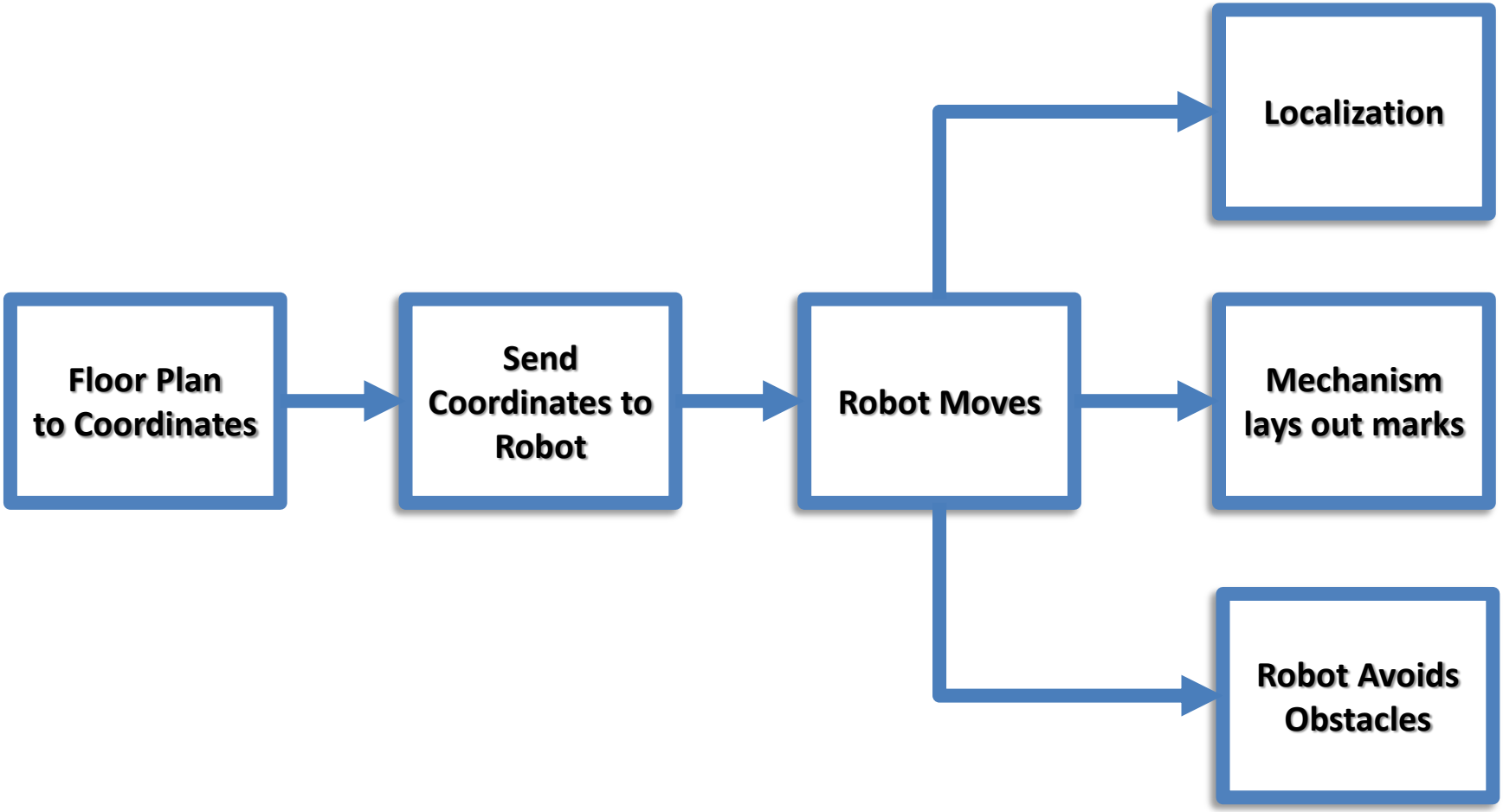
- Add functionality to robot to receive a CAD file of a floor plan and convert it into useable coordinates
- Design, fabricate, and implement a marking mechanism
- Make the robot able to navigate autonomously, avoid obstacles, and generate an error report

Design Requirements

- The final product must be:
  - Able to make marks within ½ ” accuracy
  - Easily portable
  - Able to mark on concrete
  - Able to mark across 100 sq. ft. within 10 minutes
  - Able to navigate autonomously

Methodology

Methodology



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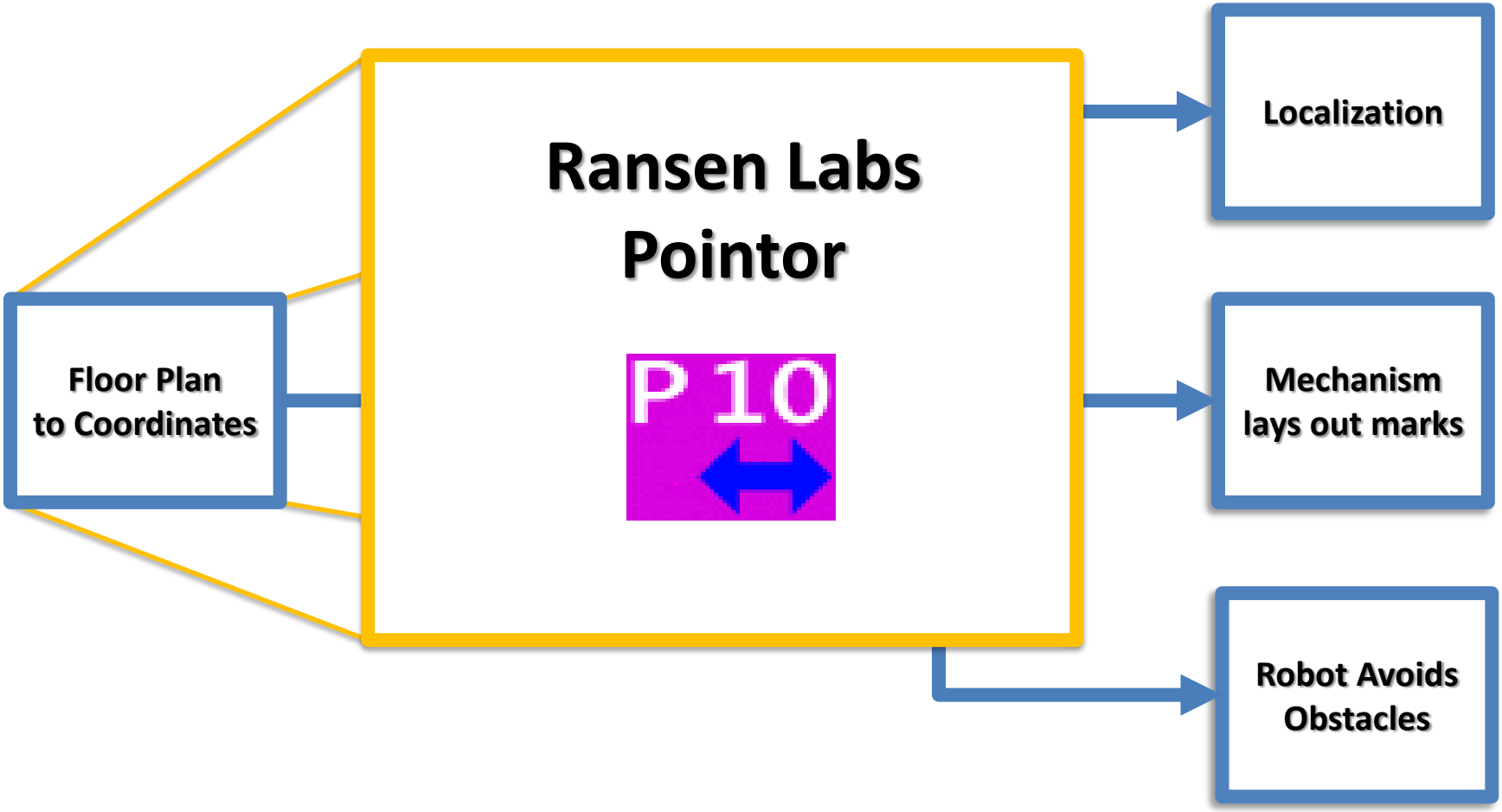

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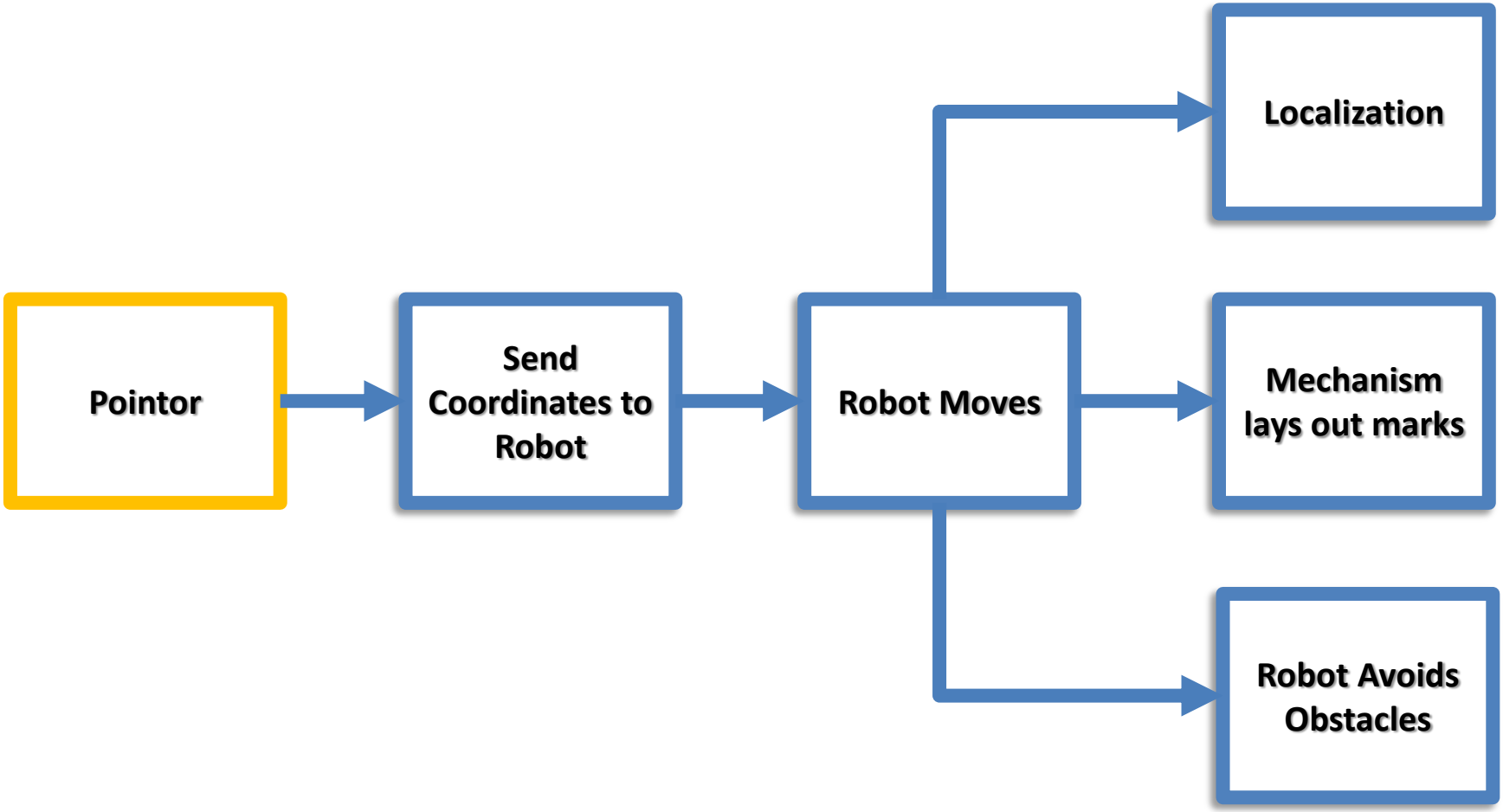

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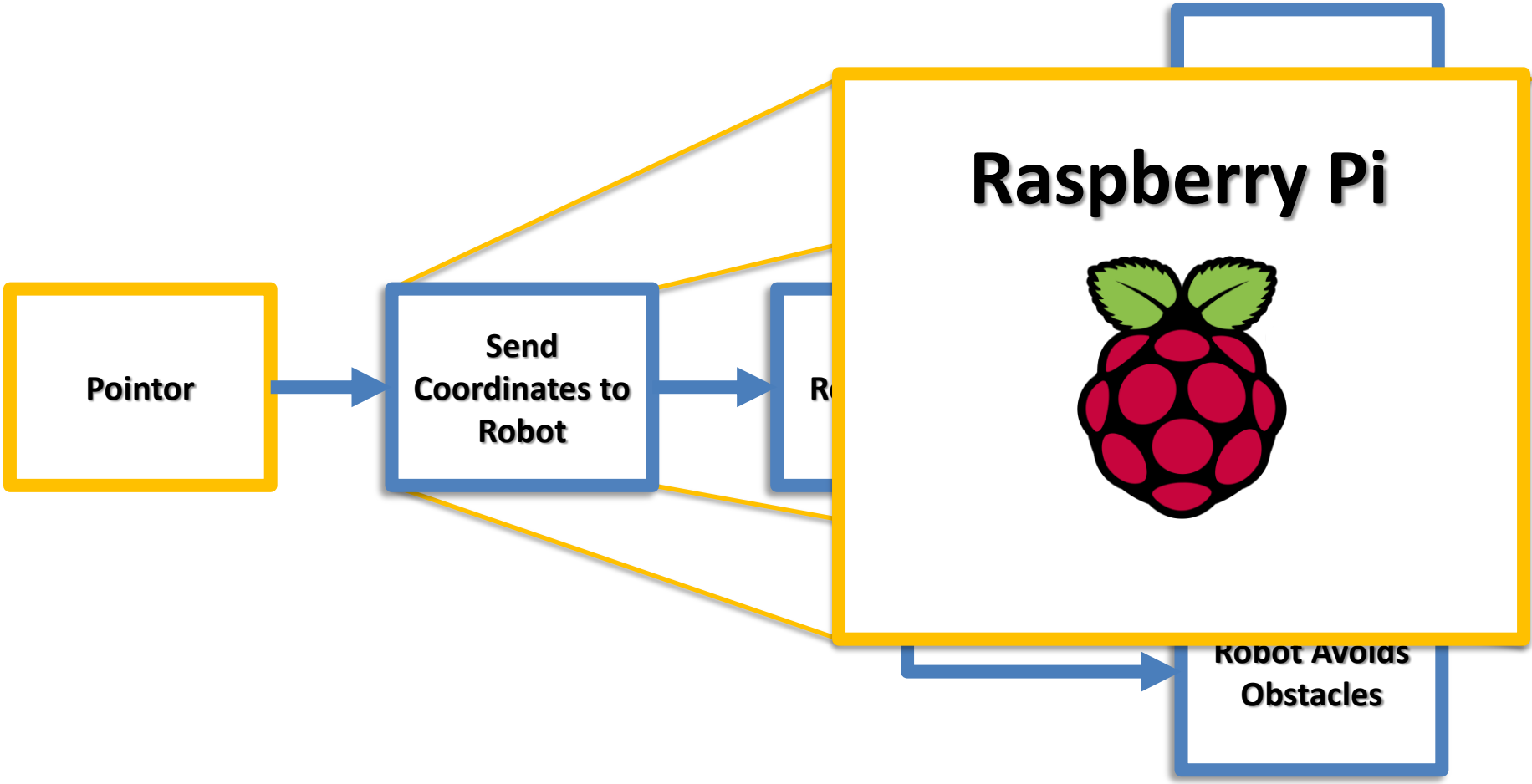

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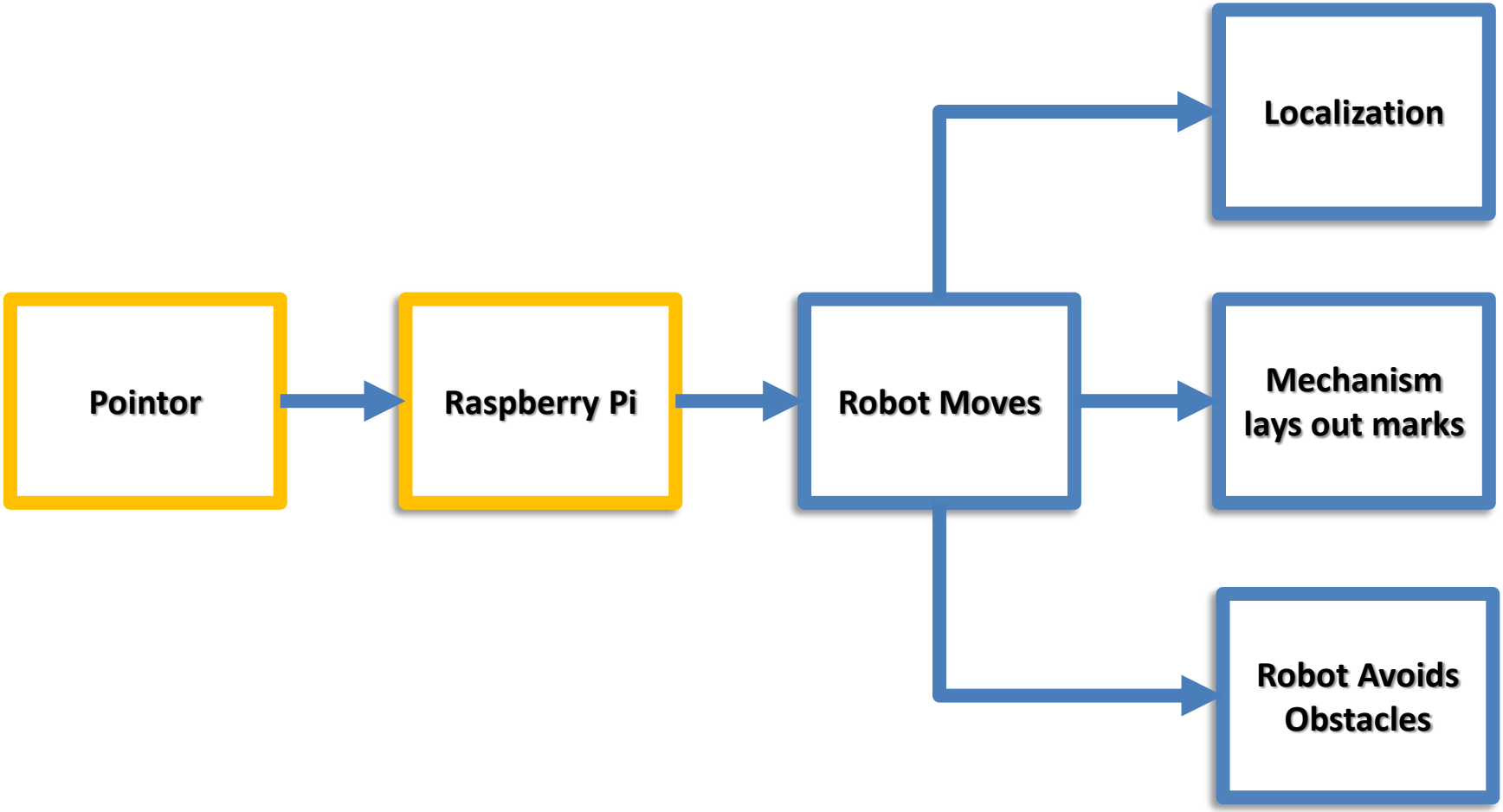

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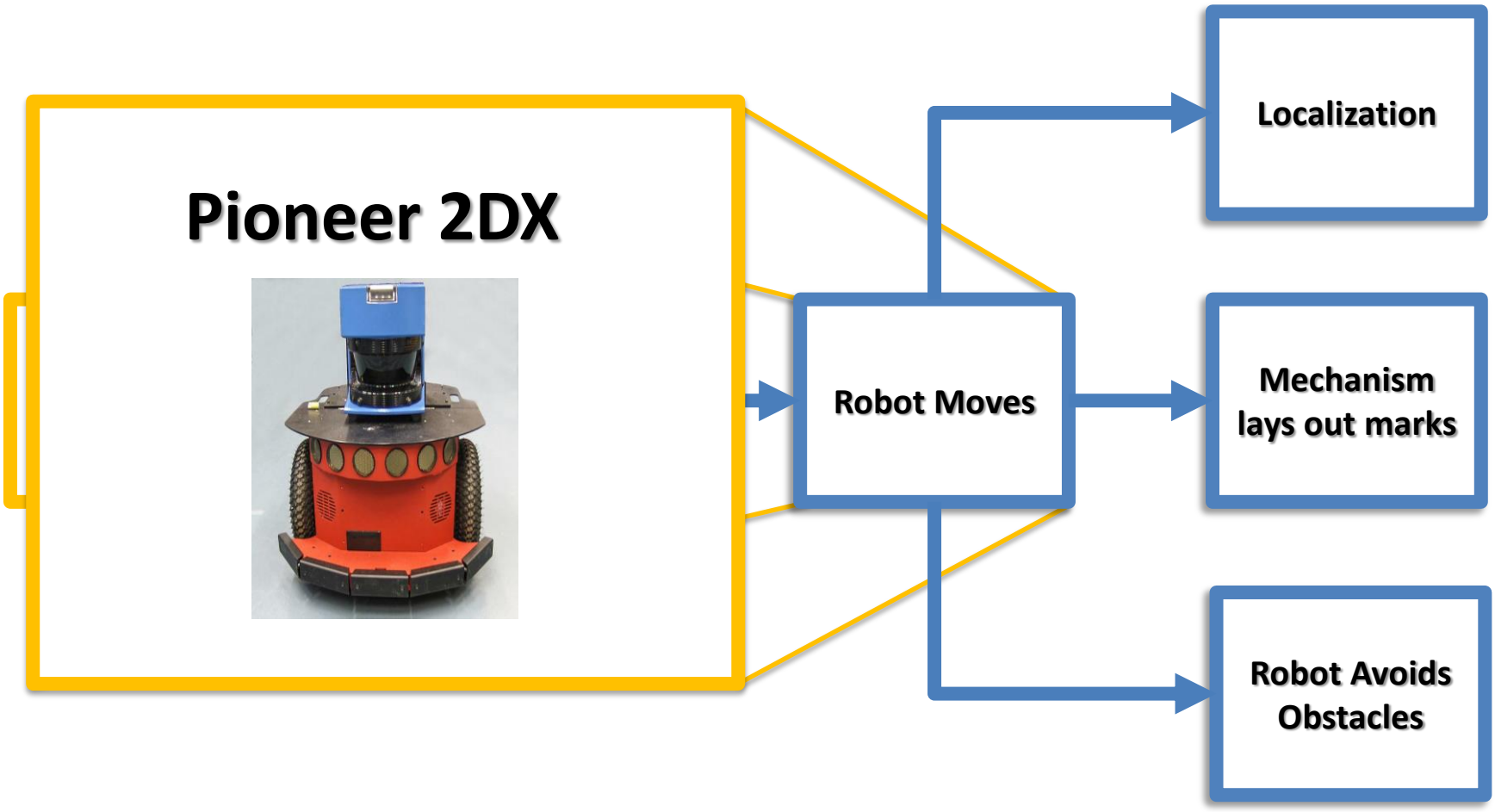

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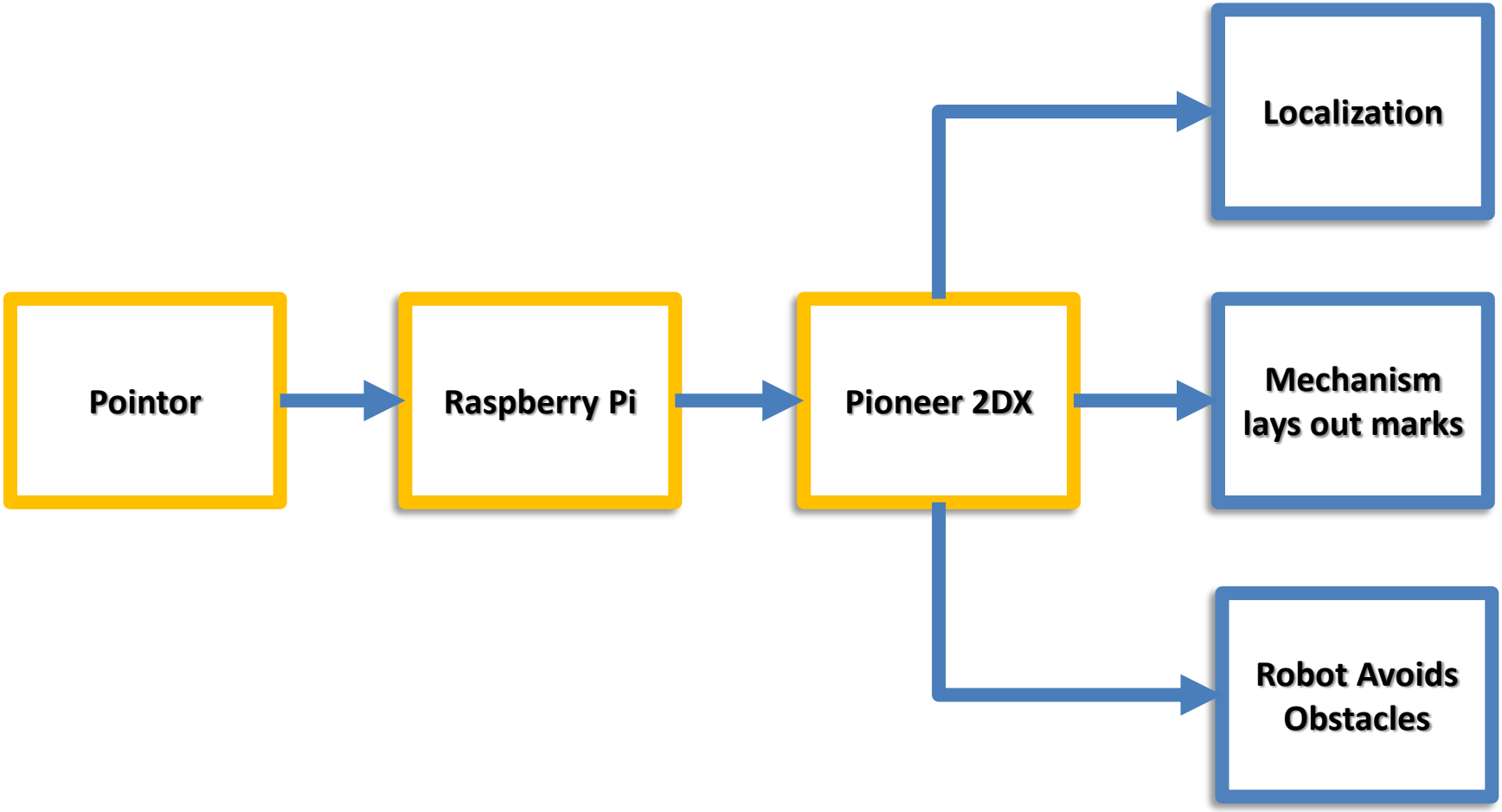

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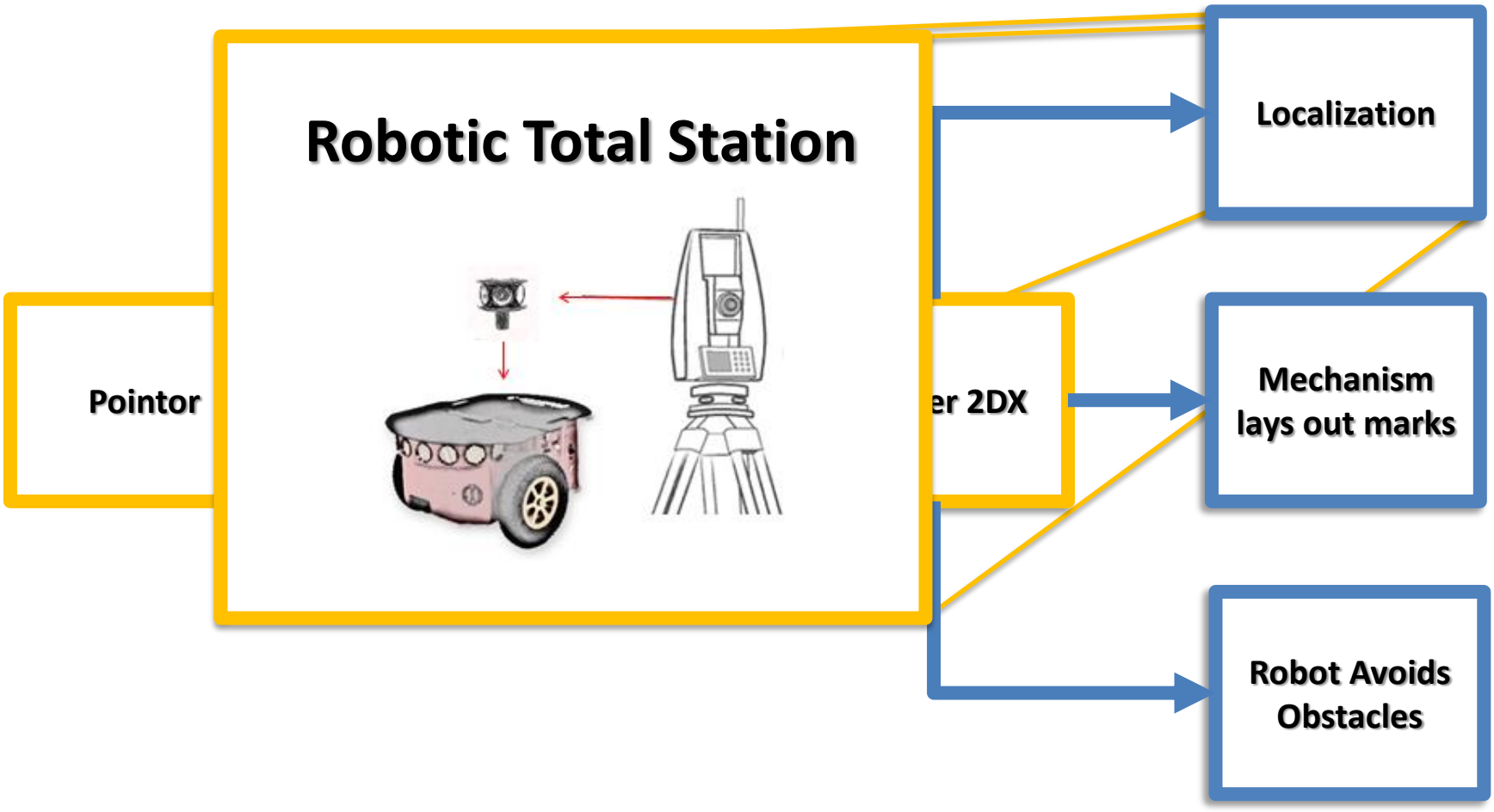

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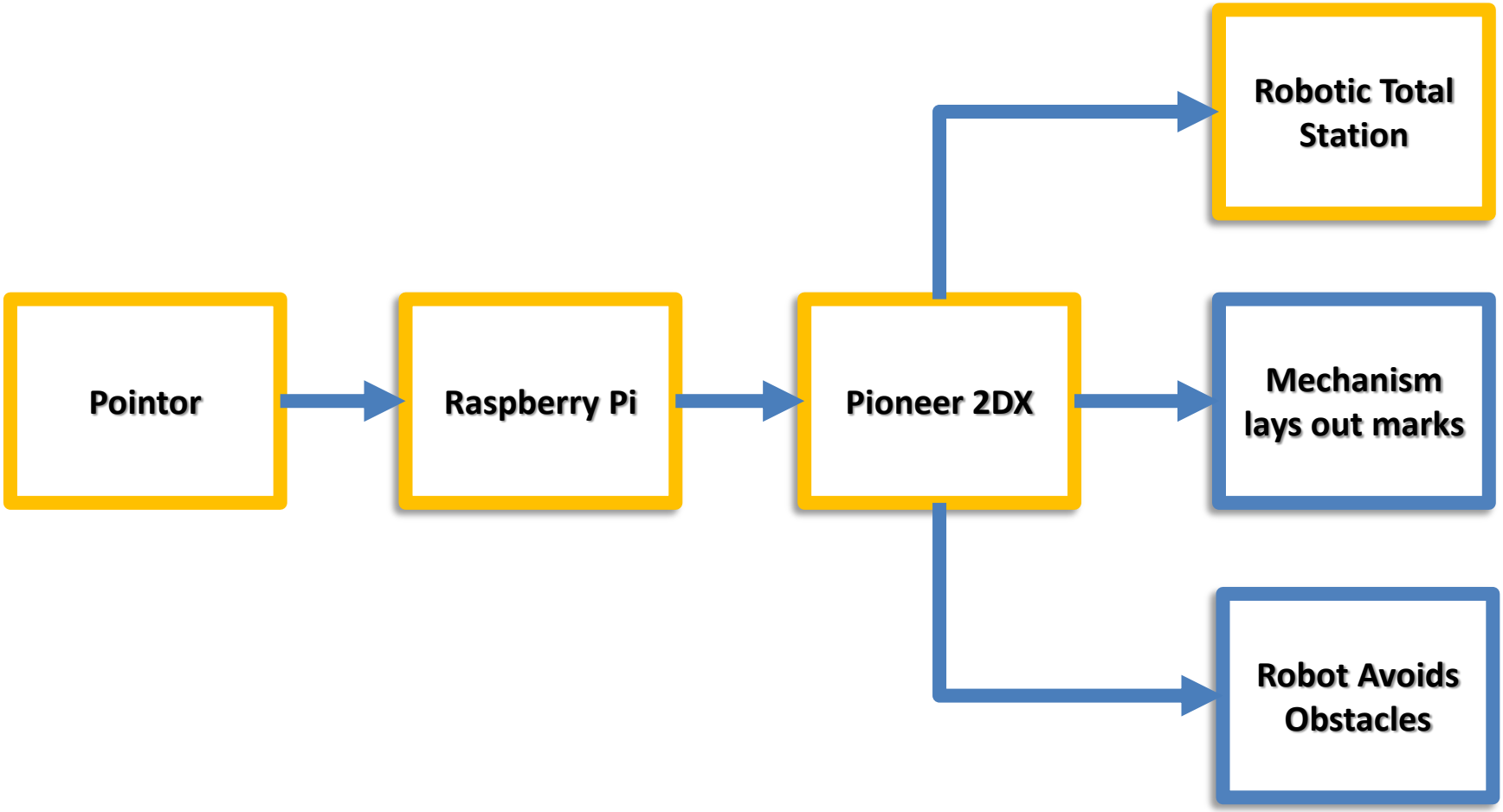

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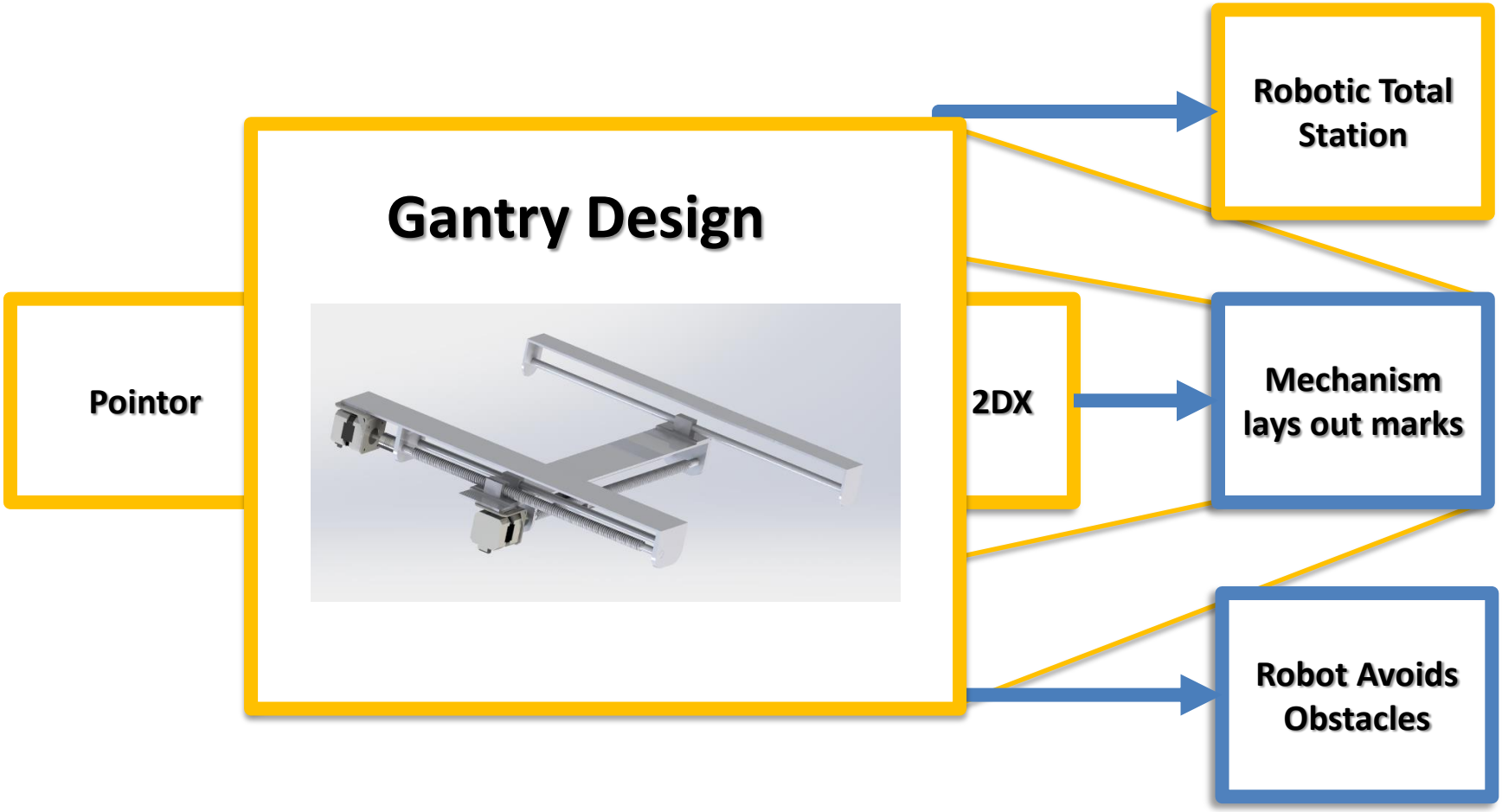

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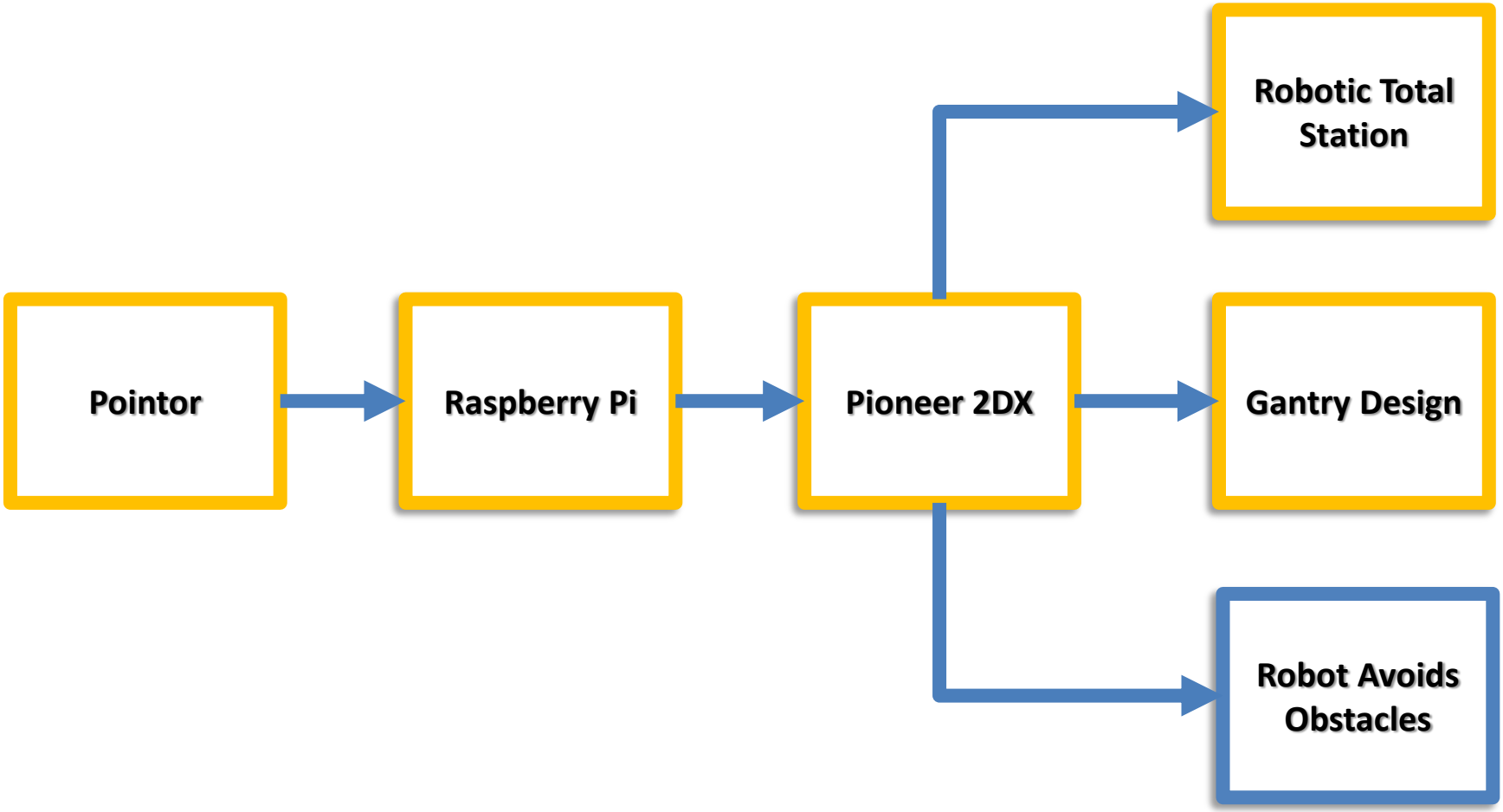

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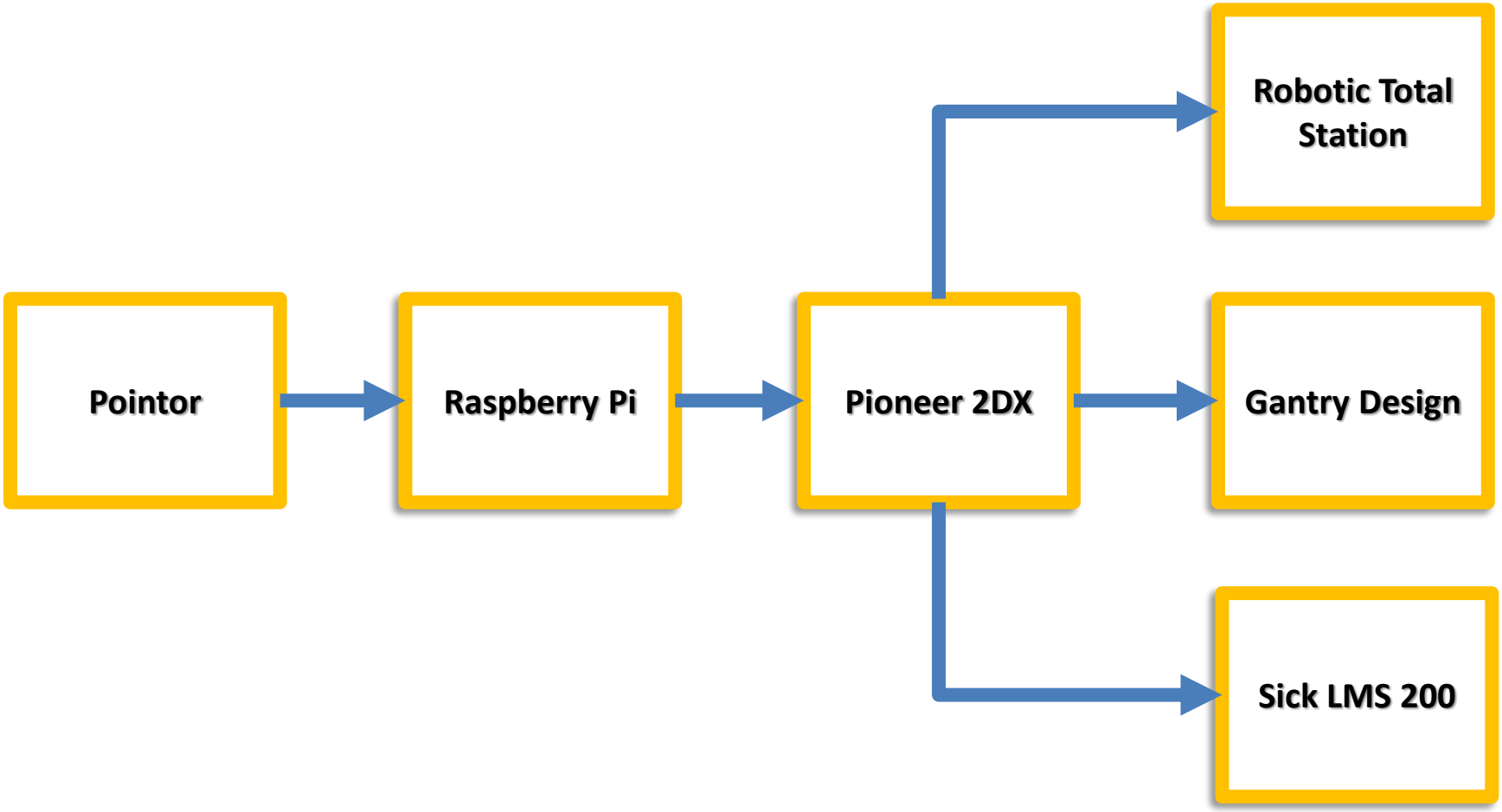
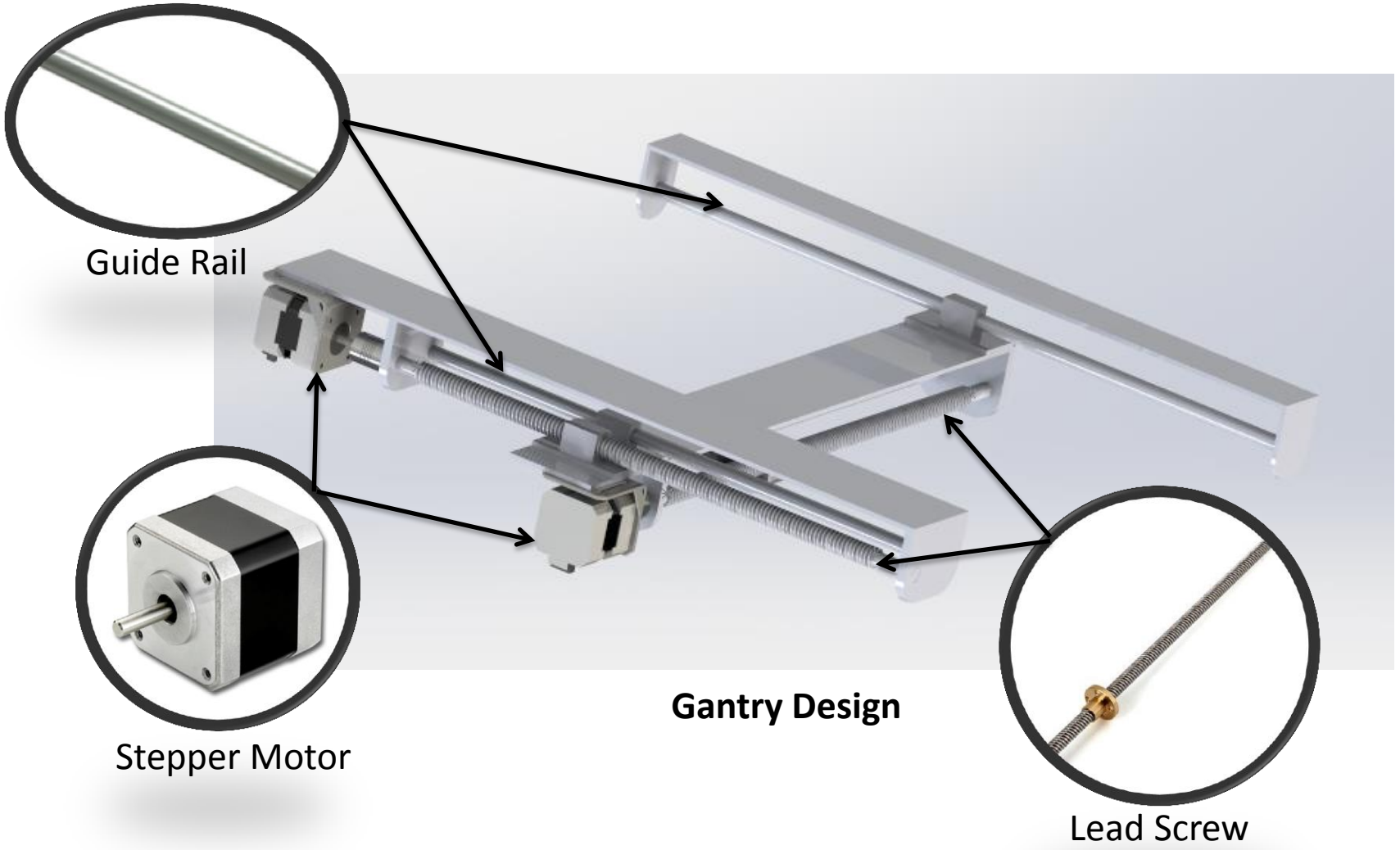


Project Updates

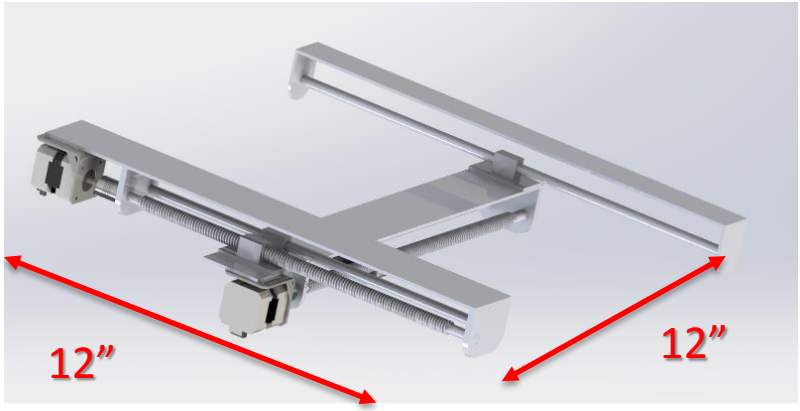
Marking Mechanism - Gantry



Gantry Design

Marking Mechanism - Gantry

- Comprised of two linear translation systems
  - lead screw driven by a stepper motor, guided by linear rails
- Mounted to the back of the robot
- Design Strengths:
  - Accurate marker placement
  - Draw various shapes with ease
  - Modular mounting design to allow for easily changing out marker holders

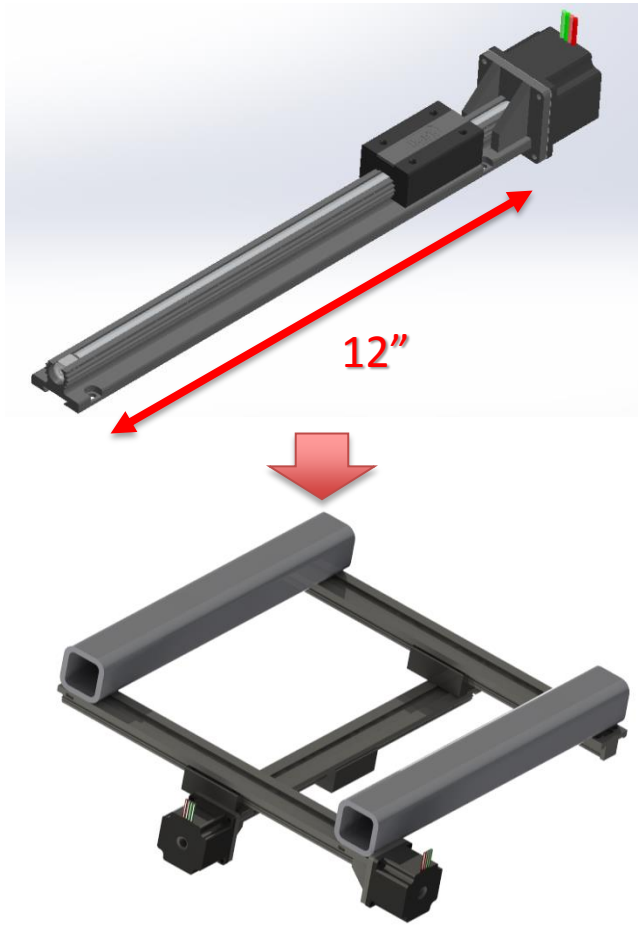


Gantry Design

Updates on Gantry

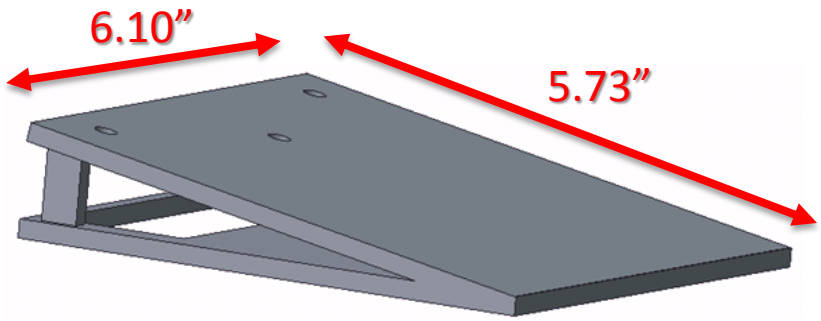
- Parts have been sourced and will be ordered by early next week
- Linear translation systems will be ordered preassembled to save time and reduce errors from assembling
- Travel length of 12” per system as desired
- Comes with mounting holes
- Future Plans: Testing, tuning, and integration into code then full gantry will be assembled with supports

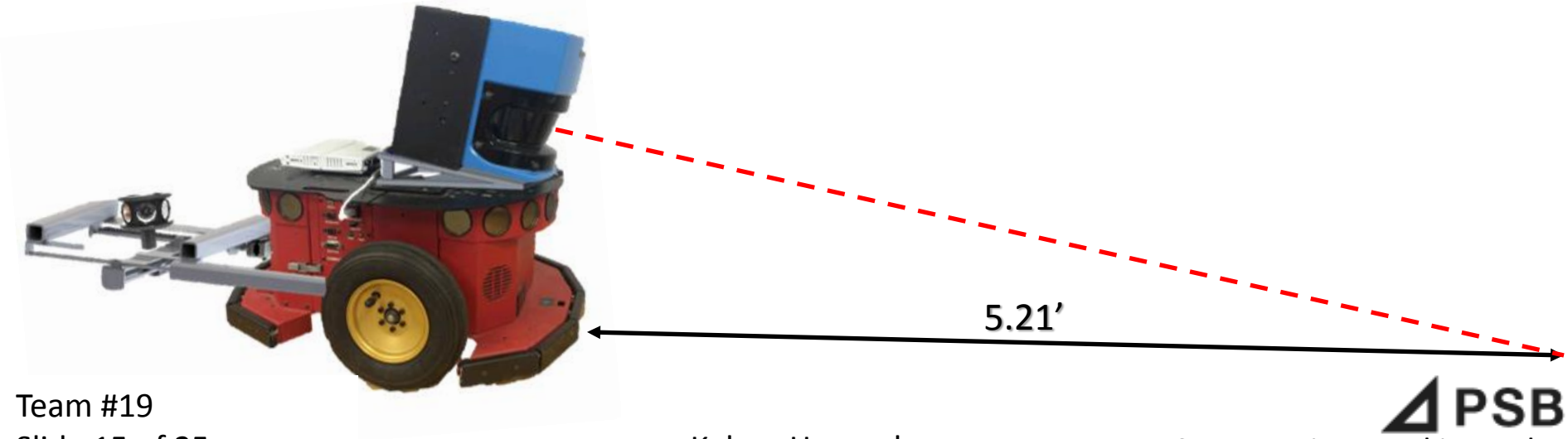
Selected Linear Translation System



Mechanical Updates – LiDar Mount

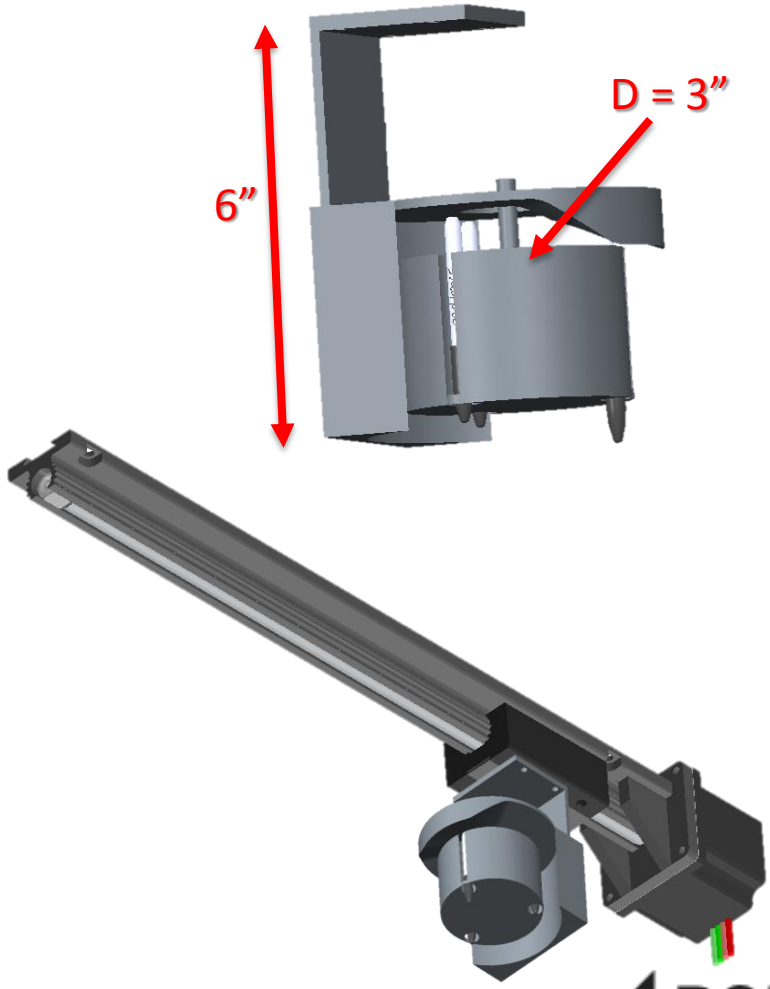
- Need LiDar to detect obstacles
  - Sick LMS200
- LiDar mount adjusts to allows scanning of ground
- 10° positioning scans at a distance of 1.59 m or 5.2 ft
- Using trigonometry, code the LiDar to know the new distance of obstacle based on 10° angle.





Mechanical Updates – Marker Holder

- Revolver Design
  - Utilizes springs to keep markers up
  - Inclined plate on casing moves markers down when in correct position
  - Driven by a stepper motor



Mechanical Updates – Robotic Total Station

- Robotic Total Station
  - Real time X,Y,Z positioning
  - Tracks prism attached to marking mechanism
  - Provides high accuracy relative to layout

Computer/Electrical Updates

Robotic Total Station (RTS)

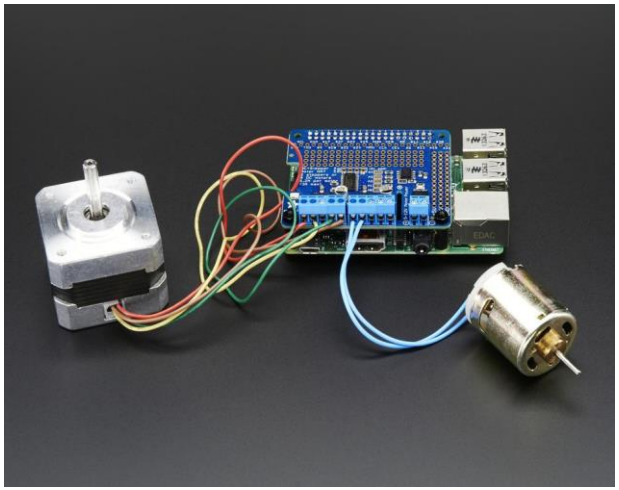
- Radio communication between RTS and Raspberry Pi
  - Ensures robot is in exact location according to CAD file
- Compares coordinates between Pointor Software and RTS

Computer/Electrical Updates

- Pioneer movement
  - Pioneer has a program that allows movement based on X and Y coordinates
    - X and Y coordinates are txt file from Pointor
    - Txt file is uploaded onto Raspberry Pi
  - Pioneer's movement function is called by the Raspberry Pi

Computer/Electrical Updates

- Arduino Uno and Raspberry Pi 2 kits
- Battery Charger & Lipo batteries - 8000 mAh
- Adafruit Stepper Motor HAT for Raspberry Pi



Planning for the Future

Gantt Chart – Mechanical

- Marking Mechanism
  - Borrow stepper motors to work on code while waiting for parts
  - Finishing LiDar mount and marker holder designs
    - Finalize material choices and design
    - Order parts/Start manufacturing

Task Name	Duration	Start	Finish
LiDar	**94 days**	**Mon 11/16/15**	**Thu 3/24/16**
Initial Design for Moving	59 days	Mon 11/16/15	Thu 2/4/16
Finalized LiDar Moving Design	45 days	Sat 1/23/16	Thu 3/24/16
LiDar Mount	**20 days**	**Mon 1/18/16**	**Fri 2/12/16**
Initial Designs	5 days	Mon 1/18/16	Fri 1/22/16
Finalize Design	3 days	Fri 1/22/16	Tue 1/26/16
Manufacture	9 days	Tue 1/26/16	Fri 2/5/16
Install on Robot	6 days	Fri 2/5/16	Fri 2/12/16
Marker Holder	**20 days**	**Mon 1/18/16**	**Fri 2/12/16**
Initial Designs	5 days	Mon 1/18/16	Fri 1/22/16
Finalize Design	3 days	Fri 1/22/16	Tue 1/26/16
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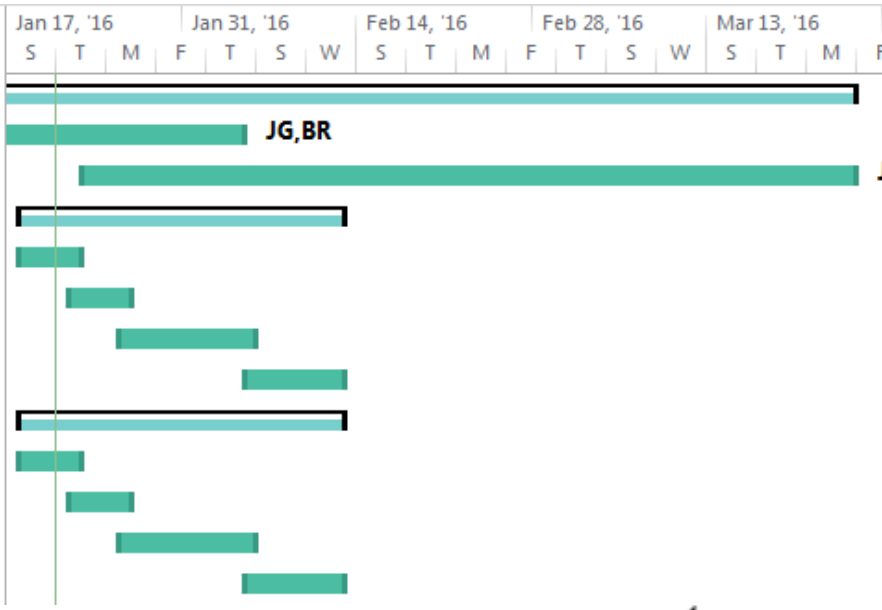
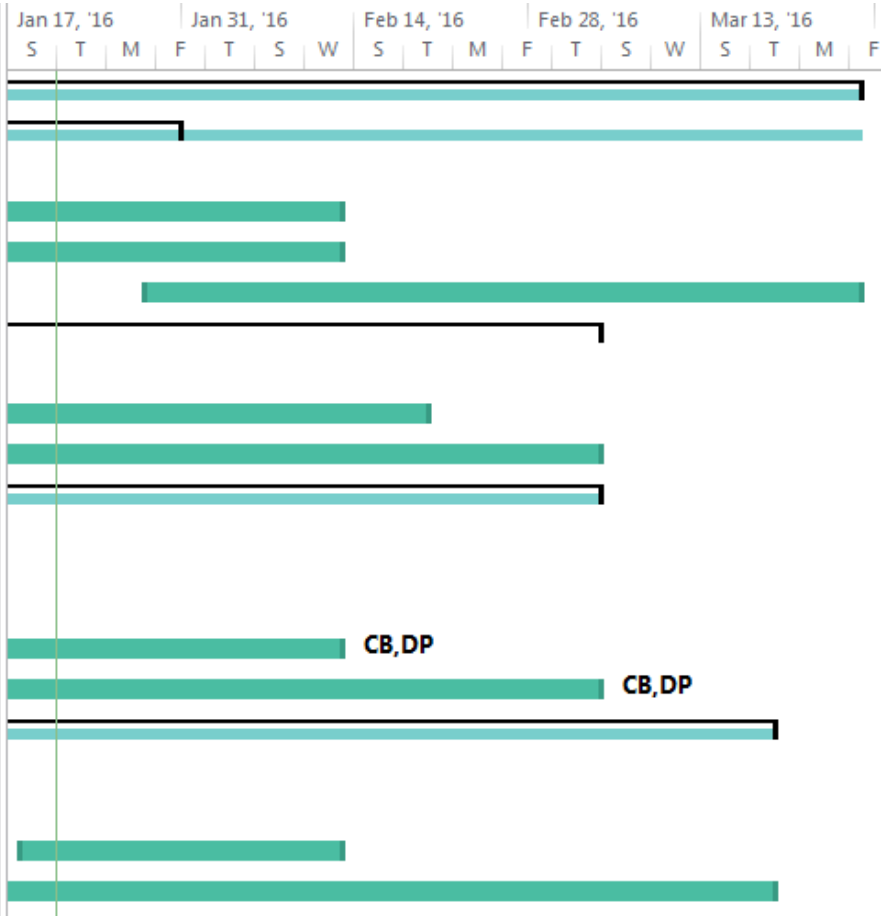


Schedule

- Programming
  - Begin work with stepper motors
  - Continue work with getting Pioneer to move
  - Connect Raspberry Pi to robot
  - Working on radio communication with Robotic Total Station and Raspberry Pi

Gantt Chart – Programming

Task Name	Duration	Start	Finish
Programming	**144 days**	**Wed 9/9/15**	**Fri 3/25/16**
Locomotion	**105 days**	**Wed 9/9/15**	**Sat 1/30/16**
QnX Code Research	49 days	Wed 9/9/15	Fri 11/13/15
Turn on LED to represent marking	30 days	Mon 1/4/16	Fri 2/12/16
Make Robot Move	30 days	Mon 1/4/16	Fri 2/12/16
Make Gantry Move	42 days	Thu 1/28/16	Fri 3/25/16
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	73 days	Wed 11/4/15	Fri 2/12/16
Path Planning	45 days	Mon 1/4/16	Fri 3/4/16
Integration with Robotic Total Station	**139 days**	**Wed 9/9/15**	**Fri 3/18/16**
Research	54 days	Wed 9/9/15	Fri 11/20/15
Gather API			
Communication Code	20 days	Mon 1/18/16	Fri 2/12/16
Testing and Integration	55 days	Mon 1/4/16	Fri 3/18/16



Questions?