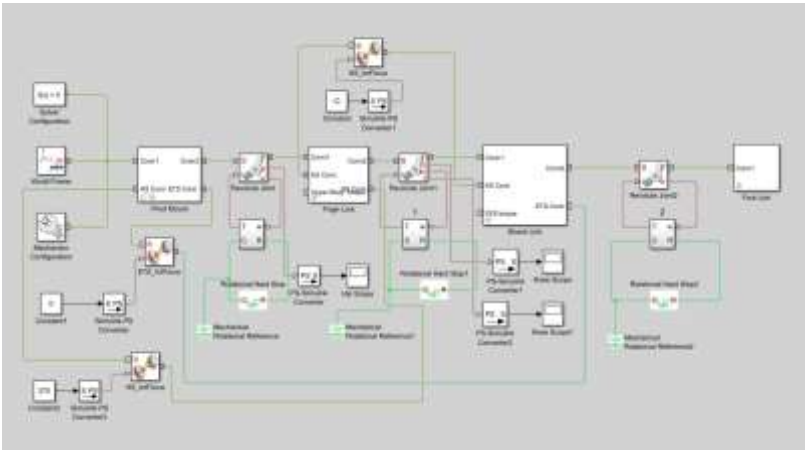
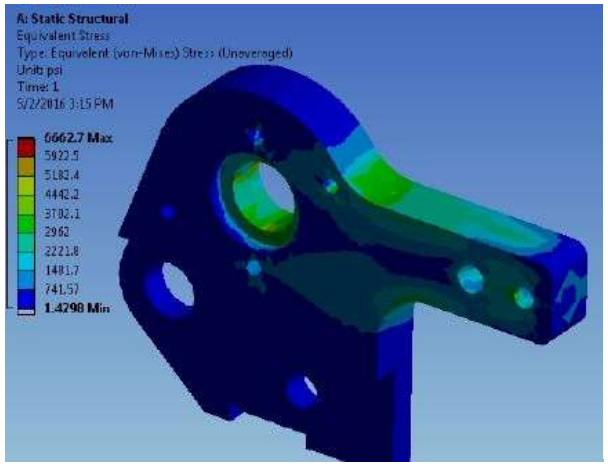
Muscle-Powered Walking Exoskeleton for People with Spinal Cord Injury

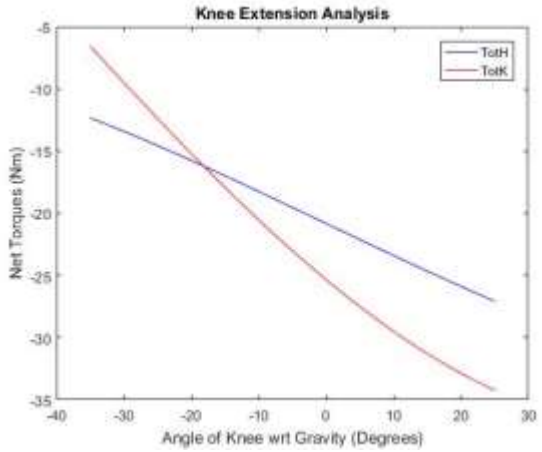
- Designed a system which uses a combination of electrical stimulation and mechanical orthosis to enable gait
- Fabricated and bench tested the exoskeleton
- Performed a pilot study using one volunteer with spinal cord injury to demonstrate the feasibility of the exoskeleton

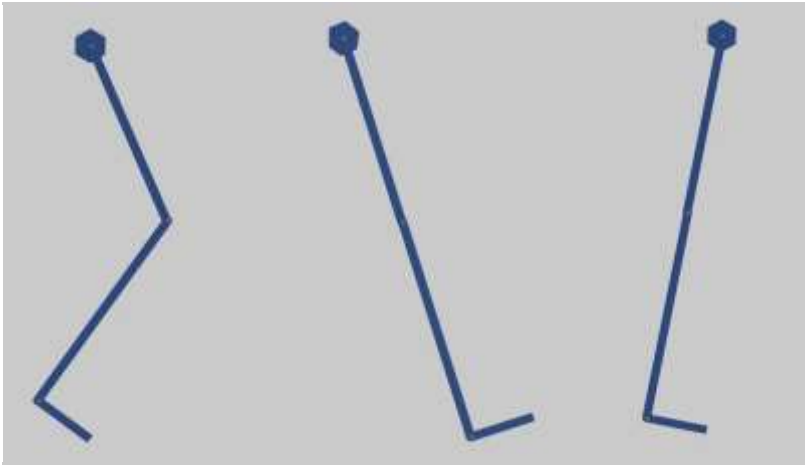
Simulink model of exoskeleton



Analysis of the design using ANSYS and MATLAB







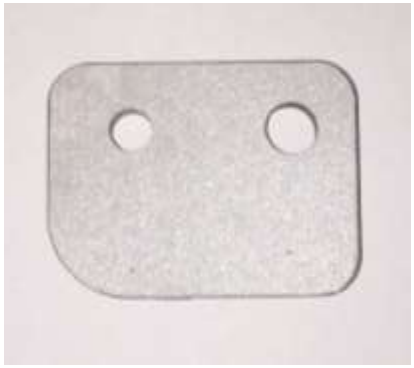
Design

Fabricate

Bench Test

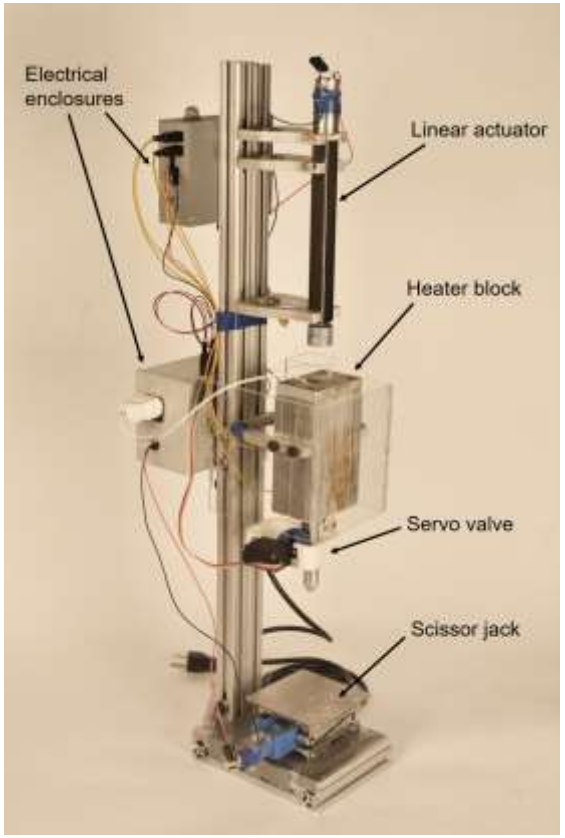
Pilot Test

Self-Fabricated Parts



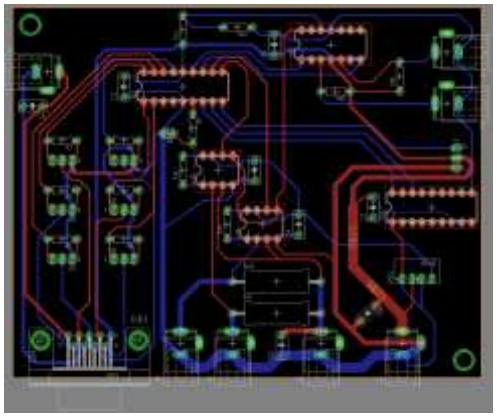
The Mini-Molder

- Designed and fabricated an automatic Mini Injection Molder that can create any shaped object out of wax
- Designed a circuit to interface with sensors and actuators
- Created a PCB for the electronics
- Created a GUI using Python



Finished Products

PCB Layout



GUI

A Non-Invasive Medical Device to Treat Lower Back Pain

CAD rendering

Prototype

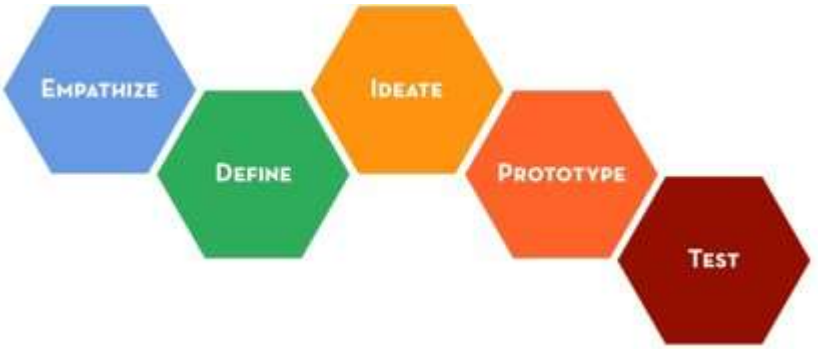
- Worked as a part of a cross-functional team to design a user-friendly, price competitive, and portable device that applies traction to the user's lower back while in a seated position

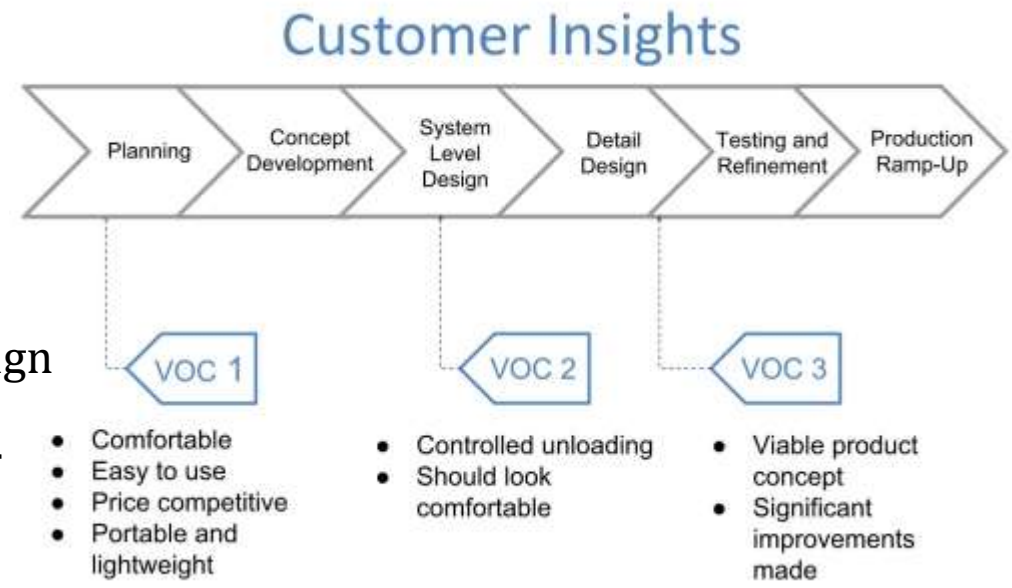
- Conducted multiple rounds of voice of customer interviews to gather user needs as well as to improve the design

- Analysed the market and drafted a business plan which we then pitched to the client and other entrepreneurs

- Drafted a provisional patent for the final design

- Collaborated with FDA to finalize the class of the device





Pugh Chart for Design Decisions

Seat Adjustment	Weight	LTX Strap (Status Quo)	Mechanical	Strap 2.0	Air Bladder
Control	2	0	2	1	0
Weight	1	0	-2	-1	0
Cost	1	0	-2	-1	-2
Ease of Use	1	0	2	1	1
Totals		0	2	1	-1

Arms (Rib Movement)	Weight	Pivoting (Status Quo)	Pin Lock	Sliding w/Friction	Ratchet w/Teeth
Tuning	1	0	-2	0	0
Durability	0.5	0	0	-1	-1
Cost	1	0	2	2	1
Ease of Use	1	0	-1	1	1
Totals		0	-1	2.5	1.5

Provisional Patent Draft

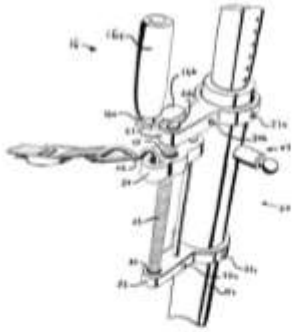


Fig. 2

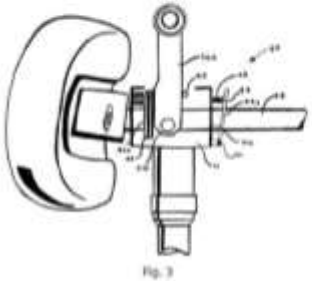


Fig. 3

Page 5 of 12

Field of the Invention

This invention refers generally to an apparatus for transferring the stress and loading from the lumbar spine to the rib cage of an individual which provides benefits associated with unloading the spine. More specifically, this invention transfers the stress from the lumbar spine to the rib cage utilizing the force of gravity and thus helps promote normal nutrition and healing of the lumbar spine and its components. This device utilizes a support which underscore the torso and a seat which can be raised or lowered independent of other components. The device further includes a foldable base support, whereby the apparatus can be reduced to a small form factor while storing, hence making it portable. The device provides an apparatus for exercise relative to the abdomen and lower extremity, especially the disc tissue of the lumbar spine. The art by which this invention was developed reflects more than a decade of medical clinical research and testing.

Background of the Invention

80% of Americans will experience lower back pain in their lifetime. It has been documented in a number of articles both medical and news periodicals that this is a large scale problem that requires a solution. Axial traction has been found to help relieve lower back pain, prevent back pain, and sustain the health of the lower back. This type of traction has been found to be an effective way of realigning the vertebral elements with their associated discs and soft tissues when used periodically. Also, this type of traction has shown to reduce herniated contained intervertebral discs. Although the results of traction have showed promise, obstacles of controlled traction directed to the lumbar area have shown difficulty.

In the early 1970s, research was conducted using a chest harness apparatus to support a person by the torso in a vertical position. It was concluded that the protrusion of lumbar discs was reversed and that the rib cage was able to serve as a site of fixation while the lower torso of a person was allowed to float. Over time, further research refined the gravity traction vest to allow the tightening around the perimeter of the rib cage, preventing a person from sliding out. Although the gravity traction vest (U.S. Pat. No. 4,421,452) could provide axial traction, it was uncomfortable. While later generations of vests have proved to be successful, each one required an overhead support.

An invention that eliminated the overhead harness and vest but allowed the transfer of stress from the lumbar spine to a rib cage of a person was patented in 1989 (U.S. Pat. No. 4,421,452). The device was found to be effective with aligning displaced vertebral elements along with their associated intervertebral disks and soft tissues. The device included pivoting members that engaged the lower torso and supported a person below the ribcage. The controlled lowering was done by releasing locking bits on the vest straps which allowed the vest the lower and the amount of unloading on the lumbar region. Although the device had proved to be effective and allowed controlled traction directed to the lumbar area, it was tedious and uncomfortable to use. With the intention to reduce the difficulty of lowering the vest and controlling the amount of traction applied, an invention of a bladder vest (U.S. Pat. No. 4,128,891) allowed greater control of transferring stress from a lumbar spine to the ribcage. Although this invention helped with controlled lowering, it did not have the ability to have controlled lifting with a seated person.

Summary of the Invention

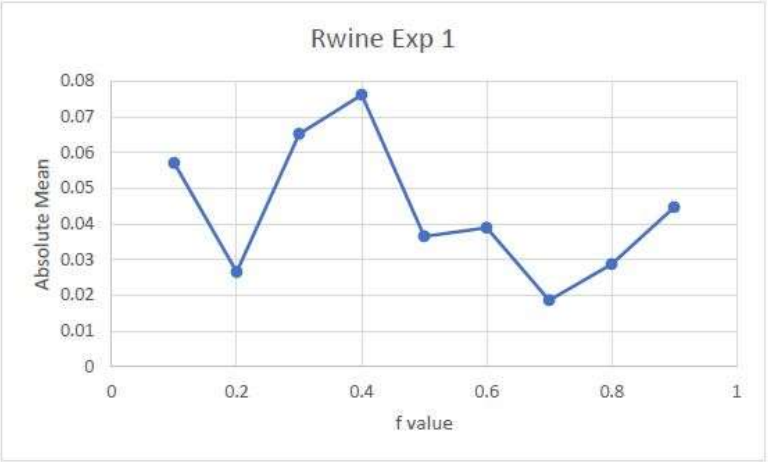
The present invention is a traction chair which includes a height adjustable seat with accompanying torso support members that work together to allow the user to decompress the lumbar spine for the purpose of low back pain relief. Unlike in prior art, the torso support members in the present invention are decoupled from the seat and may be adjusted and secured after the user is already seated. Additionally, the contact of the torso support member differs from prior art in how they engage with the user's body. In contrast with prior art, where the torso support is either a contoured harness or a pair of pivoting bars, the present invention includes a pair of laterally moving torso support members, which engage and support a person below the rib cage. These members are rigidly connected to the vertical support structures which house the apparatus for enabling seat raising and lowering, which are operatively connected to the foldable base to allow adjustability of the height of torso supporting member. The seat height

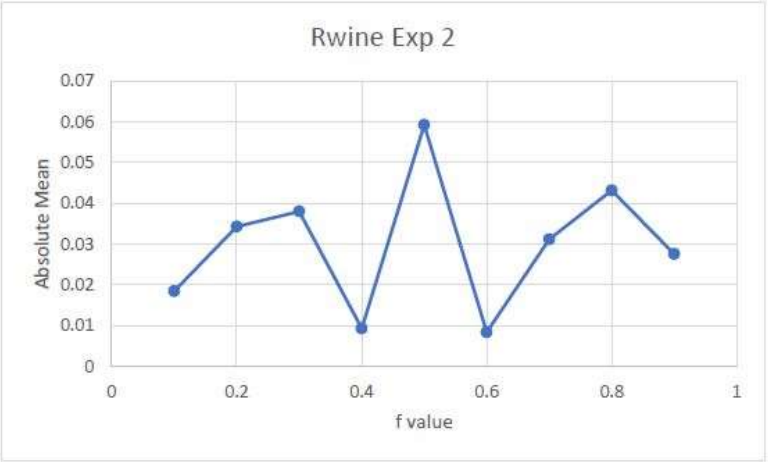
Page 6 of 12

Data Modelling Using R

- Developed multifactor linear regression models using a standard statistical approach
- Implemented data cleaning, sanity checking, training and testing on various data sets using R
- Created a linear model that predicts the quality of wine based on the various constituents

Analysing the Quality of Model





Linear Model – Backward Elimination Method

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Call:
lm(formula = quality ~ volatile.acidity + chlorides + free.sulfur.dioxide +
    total.sulfur.dioxide + pH + sulphates + alcohol, data = Rwine.dat)

Residuals:
     Min       1Q   Median       3Q      Max
-2.68918 -0.36757 -0.04653  0.46081  2.02954

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)          4.4500987  0.4029168  10.995  < 2e-16 ***
volatile.acidity    -1.0127527  0.1006429 -10.063  < 2e-16 ***
chlorides           -2.0178138  0.3978417  -5.074 4.32e-07 ***
free.sulfur.dioxide  0.0050774  0.0021255   2.389    0.017 *
total.sulfur.dioxide -0.0034822  0.0004868  -5.070 4.43e-07 ***
pH                   -0.4826614  0.1173581  -4.114 4.03e-05 ***
sulphates             0.8826651  0.1099084   8.031 1.86e-15 ***
alcohol               0.2693028  0.0167950  17.225  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6477 on 1591 degrees of freedom
Multiple R-squared:  0.3595,    Adjusted R-squared:  0.3567
F-statistic: 127.6 on 7 and 1591 DF,  p-value: < 2.2e-16
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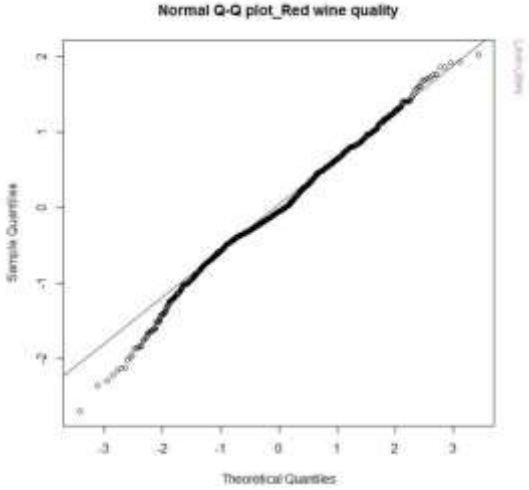
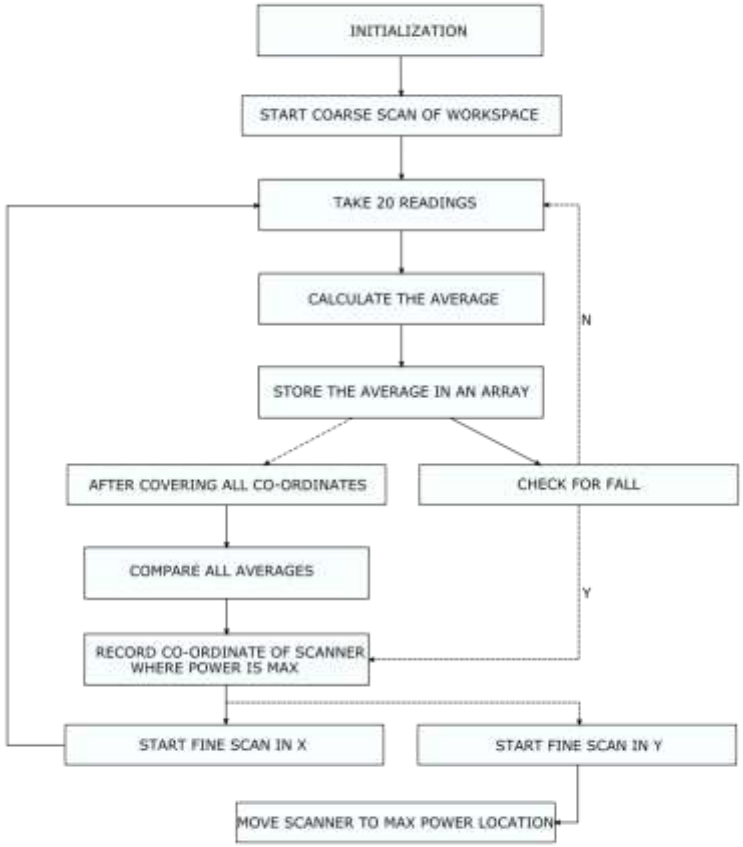


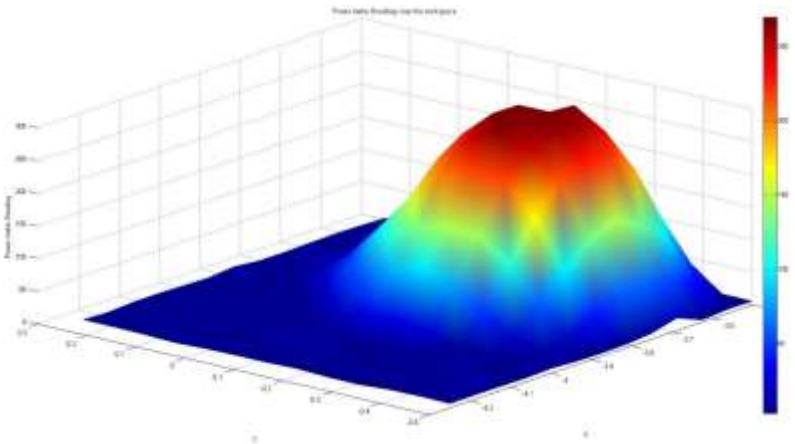
Automation of Laser Fiber Alignment

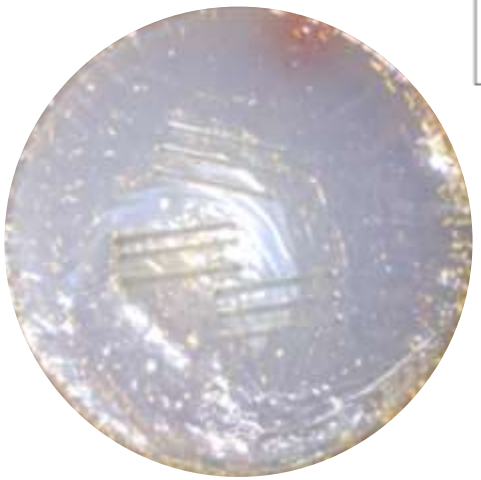
- Developed an algorithm for automatic alignment of the laser with an optical fiber which reduced the set up time from 20 min to 3 min
- Designed a focusing unit and assembled the experimental setup
- Experimentally evaluated laser ablation on agar-agar and verified the performance of the algorithm



Algorithm logic

Testing and Validation





Teaching Assistant – Motion Control Laboratory

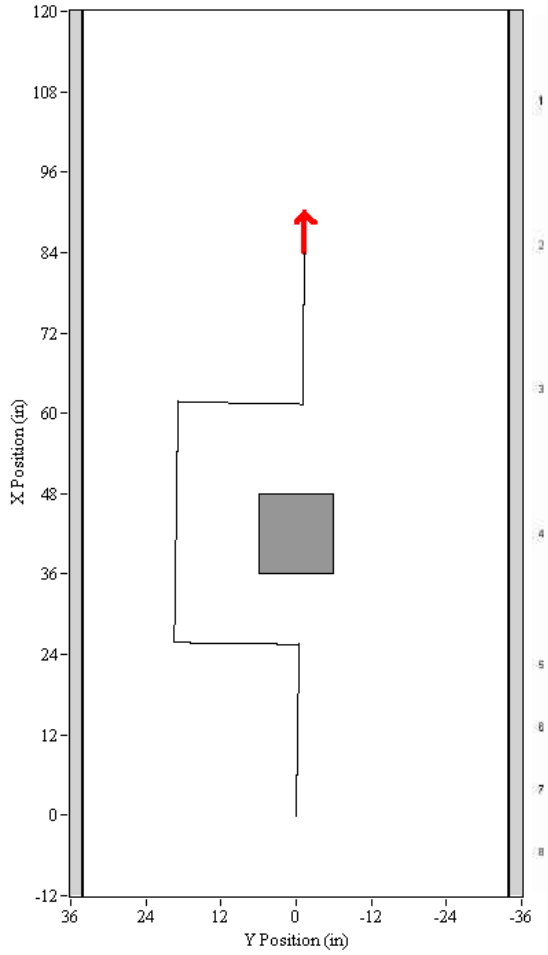
- Helped students improve their C programming skills and guided them through the various lab topics

- Lab topics included-
  - Analog to digital, digital to analog conversion
  - Implementing digital IIR and FIR filters
  - Determining frequency response of a servo motor and implementing closed loop position control
  - Using Simulink to design control system
  - Ladder logic programming
  - Using LabVIEW to control a robot

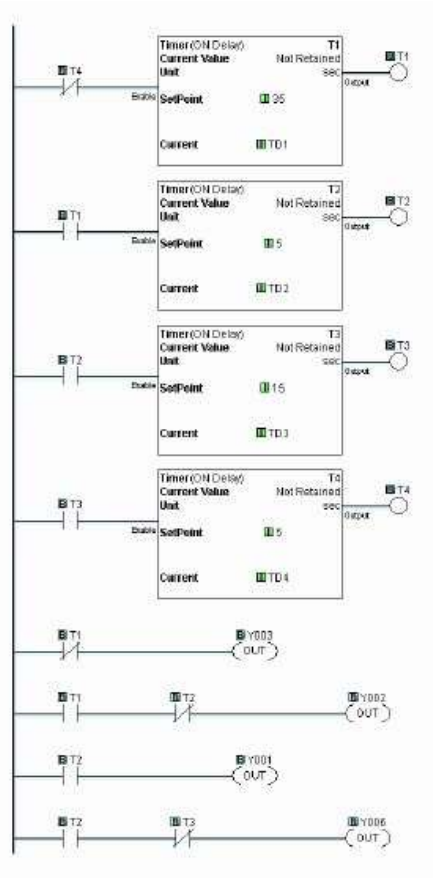
- Graded the assignments and exams

- Helped maintain the equipment in the lab (oscilloscopes, DAC's etc.)

Robot control -LabVIEW



PLC Programming



The E-Board

Assisted the development of a self propelled electric snowboard prototype