



## TRACKING OF SPEECH PARAMETERS USING ARMA ANALYSIS TECHNIQUES

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### ABSTRACT

For the development of high performance text-to-speech systems, as well as for the implementation of feature based Automatic Speech Recognition systems accurate tracking of speech parameters like fundamental frequency and formant frequencies and bandwidths is essential. Moreover, applications will benefit if the results of the parameter tracking may be interpreted in a way that appeals to phoneticians. In the case of formant parameters this means that 'formants' preferably should mean 'vocal tract resonances', rather than mere spectral maxima.

It is well known that many (and for some speakers perhaps almost all) speech sounds are characterized by vocal tract zeros in addition to poles. It is also known that these zeros may affect the pole positions provided by an all-pole analysis technique like LPC to such an extent that the mapping of poles to vocal tract resonances (or formants) is no longer warranted. None of the solutions of this problem proposed in the past has been completely satisfactory. This includes ARMA analysis techniques, that should ideally solve the problem, but that appear to suffer from a number of practical difficulties. Perhaps the most important problem precluding the large scale application of ARMA analyses (besides the high computational cost) is the fact that the interpretation of the analysis results in terms of vocal tract resonances and anti-resonances is still not straightforward.

In our contribution we will first outline an ARMA analysis technique that provides stable results in steady state speech signals. Next we will describe techniques for estimating the actual pole and zero order of the production system from the analysis results. Finally, we will present techniques for interpreting poles and zeros in terms of vocal tract resonances and contributions from the voice source by applying the ARMA analysis to voiced sounds taken from a signal database in which simultaneous recordings of many aspects of the physiology of the larynx are available along with the acoustic speech signal.

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