Production of Various Voice Qualities Using Mechanical Vocal Code Model

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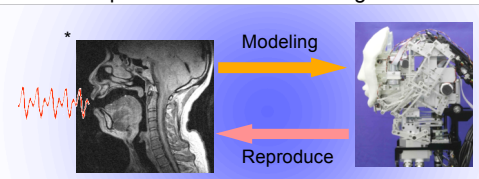
Waseda-Talker Series

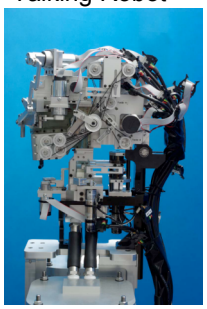
Purpose of Talking Robot

- Direct reproduction aero-acoustic phenomenon in speech production process
- Development of humanoid talking robot

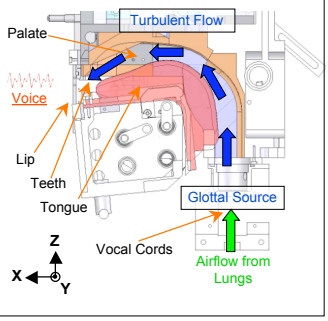


*Honda, ATR

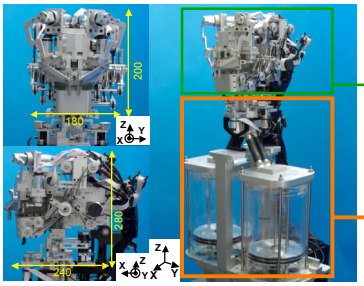
Speech Production in Anthropomorphic Talking Robot



WT-7R



Anthropomorphic Talking Robot WT-7R(Waseda Talker-No.7 Refined) in 2008



- Total DOF : 17

Articulators : 13
- Tongue : 7
- Lips : 4
- Jaw : 1
- Velum : 1

Vocal Organs : 4
- Lungs : 1
- Vocal Cords : 3

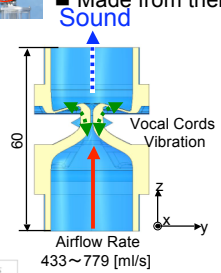
Topics of MyTalk

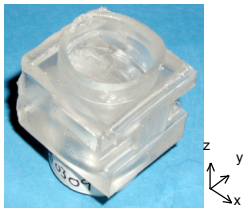
- Voice quality generation using mechanical vocal code model
  Model - Breathy – Creaky
- same control manner as human vocal cord.
- Measurements of the vibration and the aero-acoustic characteristics

OPAL-09, June 26-27, 2009, Vancouver, BC, CA

Fold Vocal Cord

- Two folds formed by thin cover and hollow inside.
- Made from thermoplastic rubber “Septon”



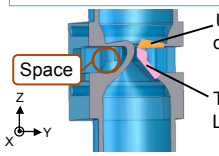


Decision Experiment of Vocal Cord Shape Methods

Procedure

- Connected to mechanical lung
- Record the sound and take high-speed movie

Variation of Parameters



UC: 0.5, 1.0, 2.0

LC: 0.5, 1.0, 1.5, 2.0

3X4=12 pattern

Decision Experiment of Vocal Cord

UC>LC (UC,LC)=(1.0,0.5), (2.0,0.5), (2.0,1.0)

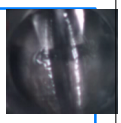
No Vibration

UC=LC (UC,LC)=(0.5,0.5), (1.0,1.0), (2.0,2.0)

Unstable Vibration (Unbalanced)

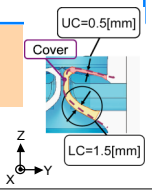
UC<LC (UC,LC)=(0.5,1.0), (0.5,1.5), (0.5,2.0)

Stable Vibration

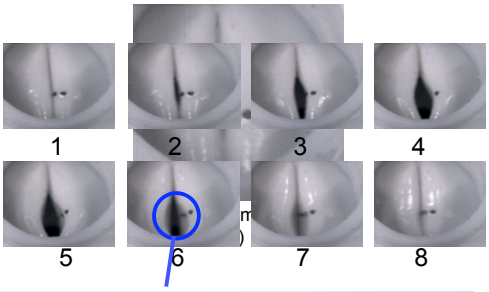


LC＞UC is needed (Restitutive force from lower part is important to keep vibration)

Select the parameters as UC=0.5[mm], LC=1.5[mm]



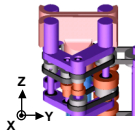
Mechanical Vocal Cord Vibration



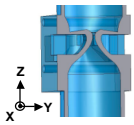
Vibrated in Different Phase

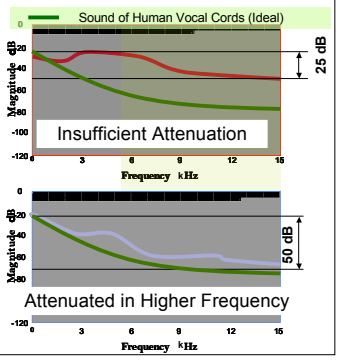
Spectrum of Robot Vocal Cord

Rubber Plate Model



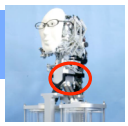
Fold Vocal Cord

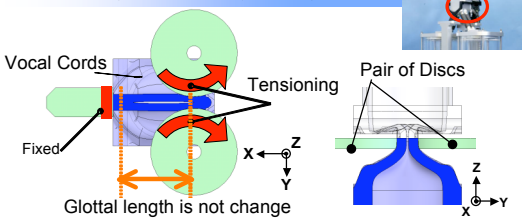




Code Tension Control

- Discs attached to the vibrating part directly
- Tensioning vocal cords by rotating the discs



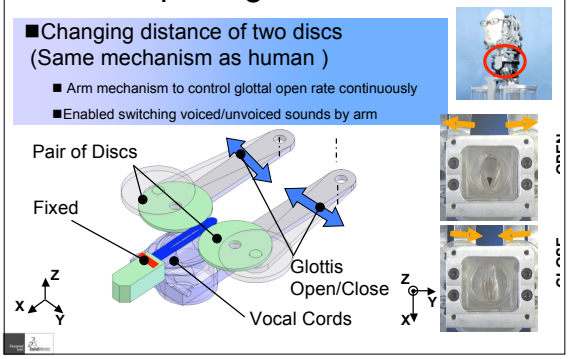


Pitch range is from 130 to 240[Hz]

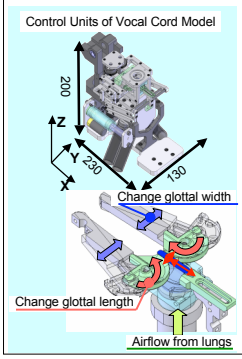
Glottal Opening Control

■Changing distance of two discs
(Same mechanism as human)

- ■ Arm mechanism to control glottal open rate continuously
- ■Enabled switching voiced/unvoiced sounds by arm

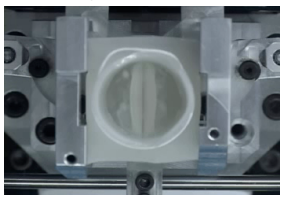


Control Mechanism of Parameters



— Pitch Control and Glottal Opening —

Pitch Change: 130 → 240 [Hz]



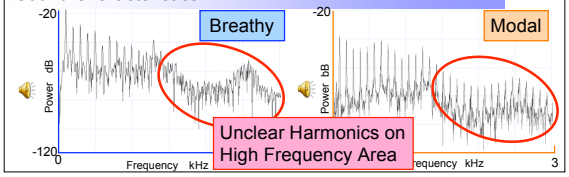
Breathy Voice

Physiological Characteristics

No Close

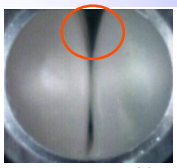
Vocal Cord Vibration of Breathy Voice

Sound Characteristics

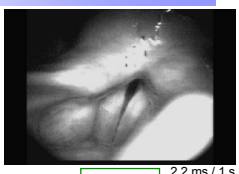


Glottal Vibration for Breathy Voice

Movie



Model 2.2 ms / 1 s



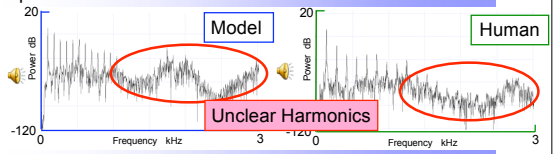
Human 2.2 ms / 1 s

※ University of Tokyo

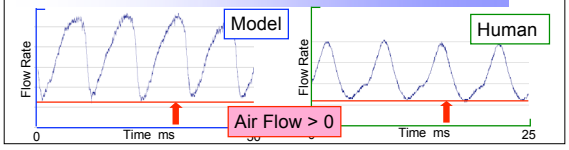
No closure in a vibration cycle

Aero-acoustics of Breathy Voice

Spectrum



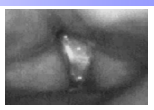
Air Flow



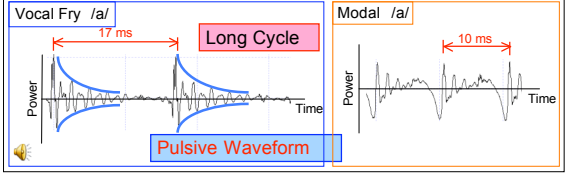
Vocal Fry Voice

Physiological Characteristics

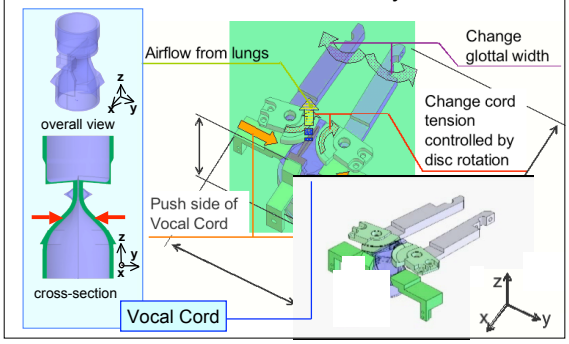
Long Closing Interval
in Vibration Cycle



Sound Characteristics

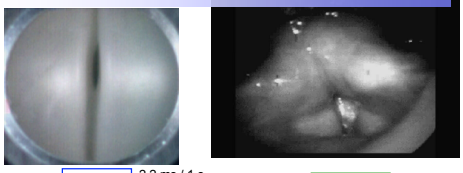


Additional Mechanism for Creaky Voice



Glottal Vibration of Vocal Fry

Movie



Model 2.2 ms / 1 s

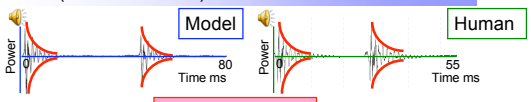
Human 2.2 ms / 1 s

※ University of Tokyo

Long Closing Phase

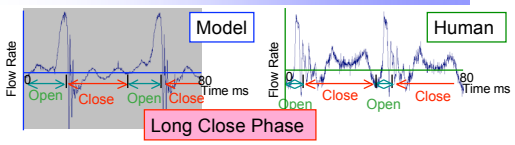
Aero-acoustic of Vocal Fry Voice

Acoustic(Sound Pressure)



Pulse Wave Form

Air Flow



Long Close Phase

Summary

- Developed mechanical vocal cord model
- Generated vocal cord vibration of modal, breathy and vocal fry voices
- Experimental results showed that the model predicts well the motional and the aero-acoustic characteristics of these human voices.