REVIEW OF TEXT-TO-SPEECH CONVERSION FOR ENGLISH

Presented by
Najeeb Khan
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INTRODUCTION

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Trace the history of progress toward the development of systems for converting text to speech.

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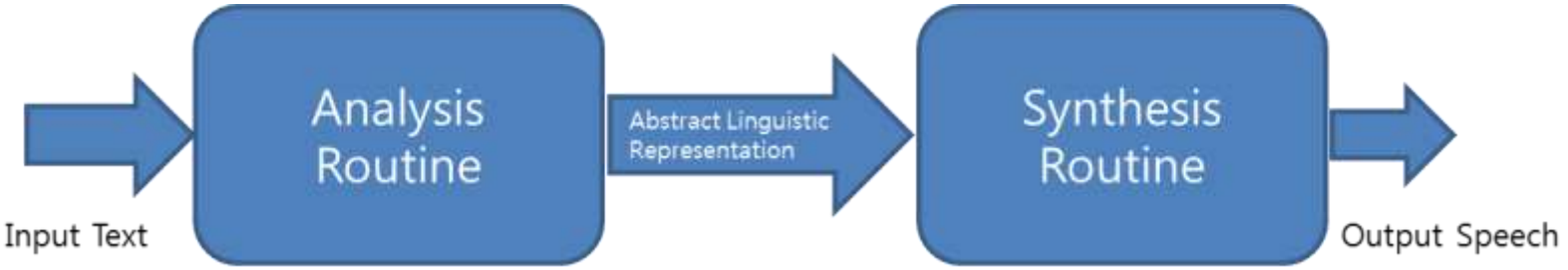

A SIMPLE APPROACH TO TTS

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- Simply concatenate them to produce sentences

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- Stress pattern, Rhythm, and Intonation are very unnatural
- Words blend together at an articulatory level
- Number of words is extremely large and new words are coined everyday

LINGUISTIC FRAMEWORK

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- Generative linguists specify rules for the generation of any legitimate sentence of the language.

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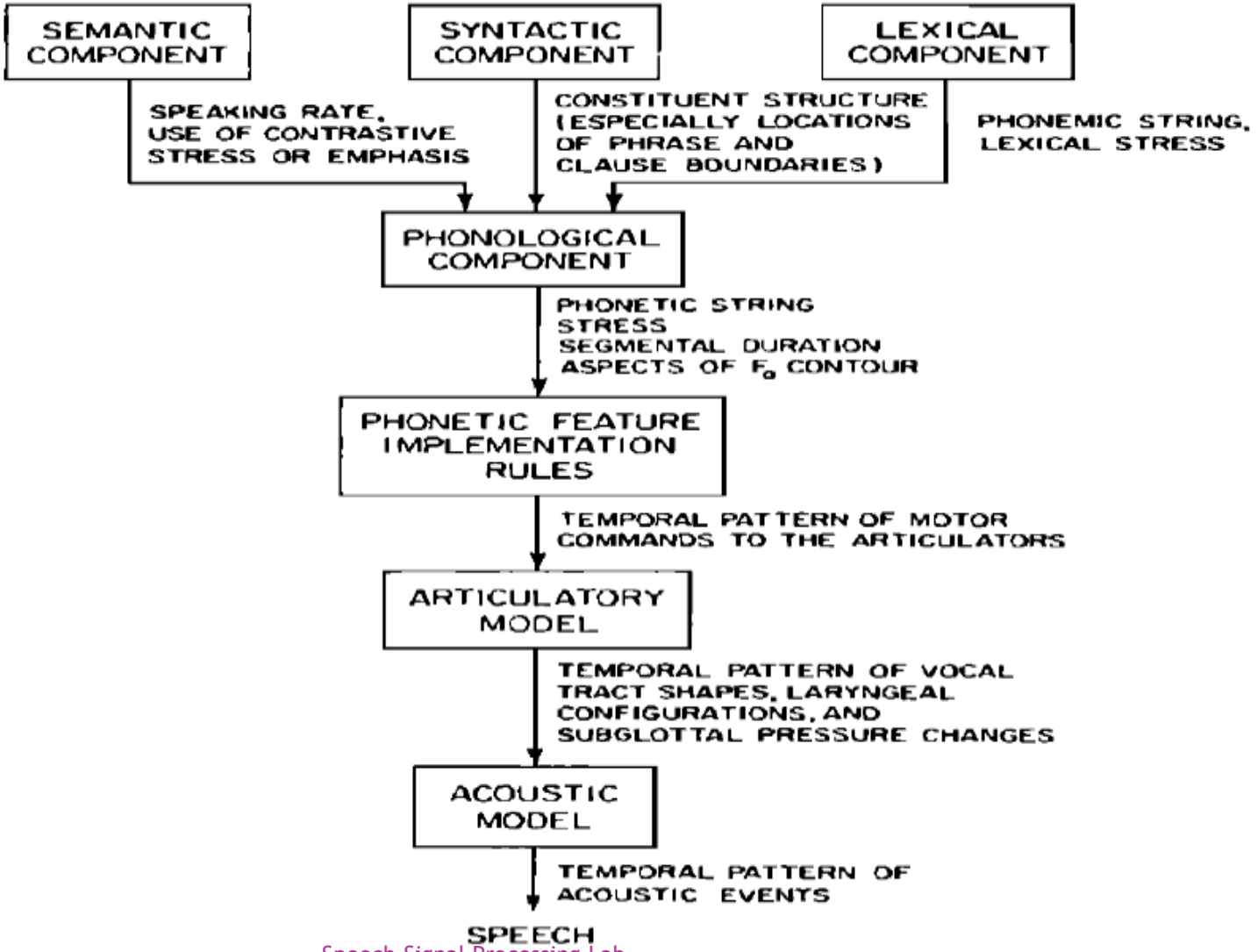

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- The stress pattern changes the durations of sounds and pitch over an utterance.

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  - A superimposed pattern of timing, intensity and f_0 motions.

PHONEMES TO SPEECH CONVERSION

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Example: “Joe ate his soup”

ABSTRACT LINGUISTIC REPRESENTATION:

/ǰo) ˈet hɪz sˈup./

ALLOPHONIC RECODING:

[ǰo ˈeɾ ɛs sˈup.]

DURATION SPECIFICATION, IN MSEC:

[100, 210, 180, 20, 65, 75, 90, 165, 75]

FUNDAMENTAL FREQUENCY GESTURES:

1. HAT RISE DURING [o]
2. STRESS PULSE ON [o]
3. STRESS PULSE ON [e]
4. STRESS PULSE ON [u]
5. HAT FALL DURING [u]

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- A fundamental frequency contour is determined by rules that specify the locations and amplitudes of step and impulse commands.

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- Finally a formant synthesizer is used to convert this parametric representation into a speech waveform.

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- Vocoder/Voder: A device for analyzing speech into slowly varying acoustic parameters that could then drive a synthesizer to reconstruct an approximation to the orignal waveform.

PATTERN PLAYBACK SYNTHESIZER

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- A wheel generates harmonics of 120Hz tone, while harmonic amplitudes are controlled over time by the reflectance of painted spectrographic patterns on a moving transparent belt.

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- Sources:
  - Vibration of vocal folds
  - Turbulence noise
- Linear Filter:
  - Simulates the resonance effects of the acoustic tube formed by pharynx, oral cavity and lips. Poles creates local peaks called formants.

PARALLEL FORMANT SYNTHESIZER

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- The outputs of a set of resonators connected in parallel are summed and the input sound source amplitude of each formant resonator is determined by an independent control parameter.

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- PAT was latter modified to have a separate circuit for fricatives and converted to cascade operation.

ORATOR VERBIS ELECTRIS

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- OVE I consisted of formant resonators connected in series, the lowest two of which were varied in frequency by movements in two dimensions of a mechanical arm. The amplitude and f_0 were manually controlled.

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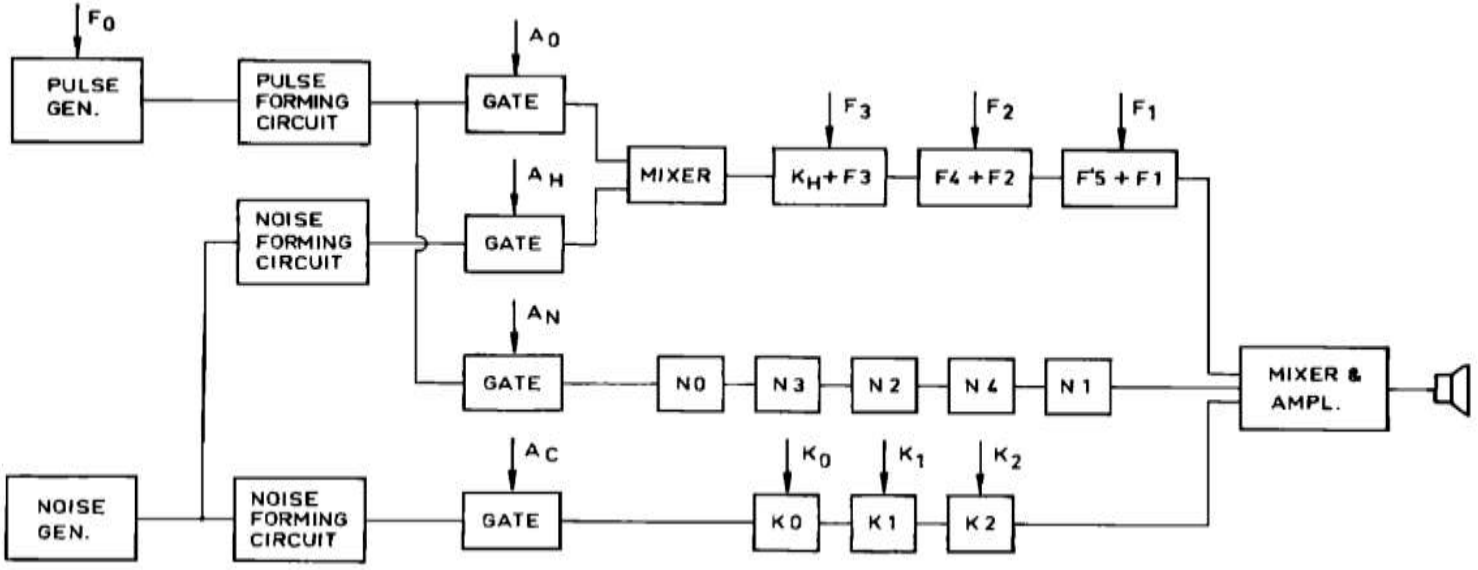

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  - Parallel formants for the synthesis of obstruents
  - An extra pole-zero for nasalization

HOLMES SYNTHESIZER

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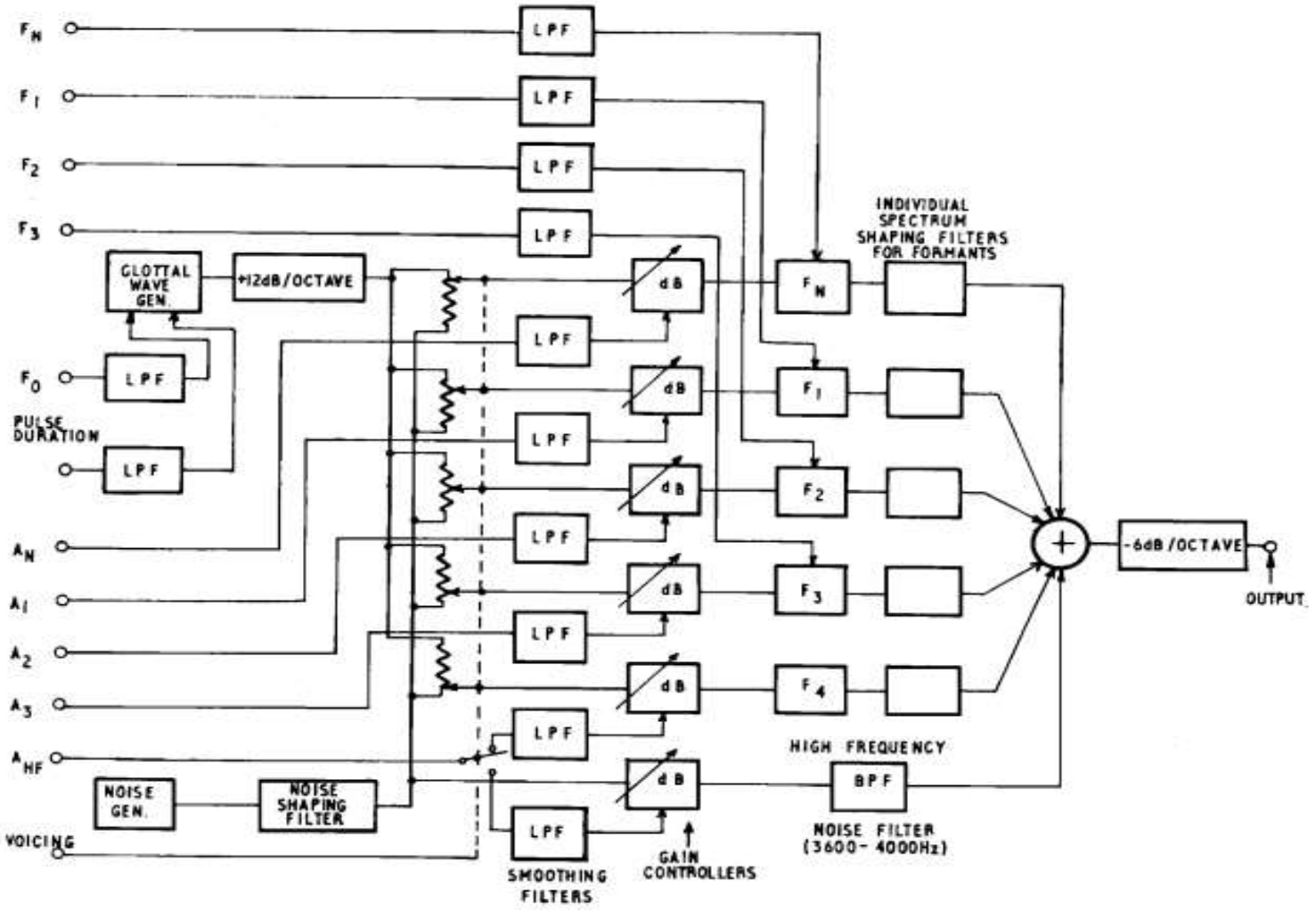
- The objective of Holmes synthesizer is to match a natural recording recording of a particular speaker

HOLMES SYNTHESIZER



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- Holmes found that variability in the spectra of natural speech can be mimicked by proper adjustments to the amplitudes of parallel formants.
- Irregularities in spectrum between formant peaks are of little perceptual importance, only strong harmonics near a formant peak and below f_1 must be synthesized.

MODELS OF THE VOICING SOURCE

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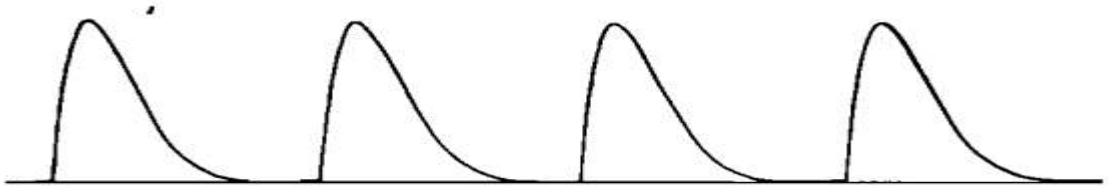

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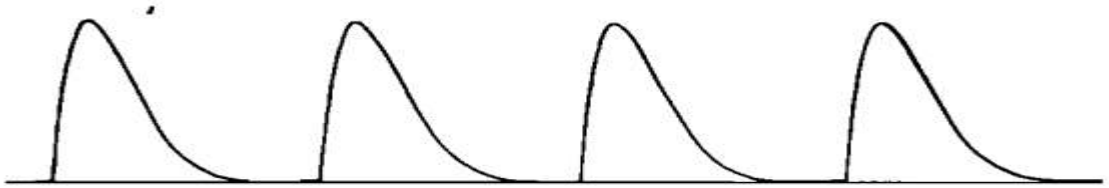

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LOW-PASS FILTERED IMPULSE TRAIN

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- Spectrum is monotonic, contrasting the presence of zeros in the spectrum of normal voicing waveforms.

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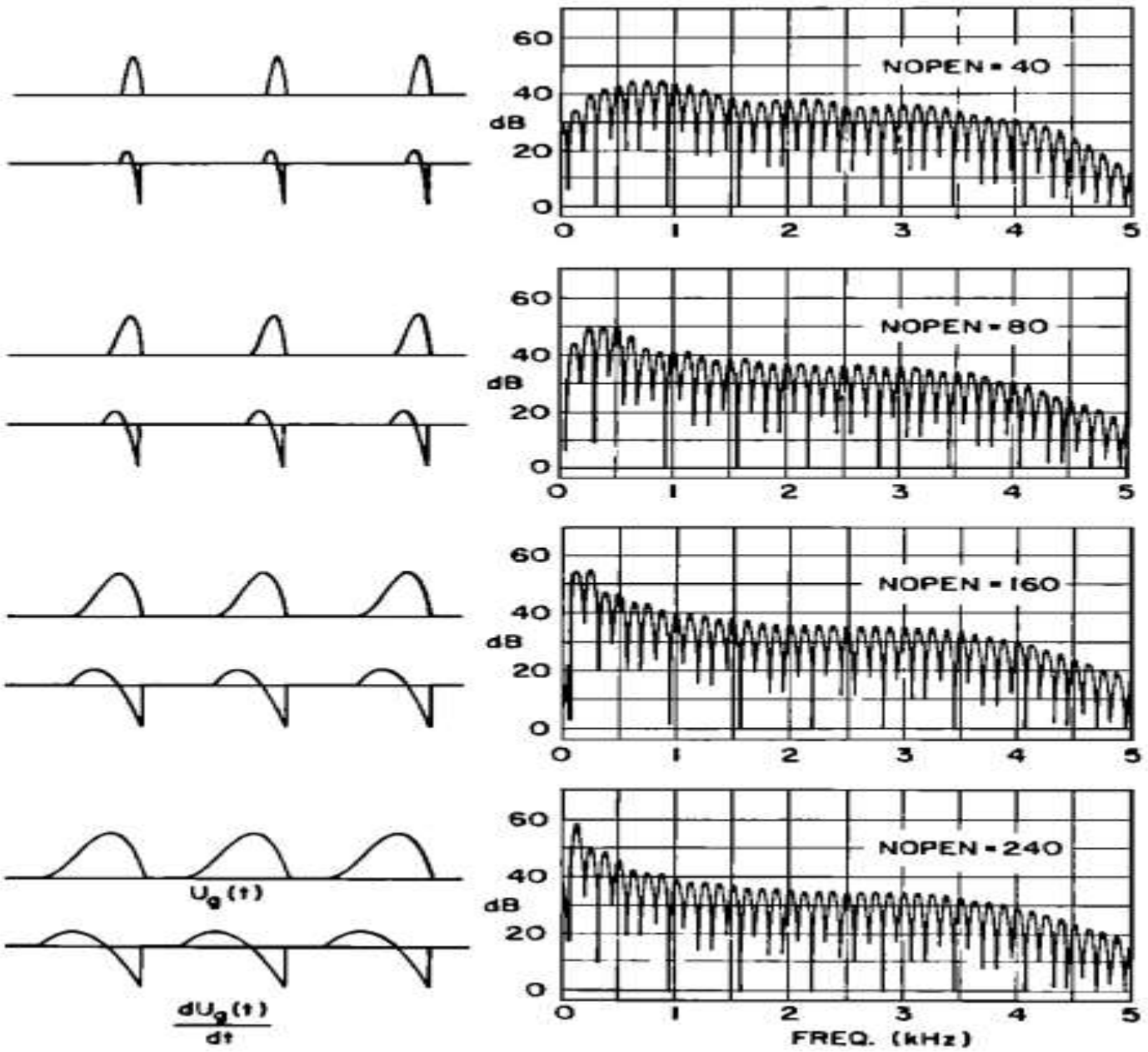
  - 3 parameter model producing waveshapes varying w.r.t f_0, Amplitude, OQ, degree of static glottal opening and breathness.

- Fant et al (1985):
  - Similar to Rothenberg model but with more control over the important acoustic variables (spectral tilt, zeros location & intensity of f_0).


NOPEN = 40
NOPEN = 80
NOPEN = 160
NOPEN = 240
dB
60
40
20
0
0
1
2
3
4
5
FREQ. (kHz)
$U_g(t)$
$\frac{dU_g(t)}{dt}$

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  - Breathness
  - Degree of diplo-phonic vibration

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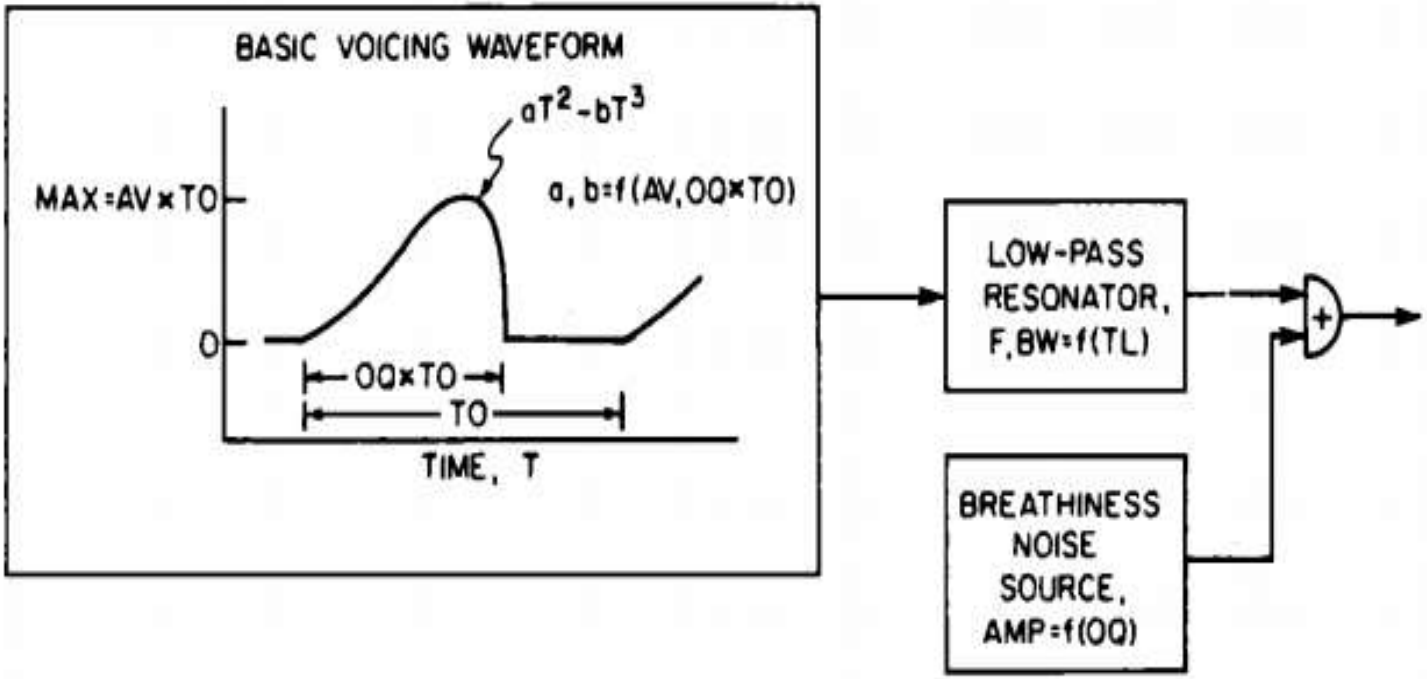
BASIC VOICING WAVEFORM
aT^2-bT^3
a, b=f(AV, OQ×TO)
MAX=AV×TO
0
OQ×TO
TO
TIME, T
LOW-PASS RESONATOR, F, BW=f(TL)
BREATHINESS NOISE SOURCE, AMP=f(OQ)
+

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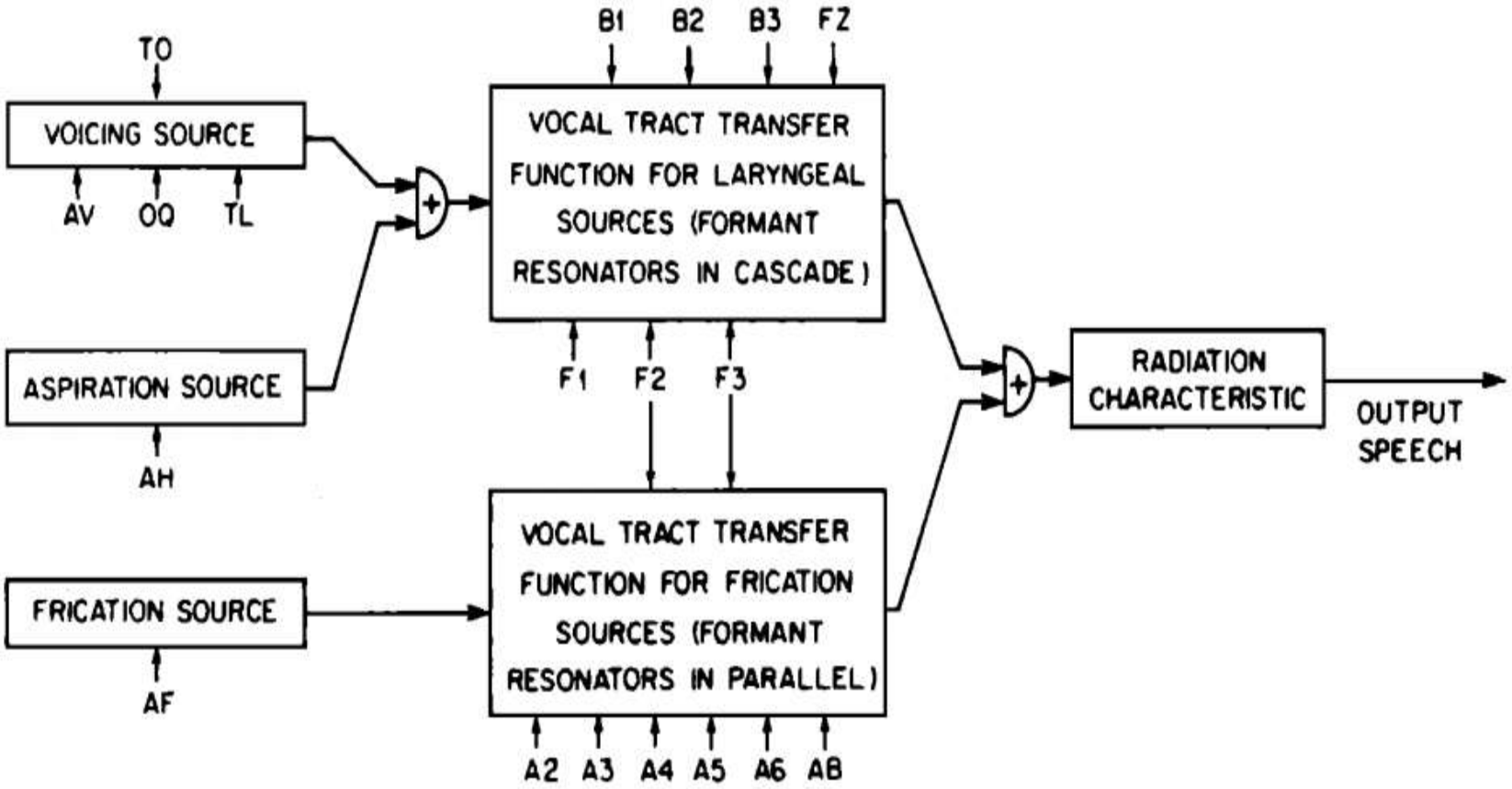

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- Limited Naturalness
  - Either the model is not correct
  - Or the control mechanism is not proper

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- Flanagan shows that the frequency locations and depths of spectral notches induced by source zeros depend on relatively small changes to critical aspects of the source waveform such as symmetry.
- Holmes didn't followed these details but followed changes observed in natural speech.

FEMALE VOICE SYNTHESIS

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- Simple scaling procedures do not result in a particular female voice quality, non-uniform formant scaling appears to be required.
- Analysis of female speech revealed the presence of considerable random breathiness noise above 2KHz & considerable variation in tilt and f_0 magnitude.
- Klattalk model achieved good approximation to female voice for vowels.

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- For breathy vowels [hv], many of the voiced intervals revealed additional formant peaks and other harmonic amplitude discrepancies.
- Presumably related to acoustic coupling with the tracheal resonances when the glottis is partially open.

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- Synthesizer augmented with extra tracheal pole-zero pair has met with some success..
- Alternatively employ articulatory model of the trachea, vocal folds and vocal tract as well as their interactions in an articulatory synthesizer.