

IPRO 332: Design & Analysis of a Longitudinal Oscillator for Cardiac Arrest Victims

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Several years ago researchers discovered that it was possible to keep a pig alive after its heart had been stopped by placing it upon a vibrating platform. After being on the platform for up to 20 minutes, the pig's heart could be restarted (e.g. with a defibrillator) and it would resume completely normal biological functioning. Essentially it replicates the process of cardiopulmonary resuscitation (CPR). The physical mechanism behind this effect, as produced by periodic acceleration (i.e. "shaking"), is under investigation. To that end, researchers at IIT and the University of Chicago are conducting similar research on mice, whose biochemistry is well-understood. IPRO 332 assisted their research by developing the mechanical device to shake the subject. The IPRO also investigated the scaling and adaptation of this technology to potentially be used by emergency medical personnel.

To accomplish these goals, IPRO 332 split into two teams. The Mouse Team focused on developing the device for use with mice by University of Chicago researchers, and the Human Team focused on determining the proper operational parameters for a human-sized device and then designing a concept for such an apparatus.

The Mouse Team developed the shaking bed for murine research. Calculations determined the proper acceleration in mice to be 3 Gs, or an amplitude of oscillation of approximately one centimeter at a frequency of 13 Hz. Due to the approximations made in the calculation and variances in size between subjects, the device must allow a researcher to vary both the frequency and the amplitude of oscillation easily and during the machine's operation.

Using an electric motor allows for easy adjustment of frequency, but adjusting the amplitude of the oscillation through mechanical means is very difficult. Two options allow this adjustment: a completely mechanical device driven by a rotary motor, or an electrical oscillator using a voice coil. A mechanical device called a zero-max speed reducer could be slightly modified to control the amplitude. A voice coil could also achieve the desired effect. However, commercial voice coils capable of the required acceleration do not have sufficient heat dissipation capabilities to run for more than a few seconds, in addition to being prohibitively expensive. Thus the team chose to build a mechanical device using the zero-max. Due to the time taken to arrive at this conclusion, in addition to difficulty contacting manufacturers for custom parts, the prototype has not yet been completed although construction is underway.

In conjunction with Harshbir, the Human Team calculated the required parameters for oscillation to allow the technology to work with humans: 0.2-0.4 Gs of acceleration, 5-10 cm amplitude, and 0.7-1.3 Hz, depending on the size of the person involved. The team also researched the legal issues surrounding the development of medical technology, and interviewed paramedics to gauge the viability of this technology as an actual asset in the field. The research concluded that there is a market for such a device. They visualized four different uses in the market: Paramedic, Ambulatory, Hospital, and Home. The team then brainstormed concepts for the design of a practical device to be used in the field, developing two systems: a two-part removable stretcher, and a built-in system that stays inside an ambulance.

Performing CPR via this method appears to be a viable and potentially valuable medical technique. More detailed study of its use with humans will commence after additional research with mice yields more complete understanding of the mechanisms behind it.