Construction Marking Robot

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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."

Goal Statement

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

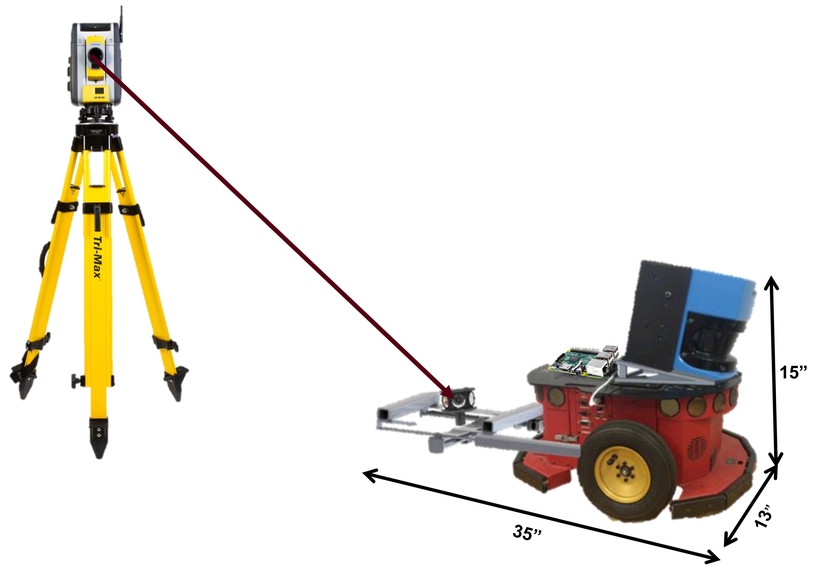
Objectives:

- 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
- Be easily portable
- Mark on concrete
- Mark across 100 sq. ft. within 10 minutes
- Navigate autonomously

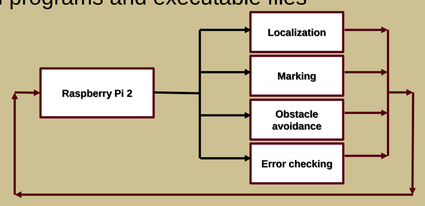


Electronics

Raspberry Pi:

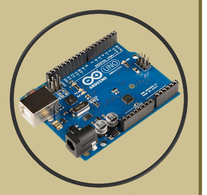
- Specifications: 900MHz quad-core CPU, 1 GB RAM, 40 GPIO pins
- Will run high level code that sends text file to robot
- Controlling marking mechanism and executes movement functions in response to external sensors
- Will operate on Windows 10 IoT Core OS to run programs and executable files

Raspberry Pi 2



Arduino Uno:

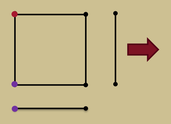
- Microcontroller that will drive stepper motor
- Stepper motor drivers will act as medium to supply enough current to motor from Arduino
- Motors will control X and Y axis and also the marking holder

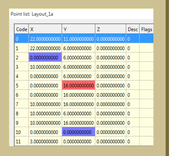


Arduino UNO

Pointor® software:

- Reads in CAD (dxf file type)
- Analyzes the CAD structure
- Replaces lines with endpoint coordinates
- Able to export point list to a text file





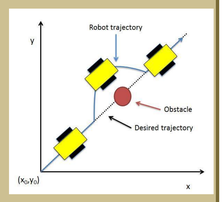
Point list: Layout_1a

Code	X	Y	Z	Desc	Flags
0	22.000000000	11.000000000	0.000000000	0	
1	22.000000000	6.000000000	0.000000000	0	
2	0.000000000	6.000000000	0.000000000	0	
3	10.000000000	6.000000000	0.000000000	0	
4	0.000000000	6.000000000	0.000000000	0	
5	0.000000000	11.000000000	0.000000000	0	
6	0.000000000	16.000000000	0.000000000	0	
7	10.000000000	16.000000000	0.000000000	0	
8	10.000000000	6.000000000	0.000000000	0	
9	10.000000000	16.000000000	0.000000000	0	
10	0.000000000	6.000000000	0.000000000	0	
11	1.000000000	0.000000000	0.000000000	0	

Obstacle Detection

Lidar:

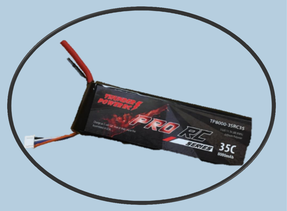
- Used for obstacle detection
- More accurate than sonar and IR sensors
- Internal mirror rotates 180°
- Placed on angled mount to scan for obstacles on ground



Robotic Platform

Pioneer 2-DX:

- Runs on real-time operating system (QnX Neutrino RTOS)
- Differentially steered
- Driven by two DC Motors
- Router for wireless communication
- Robot total weight = 13.5kg
- LiPo batteries for longer lasting battery life



Localization

Trimble Robotic Total Station

Trimble Prism

Trimble Radio Receiver

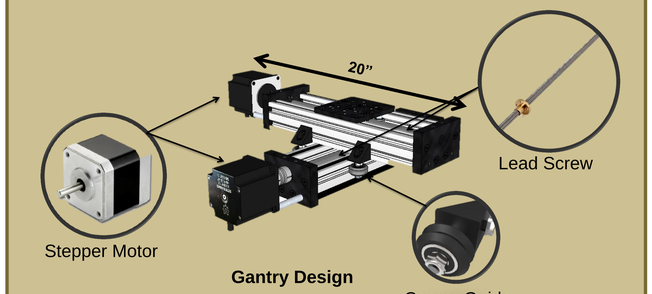
Robotic Total Station:

- Calibrates via triangulation with two structures of known location
- Tracks and measures the ***exact position*** of an external prism within ±0.01"
- Measures horizontal and vertical angles as well as slope distance
- Verifies points are being marked ***accurately***
- Contains file of layout in internal memory

Radio Communication:

- Radio will be connected to the Raspberry Pi via a serial to USB converter and will send real-time coordinates to check location accuracy
- Coordinates will be transmitted by the Robotic Total Station
- 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

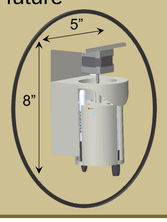
Marking Mechanism



Gantry Design

Gantry System:

- Comprised of two linear actuators
- Each actuator contains a lead screw driven by a stepper motor, guided by linear rails
- Linear Actuators mounted together with wheeled corner connectors
- Modular mounting design allows for changing markers in the future



Marker Holder:

- Revolver design powered by a stepper motor
- Markers held up by spring and pressed down by wedge
- Holds up to three different colors
- Rotates in increments of 60 degrees

Project Status

- ✓ Program for converting floor plan to useable coordinates with point propagation
- ✓ Linear actuators assembled for gantry
- ✓ Program implemented for accurately controlling the gantry's stepper motors
- ✓ Robotic Total Station procured and properly operating
- ✓ Lithium Polymer batteries purchased and implemented
- ✓ LiDar mount fabricated
- ✓ Parts and materials sourced for gantry support structure
- ✓ Marker Holder design finalized
- ❑ Full assembly of gantry and supports
- ❑ Radio communication completed
- ❑ Marker holder assembled and mounted
- ❑ Finalize path planning algorithm

For more information:
http://eng.fsu.edu/me/senior_design/2016/team19/

Acknowledgement

We would like to thank Mark Winger of PSBI for being an amazing sponsor. Dr. Gupta for guidance and advice throughout the project. The CISCOR lab for donation of the mobile robot. Finally, we would like to thank Rob Miller of Florida Building Point and Trimble for the donation of the total station suite.