CerebroSense™: A Brain Pulsatility Measurement Device

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Background

- 160,000 open-brain procedures are performed each year in the US.
- Cerebral pulsatility is used as a metric to assess brain perfusion intraoperatively.
- Currently, surgeons feel the surface of the brain to make a qualitative assessment of cerebral pulsatility.
- The amount/type of compensation is then determined by the anesthesiologist.
- Imprecise compensation may lead to potential long-term neurologic complications such as **ischemia**, **stroke**, and **edema.**

Fundamental Equations

$$Pulsatility = \frac{Change\ in\ Cerebral\ Volume}{Change\ in\ Cuff\ \ Pressure} = \frac{\Delta V}{\Delta P}$$

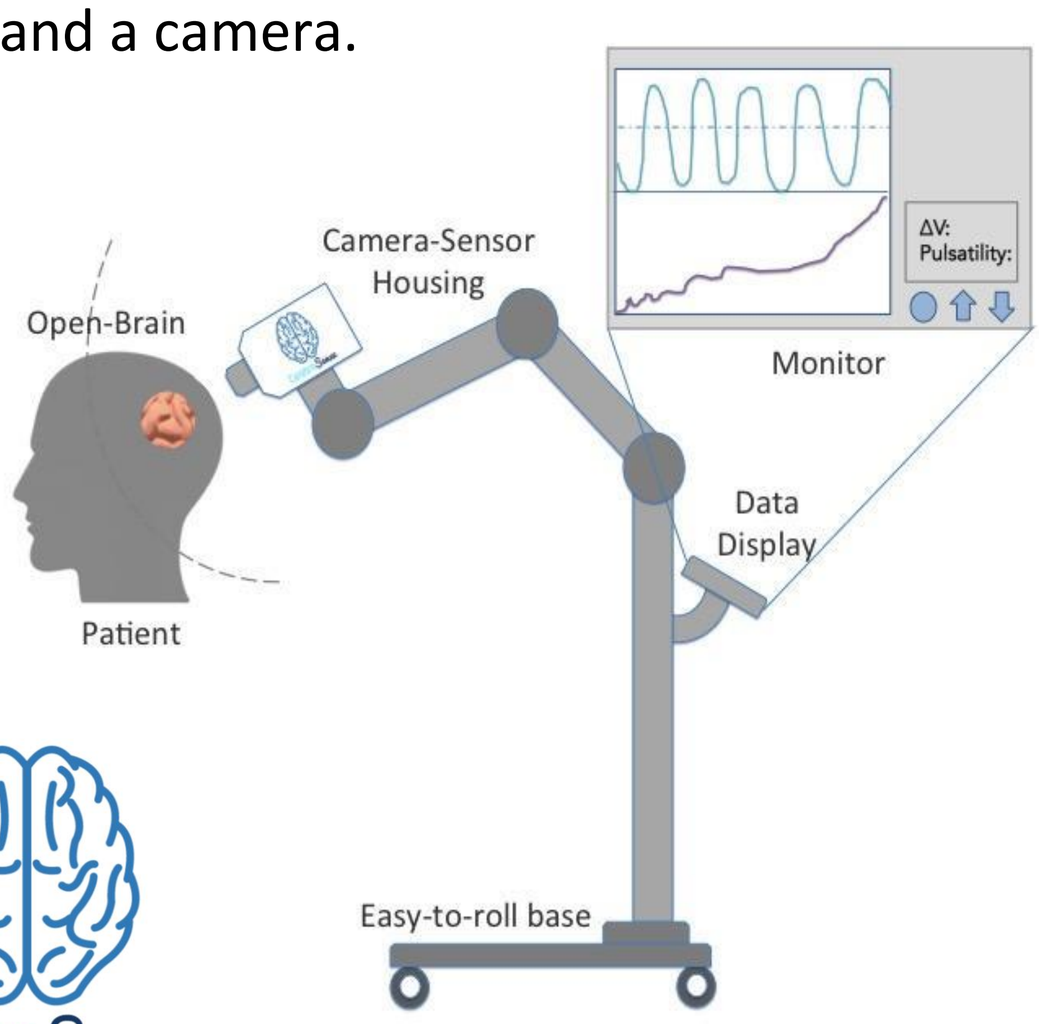
$$V_{brain} \approx \frac{\pi h}{6}(3a^2 + h^2) \longrightarrow \frac{\Delta V}{\Delta P} \approx \frac{\pi}{2}(a^2 + h_i^2)\frac{\Delta h}{\Delta P}$$

$a = radius\ of\ \ craniotomy$

$h = protrusion\ of\ \ brain\ through\ craniotomy$

Design

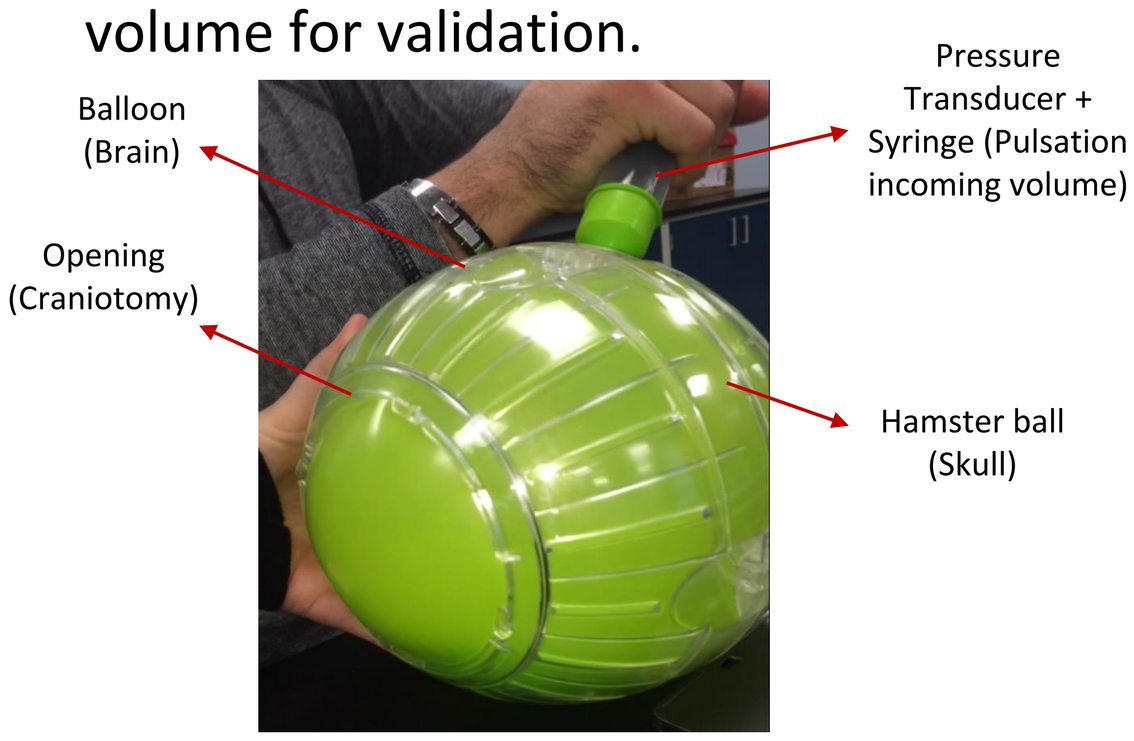
- An ultrasonic sensor is used to estimate the change in radius of the brain.
- A housing unit incorporates both the sensor and a camera.



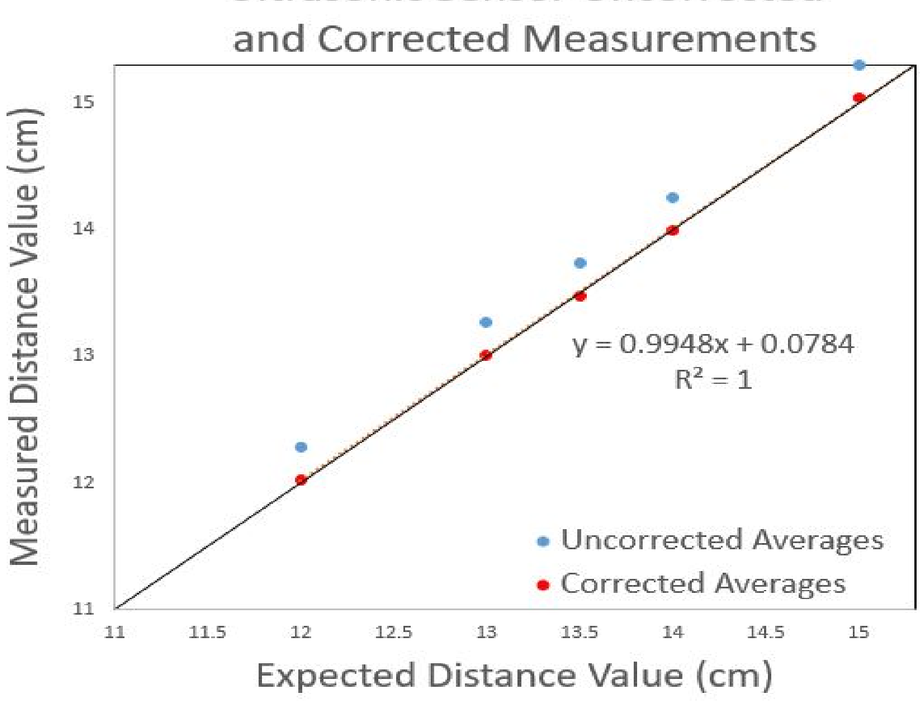
CerebroSense

Testing

- A proof of concept model is designed to simulate a pulsating brain within a skull.
- The change in volume from the device is compared to the injected volume for validation.



Preliminary Results



- An ultrasonic sensor with 1mm resolution sensing target object at distances of 12, 13, 14, and 15 cm
- Corrected results, with an SD of 0.04 cm, demonstrates measurement accuracy.

Future Work

- Completely-wireless assembly.
- Fine tuning of system resolution.
- Improved modeling of both cerebral volume and cerebral perfusion.

References
Smith, D. E. "Spherical Segment." §541 in *Essentials of Plane and Solid Geometry.* Boston, MA: Ginn and Co., p. 542, 1923.