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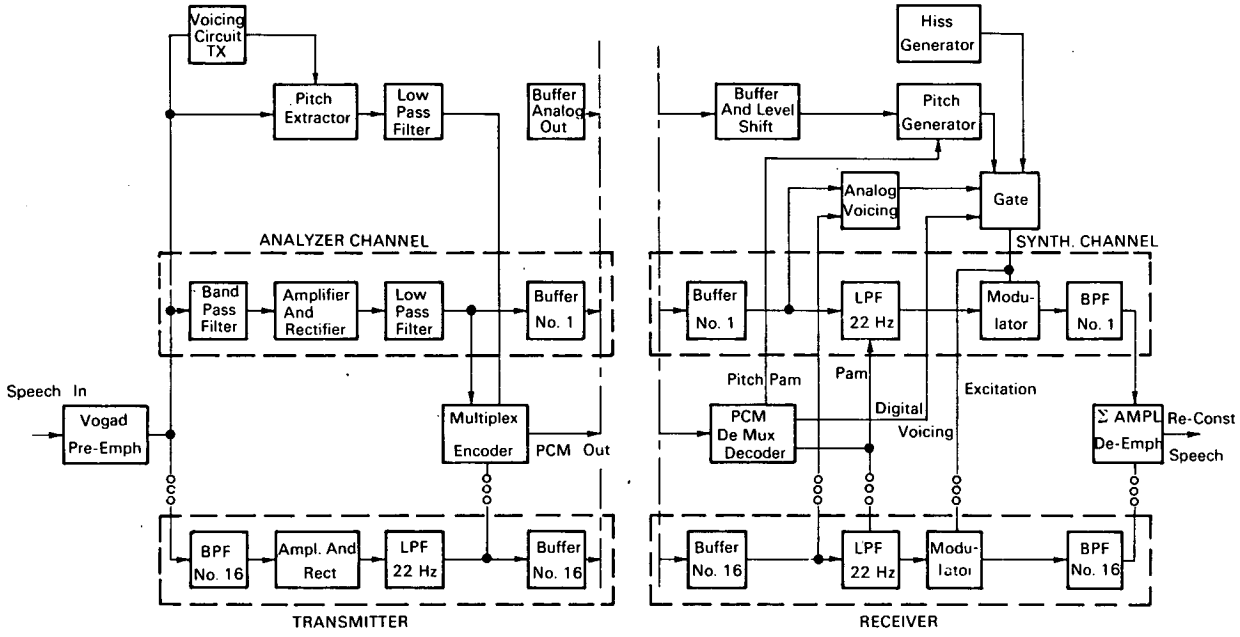
Analog Voicing Detector Responds to Pitch



An existing, commercially available electronic voice encoder (Vocoder) has been modified to include an independent analog mode of operation in addition to the conventional digital mode. The Vocoder is a bandwidth compression equipment that permits voice transmission over channels having only a fraction of the bandwidth required for conventional telephone-quality speech transmission.

Referring to the diagram, the essential elements of a channel Vocoder consist of a voice operated gain adjustment (Vogad), a pitch extractor, and a bank of (N) contiguous bandpass filters each followed by an envelope detector. The Vogad maintains a relatively constant level to the analyzers regardless of the voice, and therefore, drives the analyzers at essentially the same level for all speakers. The envelope detector in each analyzer channel provides a low frequency parameter, commonly limited to 22 Hz variations, representing the speech energy in that frequency band. In some channel Vocoders, there are 16 such frequency bands covering the speech frequency range from 200 Hz to 4 kHz.

The pitch extractor develops an analog voltage proportional to the fundamental pitch frequency of the speech waveform during voiced sounds, this voltage being limited to variations at approximately the syllabic rate of 22 Hz. The total analog bandwidth is then 22 Hz × N+1 parameters, or 374 Hz. In the receiver, the analog parameters are modulated by an excitation source in the form of a voltage-controlled

(continued overleaf)

oscillator that is controlled by the pitch signal. Unvoiced sounds are modulated by hiss which is gated in when the pitch signal is zero. The resulting signals are bandpass filtered in a set of contiguous filters, identical to those used in the analyzer, and then summed to form a facsimile of the original speech waveform.

For nominal digital operation, the low frequency parameters are time-division multiplexed to form a pulse amplitude modulated (PAM) signal that is then encoded in a binary manner for transmission in a pulse code modulated (PCM) system. The N+1 channel signals are sampled at 44.4 Hz to conform to the Nyquist sampling criterion and encoded in a 3-bit code. The pitch is encoded more accurately in a 6-bit code, resulting in a data rate of 2400 bps. Generally, one of the 16 channels is encoded in 2 bits and the remaining bit is used as a reference for synchronization. A PCM decoder in the receiver converts the PCM back to PAM form which is demultiplexed into the proper channels.

Notes:

1. Using a delta modulation technique, the Vocoder can operate at 1200 bps though there is a sacrifice in intelligibility and quality of the reconstructed signals. The PCM is readily adaptable to secure transmission; because of the nature of the signal, it is easily encrypted by combining with a preselected digital key.
2. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: B67-10571

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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