High Cycle Fatigue of Electroactive Membranes

Team 20:

Nicholas Dawkins

Matthew Drys

Kristina Dukes

Adriane Guettler

Victor Odewale

Advisor: Dr. Oates

Sponsors: Dr. Clark and Dr. Oates

Instructors: Dr. Gupta and Dr. Helzer

Project Scope

Need Statement: There is a lack of information on the fatigue of electroactive membranes.

- Electroactive membranes are being studied for application onto robots.
- There is insufficient data on the fatigue behavior for electroactive membranes [1]
- The purpose of this project is the design and implementation of a fatigue mechanism for electroactive membranes

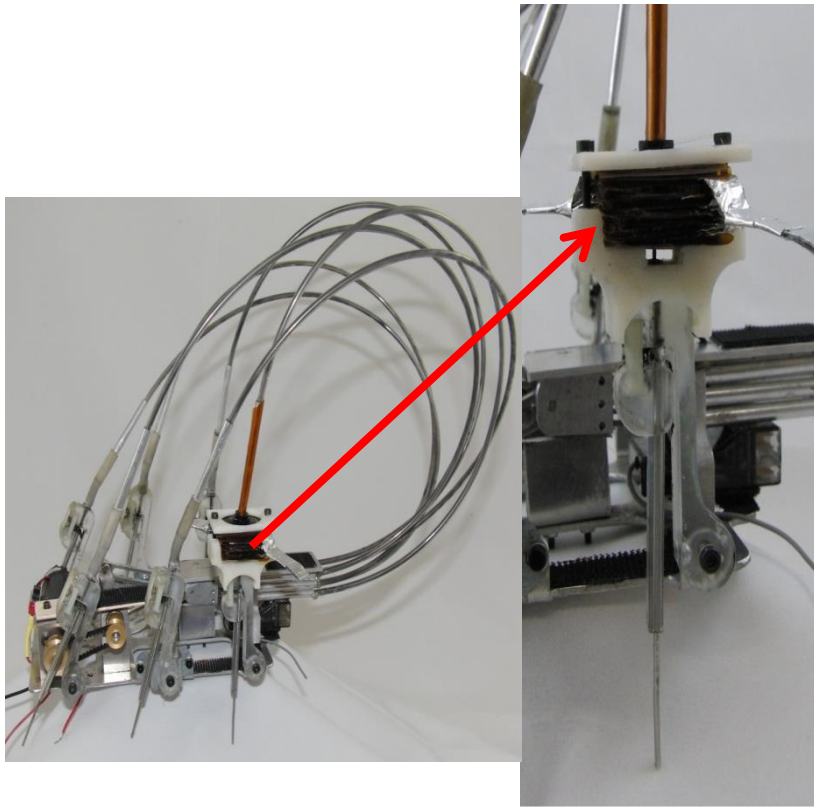


Figure 1. iSprawl Robot with VHB membrane stack[2]

Project Scope

Goal Statement: Design and build a device that produces high cycle sinusoidal mechanical fatigue of electroactive membranes.

Objectives:

- Accurately measure the fatigue placed on the specimen
- Produce various frequencies of cycling
- Produce varying stroke distances to displace the membrane
- Allow for tracking of the displacements controlled by the fatigue machine
- Measure the load associated with the stroke by implementing with the MTS machine

Project Scope

Constraints

- System should be a tabletop mechanism that is mounted to the MTS machine
- Vary stroke from 0 to 10mm
- Vary frequency from 0 to 100 Hz
- Produce consistent functionality for various specimens
- Test 1 to 5 specimens at a time
- Complete within the budget

Figure 2. MTS machine

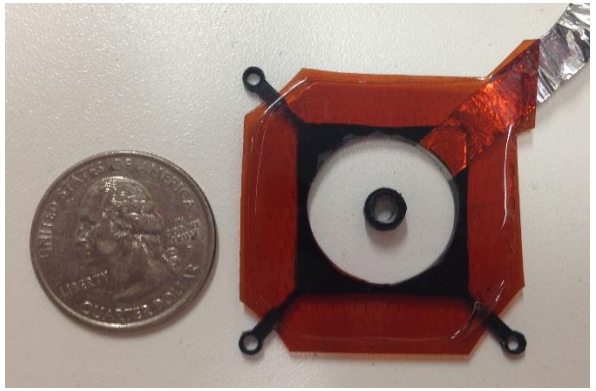


Figure 3. VHB membrane specimen

Designs

Decision Matrix

Team 20 Design Decision Matrix							
Design	**Safety**	**Low Cost**	**Easily Assembled**	**Mobility (size & weight)**	**Maintenance**	**Performance (vary stroke & frequency)**	**Total**
	0.20	**0.10**	**0.05**	**0.05**	**0.20**	**0.40**	
Solenoid	7	6	8	5	4	8	**6.65**
Four Bar	5	5	7	6	8	5	**5.75**
Cam	6	5	8	6	7	7	**6.6**
Scotch Yoke	8	5	8	5	8	6	**6.75**
Pneumatic	7	2	6	4	7	6	**5.9**

Designs

Two possible designs chosen

Figure 4. Scotch Yoke Design

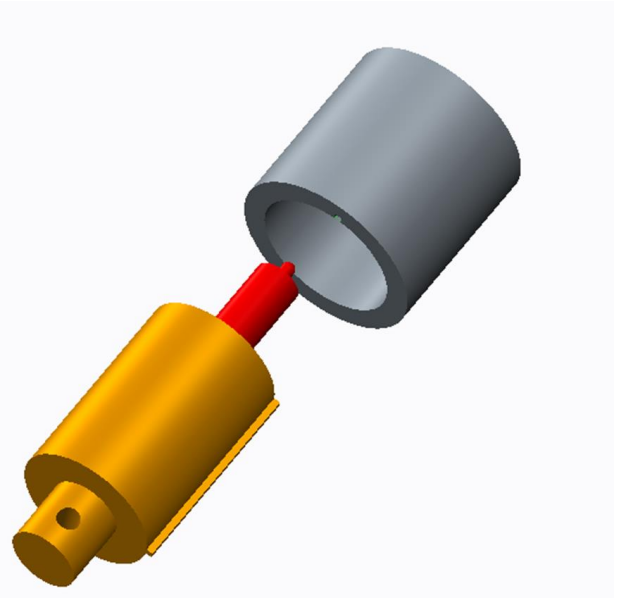


Figure 5. Solenoid Design

Modeling and Analysis

Scotch Yoke Design

- Forces acting on pin
- Friction between pin and slot
- Angular velocity based on pin location
- Failure analysis
- Preliminary cost of motors

Solenoid Design

- Forces acting on solenoid
- Friction between guide and housing
- Failure Analysis
- Preliminary cost of solenoids

Potential Challenges & Solutions

- Development of user interface
  - LabView
- Time syncing data from mechanism to MTS data
  - DAQ system
- Being a usable system on or off the MTS
  - Design base to accommodate
- Securing and testing multiple membranes
  - Variable mounting clamp

Figure 6. One VHB frame [2]

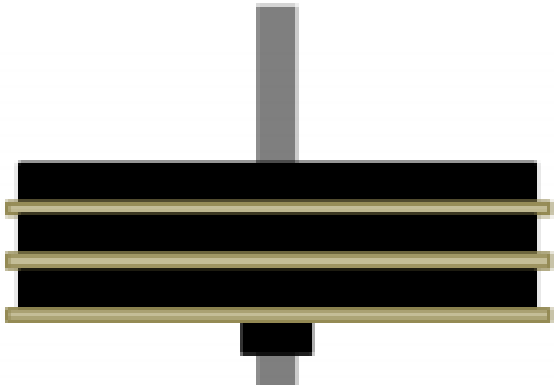


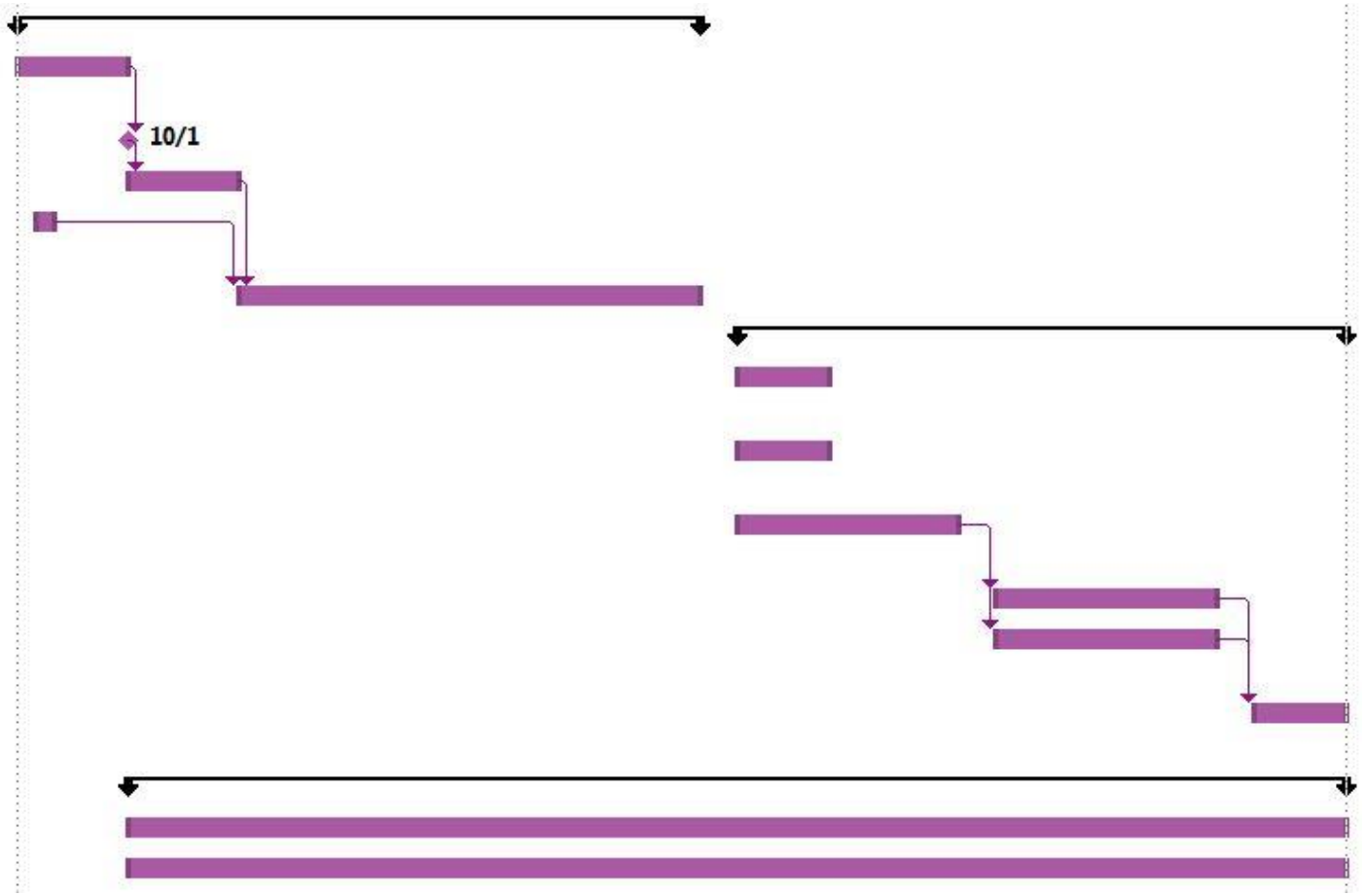
Figure 7. Multiple VHB frames [2]

Future Work

- Further research on two chosen designs
- Narrow design down to one system to begin building
- Finalize CAD drawings and renderings
- Force, friction and fatigue analysis on system
- Begin researching materials for system
- Research types of motors to be outsourced
- Complete a cost analysis on the system
- Design a working user interface

Schedule

Design of Machine	**Thu 9/25/14**	**Fri 10/31/14**
Designs by all team members	Thu 9/25/14	Tue 9/30/14
Designs Due	Wed 10/1/14	Wed 10/1/14
Decision Matrix	Wed 10/1/14	Mon 10/6/14
Measure Dimensional Constraints	Fri 9/26/14	Fri 9/26/14
CAD Drawings	Tue 10/7/14	Fri 10/31/14
Analysis of Machine	**Mon 11/3/14**	**Fri 12/5/14**
Force Analysis using CAD Assembly	Mon 11/3/14	Fri 11/7/14
Fatigue Analysis using CAD Assembly	Mon 11/3/14	Fri 11/7/14
Frequency to Velocity Analysis	Mon 11/3/14	Fri 11/14/14
Material Selection	Mon 11/17/14	Fri 11/28/14
Outsorcing of Motor and Power Source	Mon 11/17/14	Fri 11/28/14
Analysis of Cost Feasibility	Mon 12/1/14	Fri 12/5/14
Developing a User Interface	**Wed 10/1/14**	**Fri 12/5/14**
Sycronize with Lab View	Wed 10/1/14	Fri 12/5/14
GUI	Wed 10/1/14	Fri 12/5/14



Summary

Need Statement: There is a lack of information on the fatigue of electroactive membranes.

Goal Statement: Design and build a device that produces high cycle sinusoidal mechanical fatigue of electroactive membranes.

- Vary frequency
- Vary stroke

Key Next Step: Finalize design selection.

References

[1] Oates, William and Jonathan Clark. “High Cycle Fatigue of Electroactive Membranes.” Florida A&M/Florida State University, 2014. Print.

[2] Newton, Jason. "Design And Characterization Of A Dielectric Elastomer Based Variable Stiffness Mechanism For Implementation Onto A Dynamic Running Robot." Thesis. Florida State University - College Of Engineering, 2014. Print

Questions?