Hull Detection

**Definition.** Given a set of points $X$, the subset $S \subseteq X$ such that the polygon defined by the points in $S$ contains all points in $X$, is called the hull of $X$.

Hull for a set of points can be defined based on:
- Convexity
- Minimum footprint/area
- Shape templates

We define based on Largest Empty Sector Angle (LESA) criterion.

Largest Empty Sector Angle

The largest angular sector ($\delta$) around a point $x$ that is empty.

$$\max_{\alpha, \beta} \delta = |\alpha - \beta|$$

s.t. $(\theta_i - \alpha)(\beta_i - \beta) \geq 0, \forall i = 1 \ldots n - 1$

Suppose $\theta_i, i = 1 \ldots n - 1$ are the angles subtended by each point.

**Application to vocal tract realtime MR images**

**Data:**
- The USC-TIMIT corpus comprising moving vocal tract images
- Common problem is the subject’s head motion

**Approach:**
- Detect nosetip and chin as sharp points in rtMRI contour
- Estimate rotation and translation to correct for head motion

**Algorithm:**
- $\delta(x) \geq 195^\circ \rightarrow H_1, H_2\ldots$
- Center of points in $H \rightarrow H_0$
- Sort by angle at $H_0$
- Choose nosetip and chin by sorting index

Tracking Results

Check a demo of the algorithm at work.

Head motion correction

- Match nosetip points
- Estimate angle of rotation about matched nosetip points

Discussion and Future Work

- Chin point is on a non-rigid structure
- Vocal tract shape changes during head motion
- Use nosetip and chin to find other landmark points e.g. lips
- Direct adaptive tracking of the vocal tract