Dept. for Speech, Music and Hearing
Quarterly Progress and Status Report

Pole-zero matching of spectra of /l/

Mártony, J. and Fant, G.

journal: STL-QPSR
volume: 2
number: 1
year: 1961
pages: 001-002

KTH Computer Science and Communication

http://www.speech.kth.se/qpsr

I. SPEECH ANALYSIS

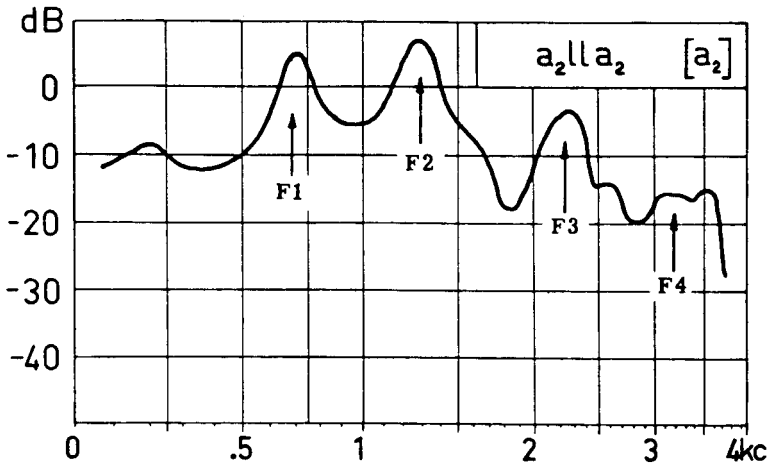
A. POLE-ZERO MATCHING OF SPECTRA OF [l]

Pole-zero matchings have been undertaken on spectral samples of the [l]-sound in intervocalic stressed position as spoken by Swedish subjects. These data have been related to the spectra and pole patterns of the particular vowels preceding the [l]-sound in the test words. Narrow-band spectral sections were first sampled with RASSLAN and the envelopes were drawn, see Fig. I-1 and I-2. The pole-zero matching started with a determination of the particular voice source. In [l]-segments the source of the preceding vowel was utilized as a first approximation.

The frequency of the first formant of the [l] ranges from 235 c/s to 375 c/s with the maximum value in the [a]-allophone of [l] and the minimum in the [I]-allophone. The frequency of the second formant ranges from 1250 c/s to 1600 c/s the maximum value pertaining to the [I]-allophone and the minimum to the [a]-allophone. The formant pattern of the [l] thus tends to deviate somewhat in a direction towards that of the adjacent vowel.

Of special interest in the present investigation is the presence of one zero and one extra pole in the mode spectrum of [l] compared with the adjacent vowel. The zero is found slightly below the third formant in [l]-allophones connected with a front vowel, but the zero is found slightly above the third formant in [l]-allophones connected with a back vowel. The extra pole increases the number of formants in the F_3- to F_5-region of [l] compared with the adjacent vowel. It is evident that the zero is attributable to the cavity bounded by the front part of the tongue and the palate behind the apex and that the extra pole is in part attributable to this cavity but is more or less dependent on the total cavity system.

The spectral effect of the additional pole and zero is to decrease the level of the third or second formant but to raise the level of the fourth formant.



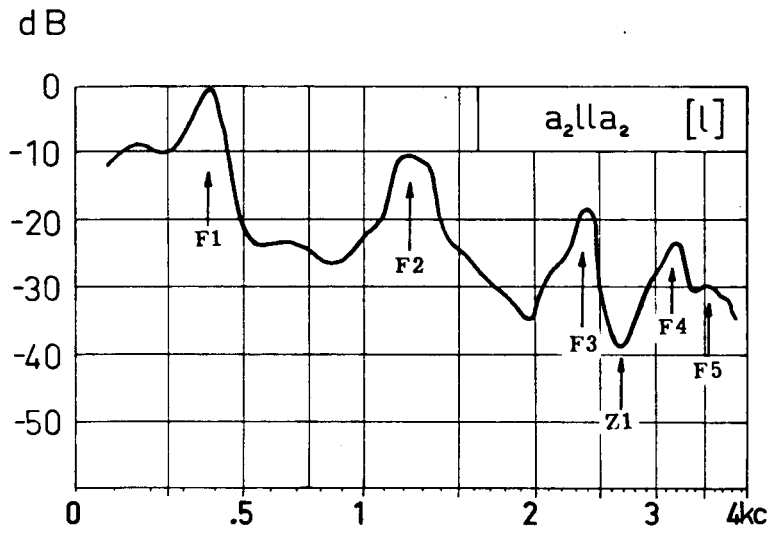
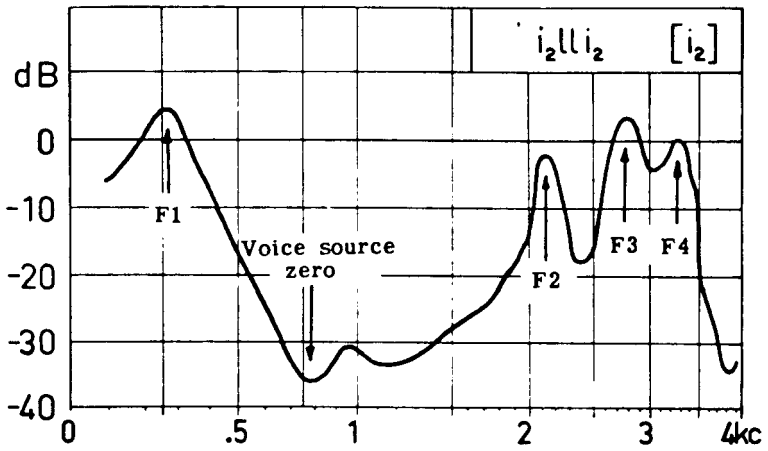


Fig. I-1 Spectrum envelopes drawn from narrow-band sections of an initially positioned [a] and the [l] of the test word [alla]. The frequency of the mouth cavity zero in the [l]-spectrum is indicated by Z1.



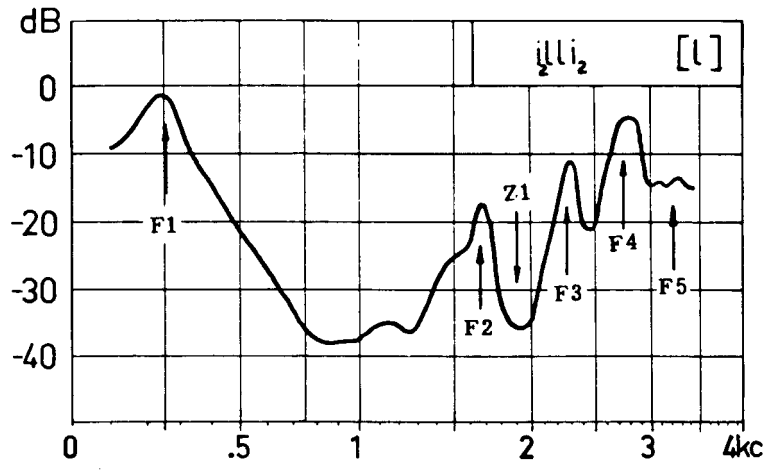


Fig. I-2 Spectrum envelopes drawn from narrow-band sections of an initially positioned [i] and the [l] of the test word [illi]. The frequency of the mouth cavity zero in the [l] -spectrum is indicated by Z1.

TABLE I-1.

Formant frequencies (F_1 F_2 F_3 F_4 F_5) and anti-resonance frequencies (Z_1) in [l]-sounds and associated vowels.

	F_1	F_2	F_3	F_4	F_5	Z_1
I	275	2050	2750	3250		
l	235	1600 1900	2300	2770	3260	1900
ɛ	550	1800	2700	3500		
l	290	1450 2000	2250	2700	3100	2000
a	700	1320	2280	3250		
l	375	1250	2400 2700	3250	3600	2700
ɑ:	270	1700	2130	3400		
l	265	1600	2380 2500	2900	3300	2500
ɒ	475	1690	2250	3600		
l	280	1475 2060	2280	2460	3250	2060

Formant bandwidths were of the order of B_1 = 50 c/s, B_2 = 80 c/s, B_3 = 110 c/s, B_4 = 180 c/s in vowels.

From our experience of speech synthesis it is quite feasible to remove the zero and its closest pole from the spectrum specification. A compensation for the lack of level in the fourth formant region does not appear to be important. Correct first and second formant transitions are of primary importance.

J. Mártony, G. Fant

(1) Fant, C.G.M.: "Acoustic Theory of Speech Production", 's-Gravenhage 1960, 323 pp.

(2) Fant, C.G.M.: "Descriptive Analysis of the Acoustic Aspects of Speech", to be publ. in LOGOS the Bulletin of the National Hospital for Speech Research.

(3) Holmes, J.N. and Kringlebotn, M.: "II.B. Synthesis Instrumentation", STL-QPSR-2/1960.