Evaluation of prototype MagTrack articulograph and its effects on speech production

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MagTrack

Poster

MagTrack

- Articulograph under development by Nordine Sebkhi, Arpan Bhavsar, Omer T. Inan
  - Of Georgia Tech and Kinemo (kinemo.io)
- Components
  - Over-glasses with permanent magnets
  - 3 tracers with accelerometer + magnetometer
  - Software runs on a laptop
- Magnets correct for head movement
- Designed to work in ~10cm cube
- Estimates position based on machine learning (trained with robotic arm)

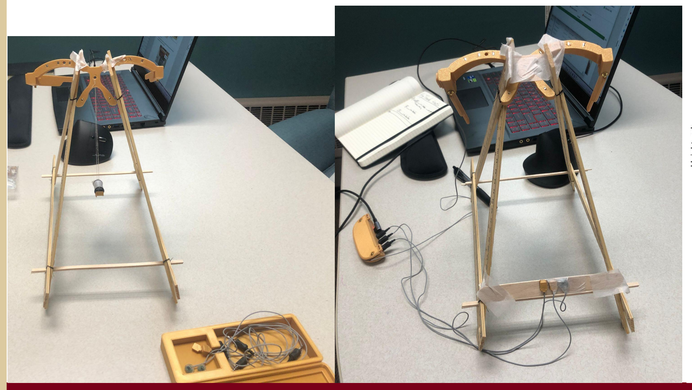
Methods

- Tests:
  - Wooden rod, 30mm apart
  - Plastic pendulum, 25mm apart
  - 3D-printed turntable based on Savarieux et al (2017)--ultimately unsuccessful
- *In vivo* tests:
  - Lower lip, lower incisor, tongue tip @ 1cm
  - Compare with same-talker EMA From Tiede et al (2018)

Analysis & Results

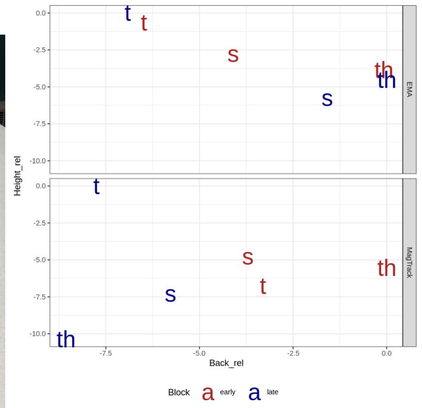
Static tests

- Distance recorded accurately!
- Two sensors placed 30 mm apart: mean 29.83 mm, SD 0.079



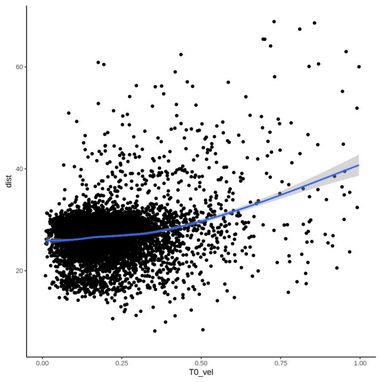
In vivo acoustics

- EMA: position didn't change much over time
- MagTrack: shift back over time



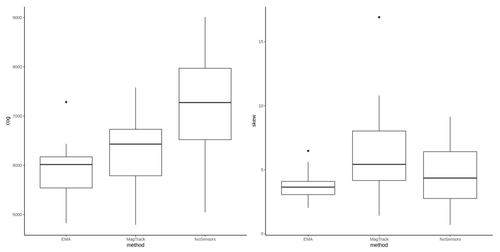
Pendulum tests

- Compared to still, less accurate and more variable (mean 27.0 mm, SD 5.3), especially at the edges of the tracking area and very high velocities.
- .5 mm/ms = 50 cm/s; most speech is slower
- MagTrack accurate at realistic velocities



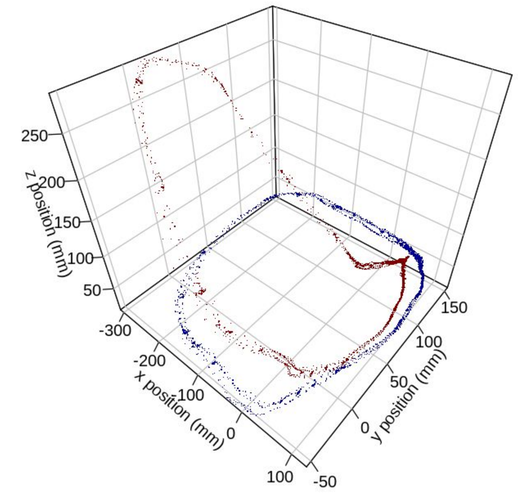
In vivo tests

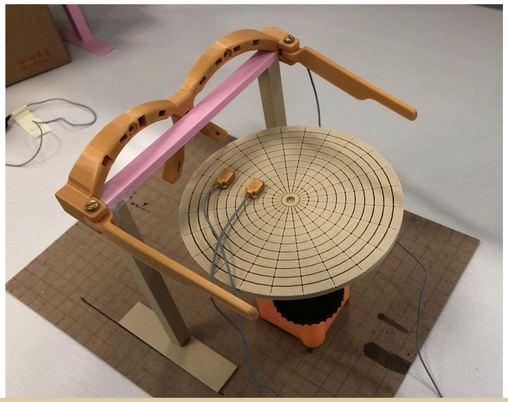
- Vowel acoustics not significantly affected
- Coronal stops: some lacked a complete closure, with audible turbulent airflow throughout (esp. /t/)
- Coronal fricatives:
  a. CoG: /s/ NoSensor>{EMA, MagTrack}; /θ/ opp
  b. Skewness: /s/ {EMA, MagTrack}>NoSensor
  c. Kurtosis: /s/ EMA>NoSensor>MagTrack



Turntable tests

- MagTrack isn't designed for >45° rotation
- Tracers were accidentally magnetized (stored near a magnetic whiteboard, we think)





Conclusions

- MagTrack seems accurate for speech-like data
- Magnetizing sensors is an issue
  - Recordings remain precise, not accurate
- Want to try vertical turntable
- Large tracers substantially affect articulation of coronal stops and fricatives, more than EMA

Cao, Beiming, Shravan Ravi, Nordine Sebkhi, Arpan Bhavsar, Omer T. Inan, Wen Xu & Jun Wang. 2023. MagTrack: A Wearable Tongue Motion Tracking System for Silent Speech Interfaces. *Journal of Speech, Language, and Hearing Research* 66(8S). 3206–3221.

Savariaux, Christophe, Pierre Badin, Adeline Samson & Silvain Gerber. 2017. A Comparative Study of the Precision of Carstens and Northern Digital Instruments Electromagnetic Articulographs. *Journal of Speech, Language, and Hearing Research* 60(2). 322–340.

Tiede, Mark, Carol Y. Espy-Wilson, Dolly Goldenberg, Vikramjit Mitra, Hosung Nam & Ganesh Sivaraman. 2017. Quantifying kinematic aspects of reduction in a contrasting rate production task. *JASA* 141(5). 3580–3580.