Comparison of distance measures in tongue contour traces of ultrasound images

Background

- Quantify the distance between tongue contours extracted from ultrasound images (traced manually or automatically) - compare two contours directly
- MAD - Mean Absolute Difference (Stone, 2005)
- RMSD - Root Mean Squared Distance (Stone, 2005)
- MSD - Mean Sum of Distances (Li et al., 2005)
- NND - Nearest Neighbor Distance (Zharkova et al., 2009)
- basically the same as MSD

Questions

Q1: What are their advantages and disadvantages?
Q2: How sensitive are they to the way of calculation?
Q3: Which is more useful for quantifying distances of tongue shapes?

Methods

- MAD and RMSD are simple and quick to calculate
- An equal number of data points are necessary on the two contours (denoted by U and V)
- If one of the contours in the comparison is significantly longer, not all parts will be involved in the calculation of the difference
- Advantage of RMSD over MAD is that more weight is given to large differences, and thus global differences are more apparent
- MSD is asymmetric in a sense that the U-to-V distance might be different from V-to-U
- Advantage of MSD is that it can measure the distance between tongue contours that are not equal in length
- MSD can be improved further by taking the squared distances to give more weight to large differences:
  - We propose to use the novel RMSSD (Root Mean Sum of Squared Distances) measure

**Figure 2: Calculation of MSD and RMSSD.**

\[ MSD(U, V) = \sqrt{\frac{1}{m+n} \sum_{i=1}^{m} \sum_{j=1}^{n} (u_i - v_j)^2} \]

\[ RMSSD(U, V) = \left( \frac{1}{m+n} \left( \sum_{i=1}^{m} \min(0, u_i - v_j)^2 + \sum_{j=1}^{n} \min(0, v_j - u_i)^2 \right) \right)^{1/2} \]

Results and discussion


References

Conclusions

- Q1: Be careful with MAD and RMSD, as they don’t quantify length differences
- RMSSD gives more weight to visually clear differences
- Q2: The number of lines in the grid is important – should be uniform
- Q3: There is no “best” distance measure
- Several options can be useful depending on the research question

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