Team 19: 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."

Objective:

- 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

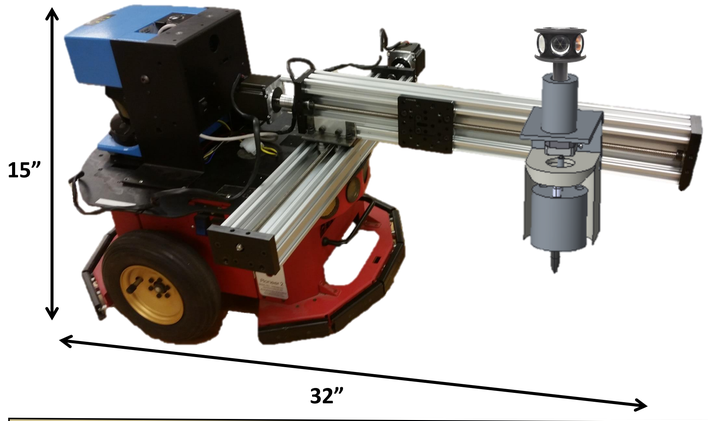
Design Requirements:

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

Design Features:

- Pointor® software for CAD to coordinates
- Raspberry Pi 2 for computation
- Pioneer 2 Mobile Robot for platform
- Trimble Robotic Total Station for localization
- LiDar for obstacle avoidance
- Gantry System for marking

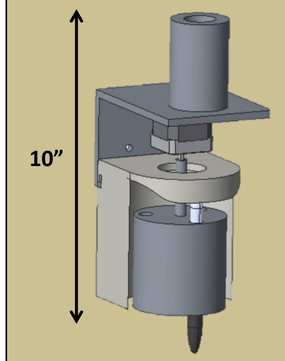


Robotic Platform

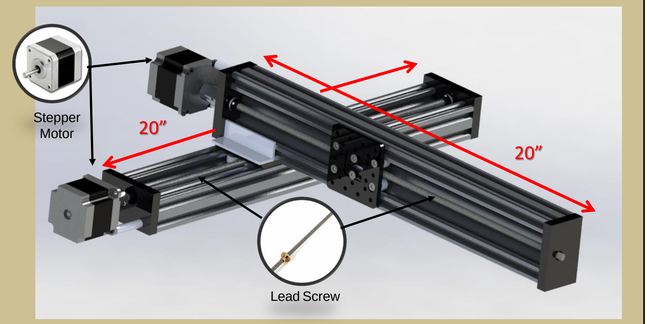
Pioneer 2-DX:

- Donated by CISCOR lab
- 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
- Includes SICK LMS200 LiDar for obstacle detection

Marking Mechanism



Marker Holder



Gantry System

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

Electronics

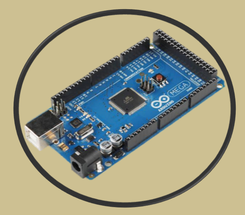
Raspberry Pi:

- 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

Raspberry Pi 2

Arduino Mega:

- 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 Mega

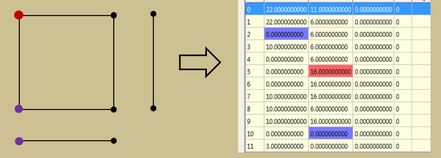
SmartLynx Motor Driver:

- Controls one gantry stepper motor per driver
- Controlled by Arduino Mega SPI connection

SmartLynx Motor Driver

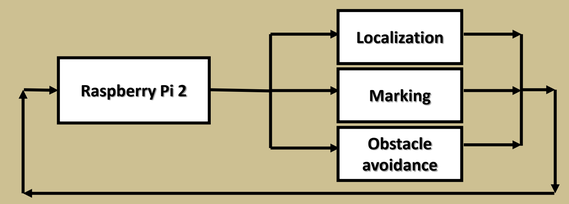
Pointor® software:

- 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	16.000000000	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	0.000000000	0.000000000	0	
11	3.000000000	0.000000000	0.000000000	0	



Localization

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"
- 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

Future Work

- Finalize obstacle detection and avoidance algorithm
- Add function to generate error reports
- Perfect communication between gantry and Trimble robotic total station
- Fully integrate gantry and robotic platform into a single platform

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

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