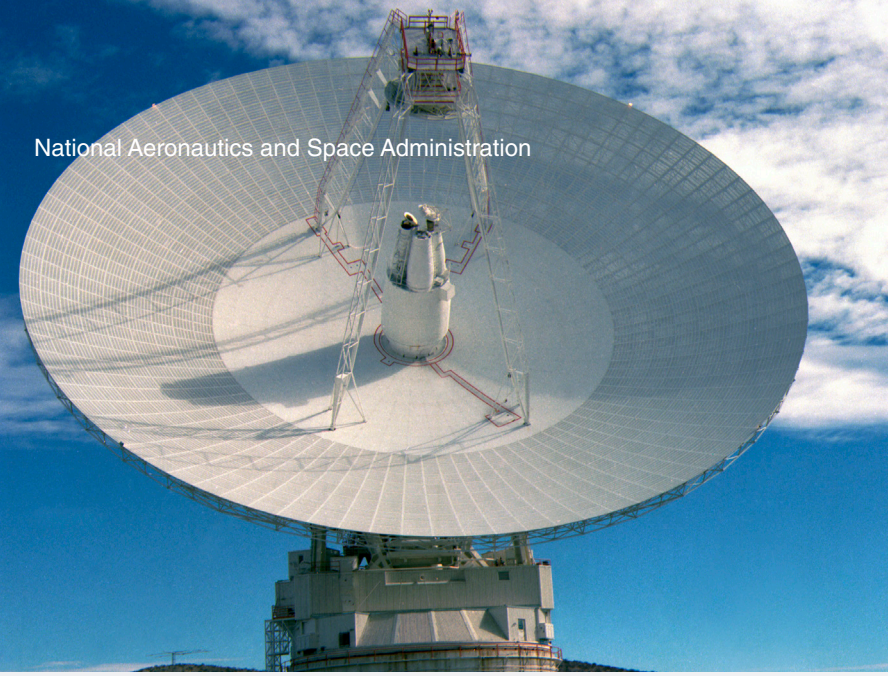


Communications

Accumulate-Repeat-Accumulate-Accumulate Codes

A family of ARAA codes for a low-cost, high-speed, high-performance decoder implementation

NASA's Jet Propulsion Laboratory has developed an Accumulate-Repeat-Accumulate-Accumulate (ARAA) channel coding scheme that enables communication at relatively low received signal-to-noise ratios and provides very high power efficiency. Channel coding—encoding information in a redundant manner—is a cost-effective method for controlling errors in data transmission over unreliable or noisy communication channels. JPL's ARAA codes can be programmed for specific applications, making them ideal for use in power- and bandwidth-constrained transmission channels such as deep-space and one-way communications. This reliable, high-speed, and high-performance coding scheme has an extremely low error floor and can be implemented with existing technology at low cost.

BENEFITS

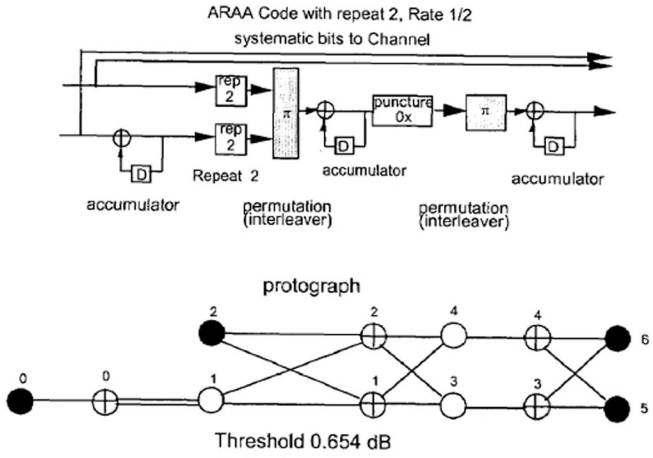
- Cost-effective for controlling errors in data transmission over unreliable or noisy communication channels
- Flexible, reliable, and ideal for use in power- and bandwidth-constrained transmission channels
- Very high power efficiency at all code rates
- Low-error flloor—bit error rate < 10-9

technology solution

THE TECHNOLOGY

JPL's ARAA codes belong to a specific class of forward error correcting codes that achieve near-Shannon limit performance over a wide range of code rates and data frame sizes. This ARAA coding scheme concatenates an accumulator as inner code with an Accumulate-Repeat-Accumulate (ARA) with repetition 2 as outer code for a greater minimum distance that is well-suited for low error floor applications. These codes possess a minimum distance that grows as block length increases, and thus they provide better performance at high signal-to-noise ratios (SNRs) than standalone ARA codes (their minimum distance does not grow with block length). JPL's codes are particularly advantageous because they have protograph representation: this allows for high-speed iterative decoder implementation using belief propagation.

Prototype ARAA codes have been constructed in field programmable gate arrays and tested for performance. The prototypes permit encoding, the addition of corruptive noise, and decoding with a throughput in excess of 10 Mbits/second. The threshold SNR for these protographs—the minimum SNR per bit that still allows reliable communication—is within 0.28 dB of the channel capacity, which indicates performance comparable with the best-known low-density parity-check codes but with very low error floor, even at moderate block lengths.



Accumulate-Repeat-Accumulate-Accumulate code. The concatenation of an accumulator as inner code with an ARA with repetition 2 as outer code provides a greater minimum distance than ARA codes and better suitability for low error floor applications.

APPLICATIONS

The technology has several potential applications:

Aerospace – reliable deep space communications

Bandwidth-constrained transmission channels – fixed and mobile wireless channels, cable modem and digital subscriber line systems

Hard disk drive systems – mass storage, data compression

PUBLICATIONS

U.S. Patent 7,343,539

More Information

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