

Humanoid using Pneumatic Muscle Actuators

Proposed by : Jai Gupta and Paras Aggarwal

Constructed by: Jai Gupta and Paras Aggarwal

ABSTRACT

Fire accidents are very common now a days and due to these accidents there is a huge loss of property and life. Many people die in these accidents because they could not be rescued by the fire fighters (as they are also human beings and cannot go into high heat zones). The idea is to bring some betterment in the scenario and utilize advanced robotics to save these lives. Based on this insight, Team Medextrous decided to create a design of a firefighting humanoid to act as a frontline warrior during firefighting incidents.

Current Problems

- The fire safety and fighting industry is in dire need to be reinforced with modern technology.
- Firefighters can only carry their operations from the periphery of fire.
- The technology with which most of the today's humanoid are fabricated (i.e. servo motors/ pneumatic pistons) cant generate enough force to create a humanoid capable of carrying out such heavy tasks like fire fighting.

Solution

- A humanoid could be designed with the help of McKibben's artificial muscle (pneumatic muscle actuators) technology which could produce the desired required amount of force to power the humanoid even in the harsh scenarios like fire fighting.
- The humanoid could be covered with heat resistant material like asbestos to prevent its delicate parts from extensive heat.

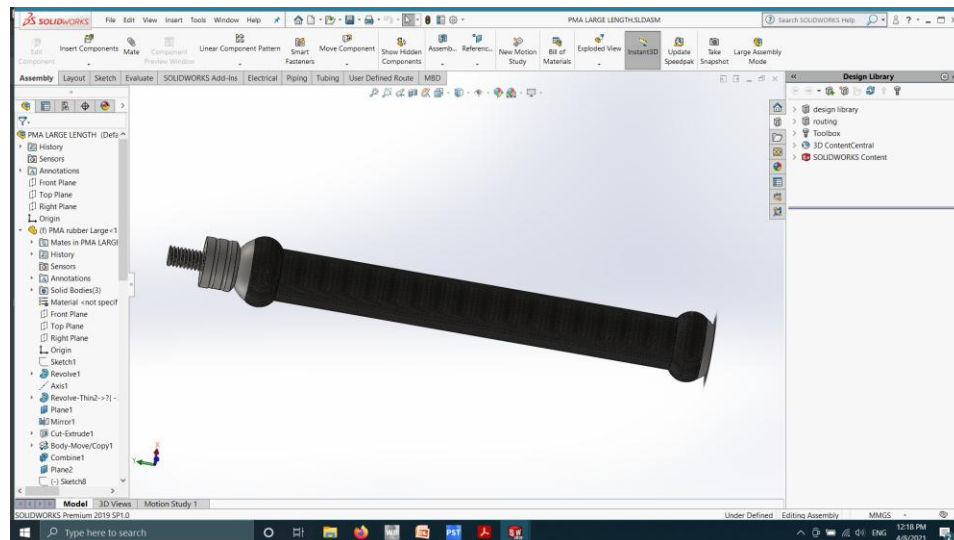
Design

The humanoid was designed on SolidWorks 2019 software. All the parts of a typical humanoid were designed using appropriate dimensioning such that the bot is half the size of a human being. Moreover, designs of additional components like battery compressor, fire extinguisher, pneumatic muscle actuators (PMAs) and pipes were created and installed in the humanoid so as to enable it to perform its function of fire fighting.

No, electronic components were designed and a filled area (black box) was created with the assumptions that all the electronic items will be located inside it.

Design of PMAs

- Pneumatic artificial muscles actuators are contractile or extensional devices operated by pressurized air filling a pneumatic bladder.
- The PMA's design was done with two ends (made of high carbon steel) covered with neoprene rubber painted with asbestos paint connecting them as shown.



Design of Joints

- The joints were created connected with PMAs as shown. Such that when one PMA contract and other extends, an angle is formed at the joint. The PMAs contract on application of air pressure.

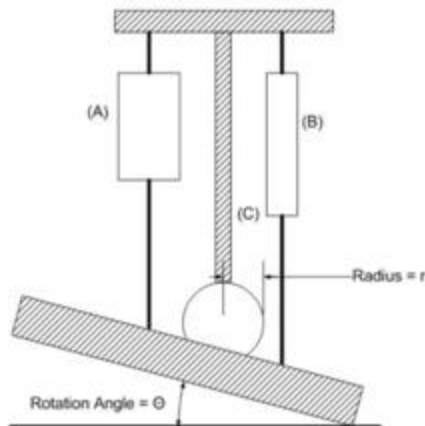
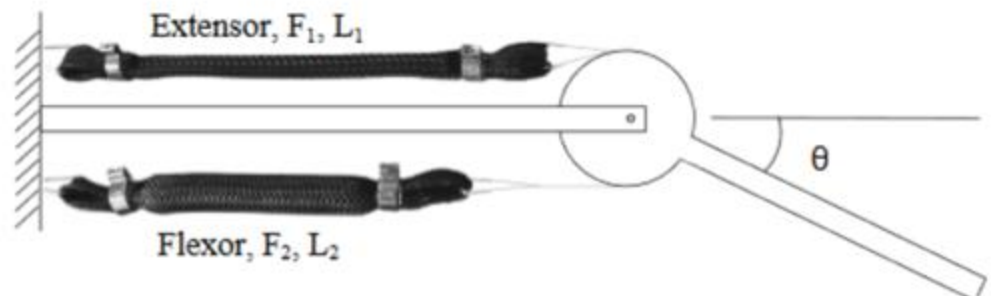


Fig. 1. Basic architecture of link actuated by PMs.



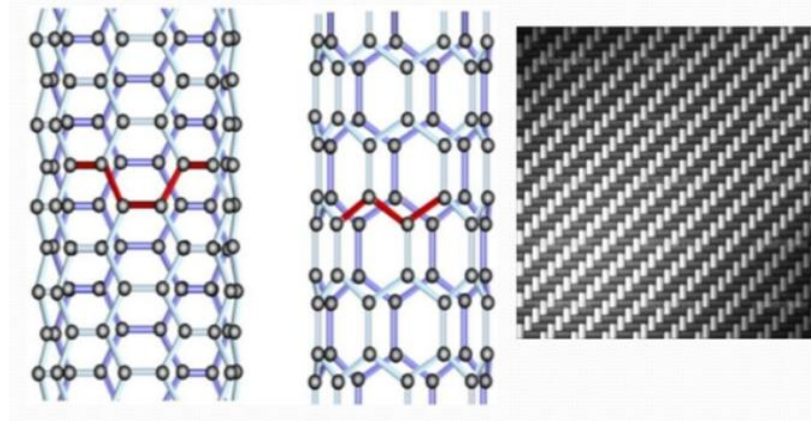
Design of Joints



Design Specifications

Carbon fibre frame

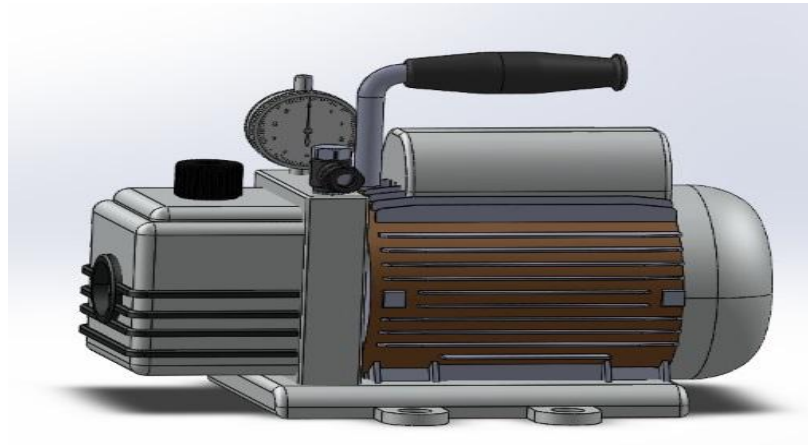
- Whole Humanoid is designed on the framework of carbon fibre.



Design Specifications

Air pump

- It is a centrifugal pump which will control pressure on PMA.
- Specifications: 194mm×100mm×143mm, weight 1Kg



Design Specifications

Battery

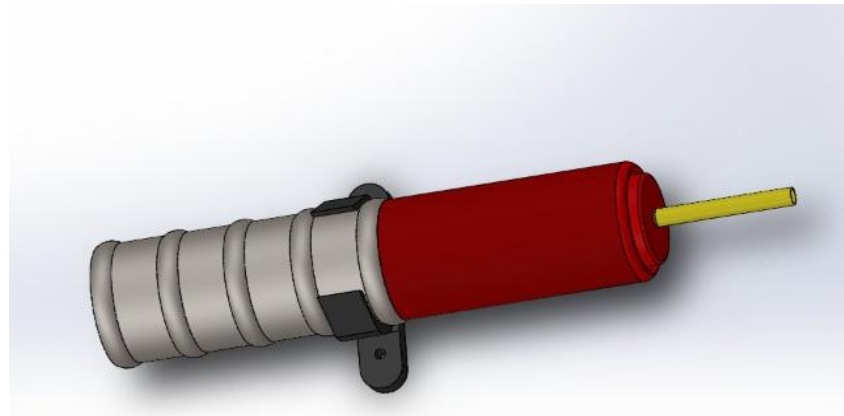
- A wet battery will be attached to the humanoid having capacity of 40Ah, voltage output=12V.
- Dimensions:174mm×70mm×100mm



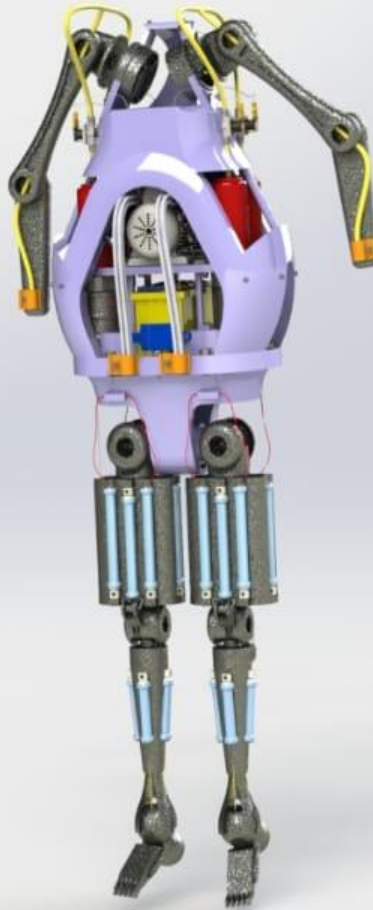
Design Specifications

Fire Extinguisher

- It is responsible for extinguish operations and it is controlled with solenoid valves.
- Specifications: 234mm and R 25.5mm, weight 1kg

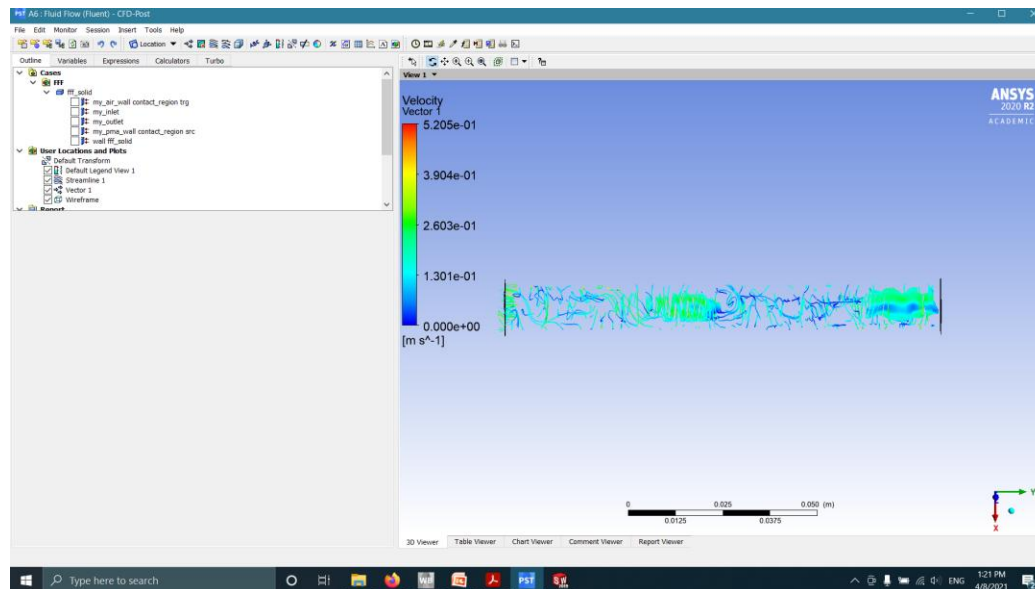


Overall Design:



Simulation and Calculations:

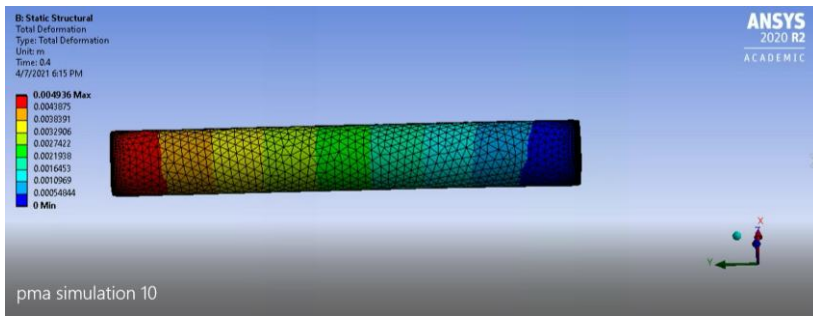
The simulation of PMA's was carried out and the following results were obtained:



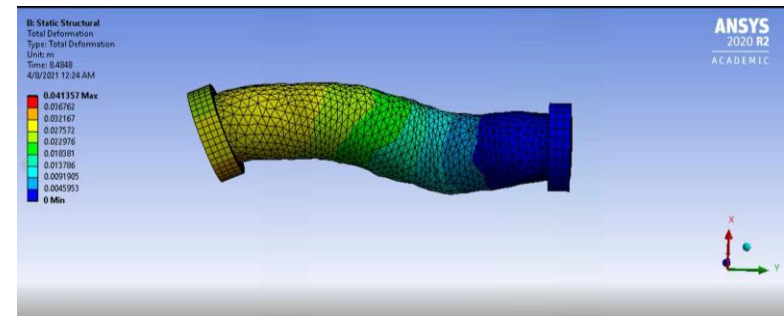
Streamlines of Air flow inside PMA
while air is filled in it.

Simulation and Calculations:

The pneumatic muscles contracted by 4-5% in length when a pressure of 0.1 MPa was applied which increased to a contraction of 20-25% when a pressure of 0.6 MPa was applied.



Deformation at 0.1 MPa



Deformation at 0.6 MPa

Conclusion:

- This Humanoid will be installed to work as a fire fighting robot. It will be extremely helpful in the area of extreme heat, where human fire fighters can't go.
- The humanoid can also be used as an surveillance in fire stricken areas .
- The main feature of the PMA technique is its remarkable capability to bear stress that too 10 times more than the current technology.
- This humanoid principle can be used for further advancements in current humanoids like Sophia.
- The PMA technology had a vast future in prosthetic human parts.



THANK YOU