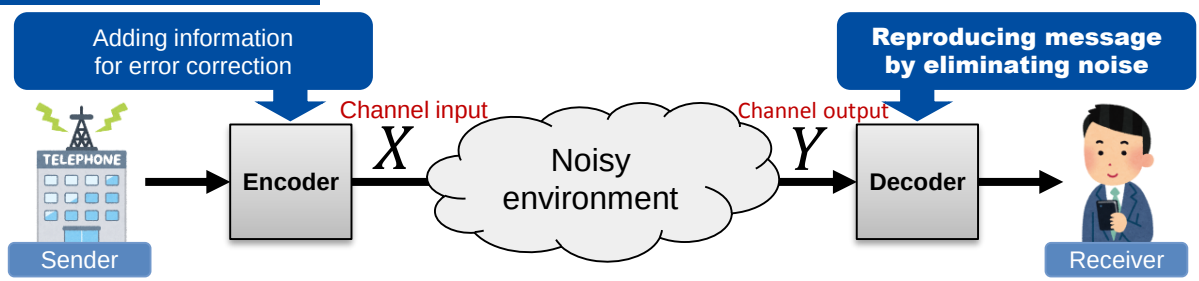
08 We can transmit messages to the efficiency limit

- Error correcting code achieving the Shannon limit -

Abstract

For the realization of high-speed digital communication, it is necessary transmitting messages reliably with high efficiency under noisy environment. The limit of efficiency is derived by a computer scientist C. E. Shannon and it is called the Shannon limit. It is known that we can achieve the limit for a paticular class of channels with LDPC (Low Density Parity Check) codes or the Polar codes, which are used in the 5G mobile communication technology. However, it is impossible to achieve the limit for a general class of channels with these codes. We propose a novel technology called CoCoNuTS (Code based on Constrained Numbers Theoretically-achieving the Shannon limit). With this technology, we can constuct a code achieving the Shannon limit for a general class of channels. Our goal is realizing future high-speed digital communication by establishing related peripheral technologies.

Error Correcting Code

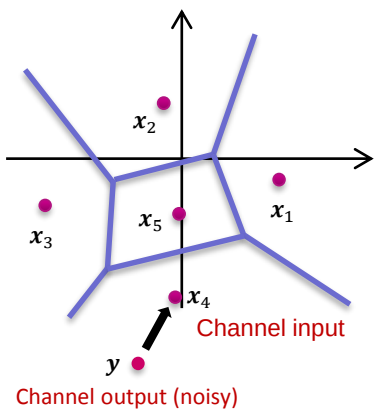


Efficiency＝(no. of message symbols)/(no. of transmitted signals)

We want to maximize efficiency to the Shannon limit.

Essence of proposed technology

Geometric illustration



Difficulty in encoding and decoding

- To achieve the Shannon limit, it is necessary to place channel inputs $\{x_i\}$ efficiently (as far as possible in the left figure).
- When the optimum distribution of a channel input X is uniform, we can achieve the limit with LDPC codes or the Polar codes. However, when the optimal input distribution is not uniform, it is impossible to achieve the limit by using these codes.
- In the naïve decoding method, we have to guess a channel input from a channel output (x_4 from y in the left figure) by using the brute-force search, which is impractical.

Proposed technology

- We can realize an ideal layout of channel inputs by using the constrained-random-number generator.
- We can avoid the brute-force search by using the constrained-random-number-generator, which provides a practical decoding method.

References

[1] J. Muramatsu, “Channel coding and lossy source coding using a generator of constrained random numbers,” *IEEE Transactions on Information Theory*, Vol. IT-60, No. 5, pp. 2667-2686, May 2014.

[2] J. Muramatsu, S. Miyake, “Channel code using constrained-random-number generator revisited,” *IEEE Transactions on Information Theory*, Vol. IT-65, No. 1, pp. 500-508, Jan. 2019.

Contact

Jun Muramatsu Email: cs-liaison-ml at hco.ntt.co.jp

Learning and Intelligent Systems Research Group, Innovative Communication Laboratory

Innovative R&D by NTT

Open House 2019