



The Larynx Model



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Abstract

The purpose of this project is to develop an automated larynx model for patient education. We developed a movable plastic and gypsum-based Plaster of Paris framework controlled by motors and cables, and added silicone muscles to mimic laryngeal anatomy. Our tests indicate that this model improves comprehension of the larynx anatomy and function by 36%. In the future, we hope to further develop this model by both improving its realism and increasing its movement capabilities.

Background

- 500 patients per month come to the UW Voice and Swallowing Clinic
- Due to the complexity of the larynx, patients have difficulty understanding their diagnoses
- Six major muscle groups control larynx movement
- Dynamic model would improve patient comprehension

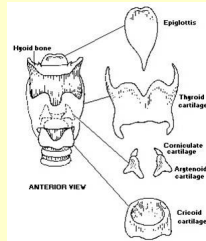


Figure 1: Cartilages

Competition

- Static Models show anatomy, but not function
- Manually Controlled Models show limited cartilage motion but no muscle interactions
- Both model types make it difficult to visualize the muscle interactions



Figure 2.: Static Model

Design Criteria

- The model must be 3x scale or greater.
- The model needs to be portable, i.e one person can easily move it
- The model must span from the hyoid bone to the second tracheal ring, and show tissue, major muscles, and bone.
- It must show the vocal folds opening, closing, and stretching.
- The movements must take at least 2 seconds.

Final Design

The Materials

- **Silicone:** used to create muscles, hold together arytenoid cartilages, and connects hyoid bone to thyroid cartilage
- **Plaster:** used to construct the trachea, cricoid cartilage, and hyoid bone
- **Plastic:** thyroid cartilage and arytenoid cartilages from purchased larynx model used
- **Wood base:** encloses motors and circuitry
- **Metal rods:** attach hyoid bone to base, and anchor cricoid to base
- **20 lb. Fishing Line:** attaches movable cartilages to motors



Figure 3: Plaster cricoid cartilage and trachea

The Framework

- Motors apply tension to fishing line and the cartilages move, mimicking muscle contraction
- Silicone returns the cartilages and muscles back to their relaxed positions
- Vocal chords open, close, lengthen, and shorten with corresponding muscle contractions

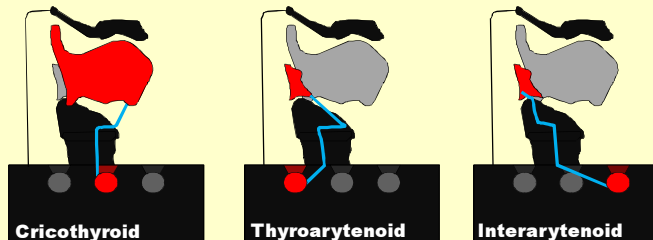


Figure 4: Each motor controls a different muscle group

The Circuit

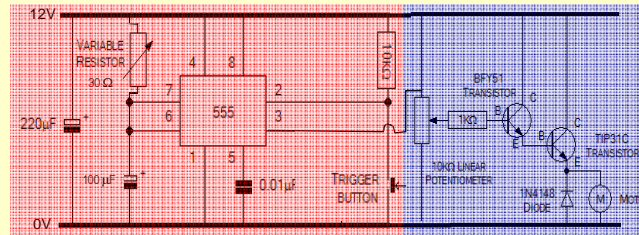
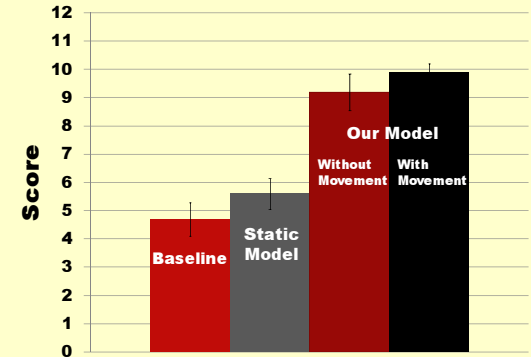


Figure 5: The circuit includes a timer circuit (red), and a motor speed control circuit (blue).

Test Results

Educational Effectiveness



Graph 1: Average quiz scores for each of the four groups tested.

Static Model - Our Model with movement ($p=1.976 \times 10^{-5}$)

Baseline: no presentation before quiz
Static model: presentation with static model before quiz
Our Model: presentation with and without muscle movement before quiz

Future

- Tune the movements to mimic the larynx more closely
- Add a silicone veneer to mimic anatomy
- Add complex movements (i.e. swallowing)
- Add disorders, especially paralysis

References

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