Hamming and Accumulator Codes Concatenated With MPSK or QAM

Multiple constituent codes would be utilized in a high-speed parallel architecture.

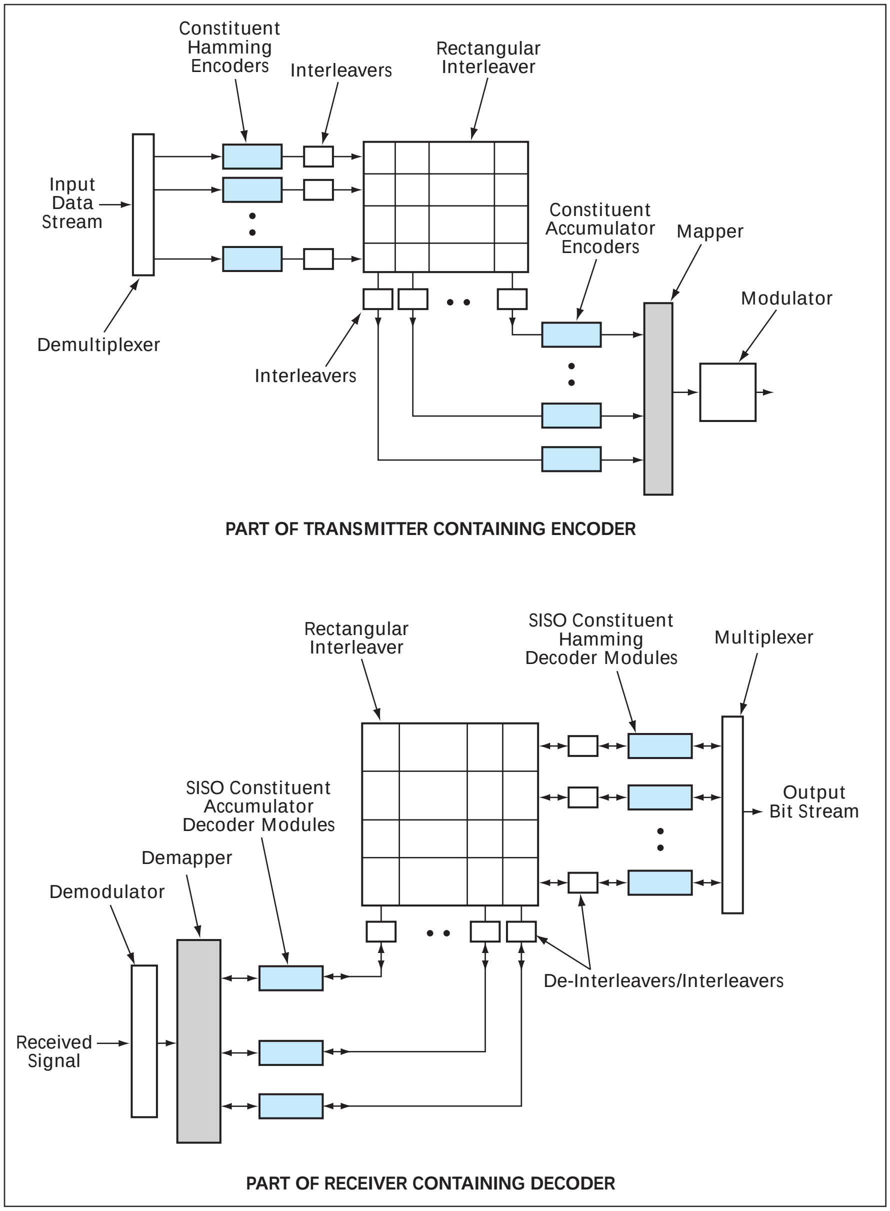
NASA's Jet Propulsion Laboratory, Pasadena, California

In a proposed coding-and-modulation scheme, a high-rate binary data stream would be processed as follows:

1. The input bit stream would be demultiplexed into multiple bit streams.
2. The multiple bit streams would be processed simultaneously into a high-rate outer Hamming code that would comprise multiple short constituent Hamming codes — a distinct constituent Hamming code for each stream.
3. The streams would be interleaved. The interleaver would have a block structure that would facilitate parallelization for high-speed decoding.
4. The interleaved streams would be further processed simultaneously into an inner two-state, rate-1 accumulator code that would comprise multiple constituent accumulator codes — a distinct accumulator code for each stream.
5. The resulting bit streams would be mapped into symbols to be transmitted by use of a higher-order modulation — for example, M-ary phase-shift keying (MPSK) or quadrature amplitude modulation (QAM).

The novelty of the scheme lies in the concatenation of the multiple-constituent Hamming and accumulator codes and the corresponding parallel architectures of the encoder and decoder circuitry (see figure) needed to process the multiple bit streams simultaneously. As in the cases of other parallel-processing schemes, one advantage of this scheme is that the overall data rate could be much greater than the data rate of each encoder and decoder stream and, hence, the encoder and decoder could handle data at an overall rate beyond the capability of the individual encoder and decoder circuits. A less-obvious advantage is that the scheme would utilize bandwidth efficiently and would make it possible to reduce transmitter power by about 2 dB without exceeding a given bit-error rate for the best prior coding-and-modulation scheme.

In one instantiation of the scheme, the outer code would consist of 372 Hamming codes characterized by a block length of 15 symbols, of which 11 would be information symbols [denoted a (15,11) code in the art]. The inner code would consist of 15 rate-1, two-state accumulator codes of block length 372. The parallel nature of the interleaver would enable the permutation of the 15 symbols of each of the 372 Hamming code words by 372



The **Encoder and Decoder** would concatenate and interleave an outer set of parallel constituent Hamming codes with an inner set of parallel constituent accumulator codes.

independent interleavers, and the 15 groups of 372 Hamming symbols would be permuted by 15 independent interleavers before being fed to the 15 accumulators. This code structure at the transmitter would enable the use, in the receiver, of a high-speed iterative decoder that could include 372 soft-input, soft-output (SISO) modules to decode the 372 constituent Hamming codes in parallel and 15 SISO modules to decode the 15 constituent accumulator codes in parallel. Hence, the overall decoder could have a parallel architecture.

This work was done by Dariush Divsalar and Samuel Dolinar of Caltech for NASA's Jet Propulsion Laboratory. For further information, contact iaoffice@jpl.nasa.gov. NPO-40678

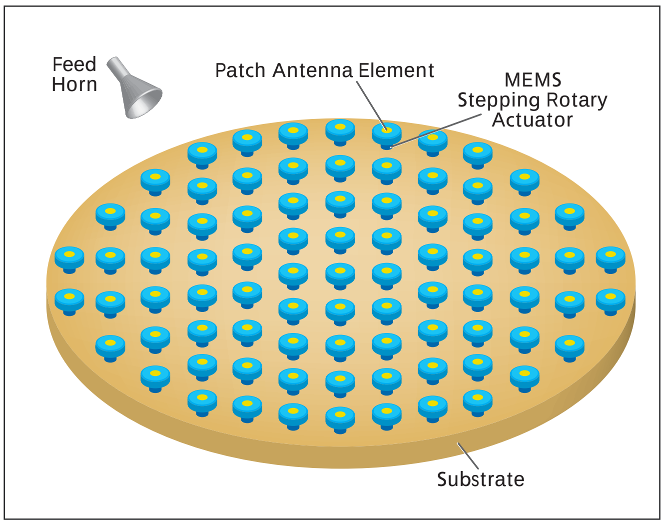
Wide-Angle-Scanning Reflectarray Antennas Actuated by MEMS

These could be simpler, cheaper alternatives to electronically scanned phased-array antennas.

NASA's Jet Propulsion Laboratory, Pasadena, California

An effort to develop large-aperture, wide-angle-scanning reflectarray antennas for microwave radar and communication systems is underway. In an antenna of this type as envisioned, scanning of the radiated or incident microwave beam would be effected through mechanical rotation of the passive (reflective) patch antenna elements, using microelectromechanical systems (MEMS) stepping rotary actuators typified by piezoelectric micromotors. It is anticipated that the cost, mass, and complexity of such an antenna would be less than, and the reliability greater than, those of an electronically scanned phased-array antenna of comparable beam-scanning capability and angular resolution.

In the design and operation of a reflectarray, one seeks to position and orient an array of passive patch elements in a geometric pattern such that, through constructive interference of the reflections from them, they collectively act as an efficient single reflector of radio waves within a desired frequency band. Typically, the patches lie in a common plane and radiation is incident upon them from a feed horn. Certain phase-sensitive types of such elements can be clocked to predetermined angles, relative to those of their neighbors, to modify the phase of the radiation incident from the feed horn and reflected from the elements so as to, for example, make the a flat array of patches act as though it were a parabolic reflector.



Passive Patch Antenna Elements in an array would be mounted on shafts of MEMS stepping rotary actuators that, in turn, would be mounted on a common substrate. The patch elements would be circularly polarized, and would be phase-sensitive in the sense that each would alter the phase difference between incident and reflected radiation by an amount that would depend on the actuator shaft angle.

Another reflectarray characteristic, essential to the present development, is that if the patch elements are rotated in unison, then the beam radiated by the antenna can be steered in elevation and azimuth through angular displacements of as much as ±50°. In an antenna of the type under development, the patch elements would be phase-sensitive in the sense mentioned above, would be circularly polarized, and would be mounted on the shafts of MEMS stepping rotary actuators (see figure). The maximum range of element rotation needed for wide-angle beam scanning would be only about ±180°, and scanning could be effected by use of relatively coarse rotational steps.

This work was done by Houfei Fang, John Huang, and Mark W. Thomson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). ***NPO-45971***

Biasable Subharmonic Membrane Mixer for 520 to 600 GHz

This is a prototype of mixers for future submillimeter-wavelength spectrometers.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure shows a biasable subharmonic mixer designed to operate in the frequency range from 520 to 600 GHz. This mixer is a prototype of low-power mixers needed for development of wideband, high-resolution spectrometers for measuring spectra of molecules in the atmospheres of Earth, other planets, and comets in the frequency range of 400 to 700 GHz.

Three considerations dictated the main features of the design:

- It is highly desirable to operate the spectrometers at or slightly below room temperature. This consideration is addressed by choosing Schottky diodes as the frequency-mixing circuit elements because of all mixer diodes, Schottky diodes are the best candidates for affording sufficient sensitivity at or slightly below room-temperature range.