IPRO 319: New Technologies for Cardiac Arrest Victims

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IPRO It takes a team! INTERPROFESSIONAL PROJECTS PROGRAM

ILLINOIS INSTITUTE OF TECHNOLOGY

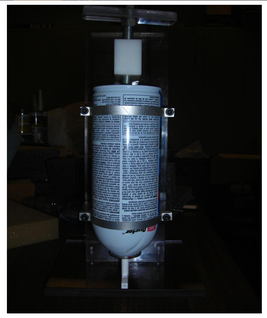
Introduction

Due to the high rate of death associated with cardiac arrest, a prototype has been developed for on the scene response. The goals were to create a citizen-friendly device that would address various lifesaving technologies associated with cardiac arrest patients such as induced mild-hypothermia, controlled oxygen deprivation, and spinal-track oscillations. The product needed to be intuitive, portable, and fast so that it could be used before trained emergency response teams arrive.

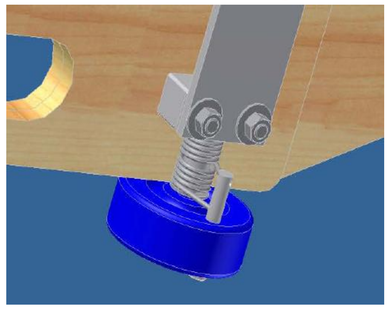
Long standing research on cardiac arrest patients shows that individuals endure the most amount of brain damage as oxygen is rushed back to the brain after the patient's heart begins beating again.

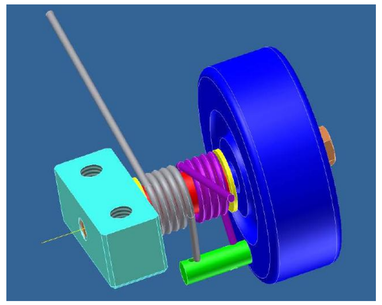
- cooling a person by 3° C decreases the amount of brain damage as long as the cooling is done within 24 hours of the original attack.
- research in pigs has shown that allowing a heart to not beat for 20 minutes while oscillating the subject along the spinal axis at 0.6g allows the subject to be revived without any apparent brain damage.

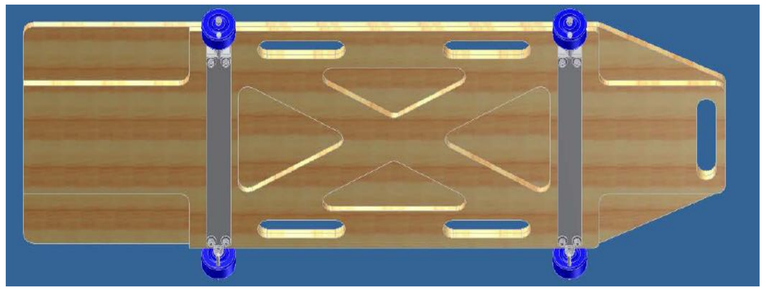
Cooling Mechanisms



Prototype Design







Calculations

- Engineering Equation Solver (EES) software calculates the heat capacity of R152a at -238.5 kJ/kg.
- Ammonium Nitrate and water reaction has a heat capacity of -197.4 kJ/kg.
- phase-change cooling technique using R152a is more efficient.

Operating at 0.6g gives the bed a linear frequency (f) of 1.5 Hz and critical acceleration (a_{crit})of 5.88 m/s².

$$x(t)= A_x\cos(\omega t) \qquad \omega=2\pi f \qquad A_x= a_{crit}/ \omega^2 = 0.0062m$$

where A_x is the linear amplitude and ω is the angular frequency. The force per wheel is

$$F_{lin}=ma_{crit}=(100kg)*(5.884m/s^2)= 161.81N.$$

Given this information the team was able to decide on wheels of radius 3 ½" with springs each with spring rating of 34.290 lbf-in.

Results and Conclusions

Power spectrum data shown below in Figure 1, the prototype bed falls short of the required critical frequency and thus falls short of maximum acceleration. Frictional dampening also absorbs energy which slows down the oscillation.

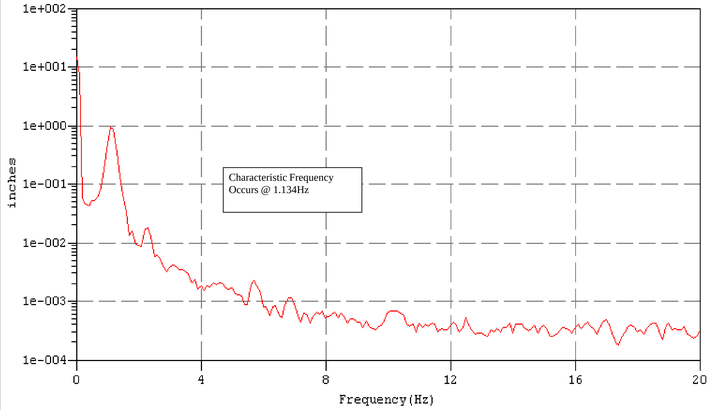


Fig. 1. Shows the power spectrum analysis of the prototype oscillating system. The characteristic frequency of the system is found where displacement is a maximum. From the graph, the characteristic frequency is 1.134Hz, this is slightly off from the critical frequency of the desired system of 1.5Hz

Some modifications will need to be made to the bed in order for it to be more successful.

- Bigger wheels must be attached to achieve the desired acceleration and frequency.
- A small motor should be attached to deal with frictional force

The cooling system will increase efficiency significantly once the design allows the liquid R152a to be closer to the surface of the skin as to increase the amount of cooling specifically to the patient.

Applications and Future Work

Many hospitals and companies are in the process of developing more effective cooling methods to try and alleviate the long term effects of cardiac arrest. In addition, the oscillating bed is known to serve as a novel form of CPR with beneficial side effects that are currently being studied by outside companies. Though there is a similar form of cooling administered in some hospitals, this prototype is to serve as an emergency response that can be used by anybody without training. The solution is to be simple and portable so that it can be stored and if possible used in combination with AED's that are currently stored and used in public buildings.

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