Robotic Jumping Tiger

McKibben Air Muscles

Senior Design P13029

Engineers:
Trevor Crandell (ME), Andrew Pace (ME), Jeff Manicone (ME),
Phil Brown (ME), Sean Mosier(ME)

Abstract:

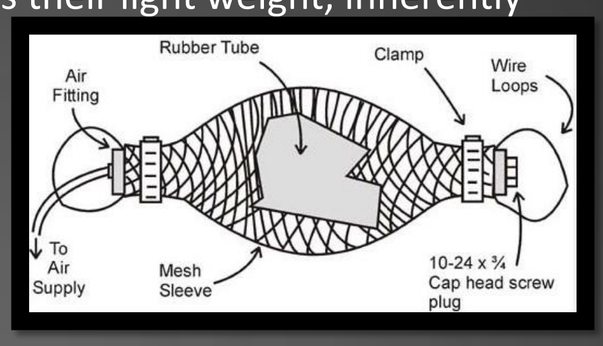
The goal of this project was to create a robot using McKibben Air Muscles to mimic the jumping motion of a tiger. The project builds upon past research and projects on pneumatic air muscles under the direction of Dr. Lamkin-Kennard.

Customer Needs:

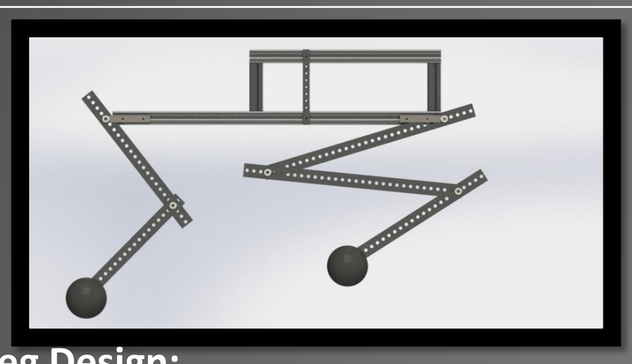
- Uses air muscles
- Jumps forward at least the length of it's body
- Self contained
- Lands without damage
- Successive jumps without user adjustment
- Resemble a tiger

McKibben Air Muscles:

The McKibben Air Muscle is a pneumatic artificial muscle that harnesses the force of air pressure to actuate in a motion/force that is similar to that of muscles. Some of the advantages of these devices is their light weight, inherently compliant manner, flexibility, and adjustability. Usually used for prosthetics or bio-mimicing robotic design.



Design and Dynamics:



Leg Design:

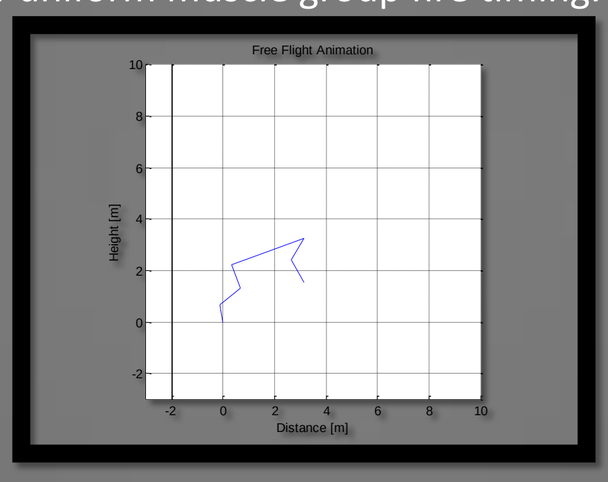
The design of the legs came from the idea of flexibility during testing. The design also allows for inexpensive manufacturing. This idea was implemented while keeping the proportions of a tiger in mind.

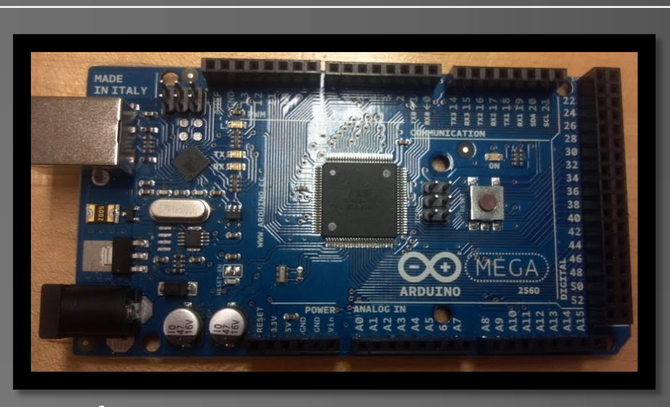
Body Design:

Similarly to the legs, the body was designed to be adjustable and cheap.

Dynamic Analysis:

A MatLab simulation of our tiger was created to help identify necessary forces and predict resulting motion. The model was a simplified 2D animation. This model showed the need for hard stops in our legs. It also revealed the need for non-uniform muscle group fire timing.

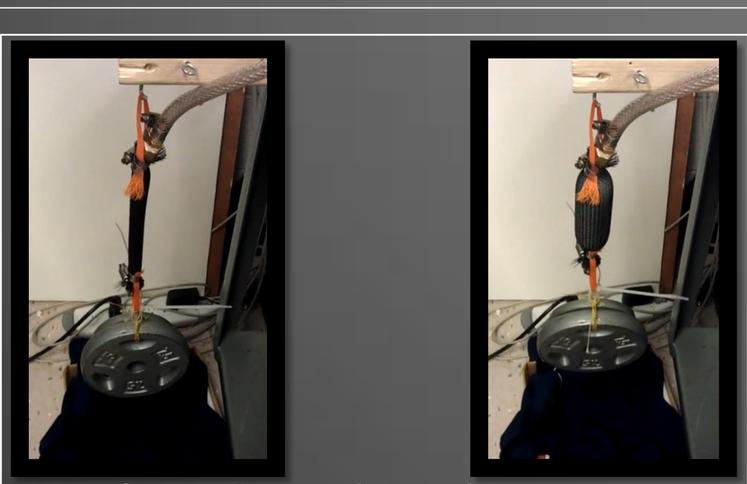




Control:

Control of the solenoids is done with an Arduino microcontroller board. This microntroller is responsible for the actuation and timing of the solenoids that control the muscle fill and exhaust sequence. A visual basic graphical user interface was created for input of the timing sequences and initiating the jump command.

Prototype Build and Testing:

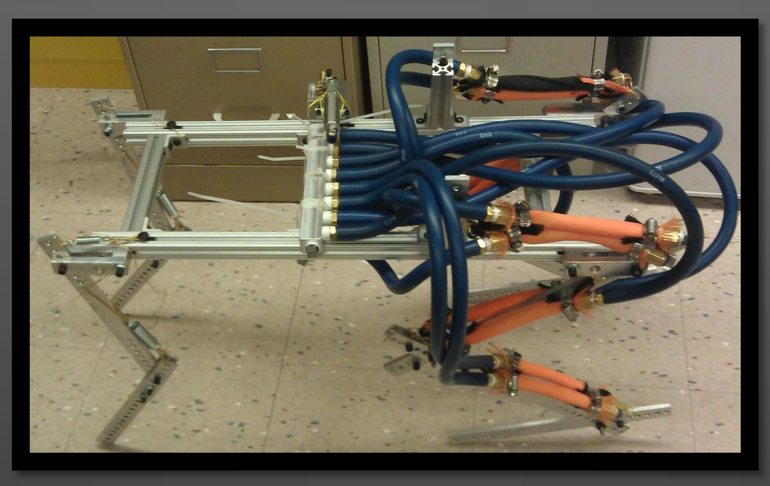


Muscle Testing and Development:

- Wall thickness was optimized to produce a balance of force and displacement
- Testing revealed that larger orifice sizes generate quicker fill times and higher forces
- New muscle fittings and attachment points were developed

Final Prototype:

- Too much vertical jump motion
  - Starting block and muscle timing optimization needed
- Large number of muscles used to overcome weight of components
- Untethered due to lack of economical lightweight tank options



Valve Actuation:

Custom pneumatic actuator mechanisms open ball valves to muscles.

Air Tanks:

Ten gallon 200psi air tanks were tethered to robot.

Future Work:

- Starting block to aid forward motion
- New lightweight frame design
- Landing mechanism
- On board air supply/untethered operation

Acknowledgements:

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