Infinite-Rate Transmission in Noisy Environments via Modulation and Demodulation

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Abstract

In this paper, based on the method for error-free transmission at infinite rate in noisy environments proposed in the preceding study [1], combined with analog communication methods, a modulation and demodulation method that may be required for engineering implementation is proposed.

Index Terms

Information Theory, Transmission Limits, Simulated communication, Modulation

I. Introduction

In transmission processes, enhancing the error-free transmission rate in noisy environments has been a major research direction. In this paper, a new method for infinite-rate transmission in noisy environments, based on previous research [1], is presented, along with modulation and demodulation techniques. This provides a practical approach for achieving error-free communication with infinite rates in noisy environments.

II. Principles of mathematics

We need to transmit n ($n \longrightarrow \infty$)binary numbers simultaneously, we just need to find a set of n numbers: $N = \{a_1, a_2, ..., a_n\}$. The sum of elements in all subsets of N must be distinct. Specifically, for any two subsets A and B of N, $\sum_{a\in A} a \neq \sum_{b\in B} b$.

To construct such a set N, it is necessary to ensure that each element in the set grows sufficiently fast. Specifically, the k-th element should be greater than the sum of the previous k-1 elements in the set,namely: $N\{k\} > \sum_{i=1}^{k-1} N\{i\}$. It is evident that each new element is greater than the sum of all previous elements, thus ensuring that the sum of any subset including the new element will be greater than any previous sum, and all sums will be distinct.Moreover, by increasing the spacing between elements in the set N, the influence of noise can be ignored during decoding, and this can also be achieved in a noisy environment.

III. Principle of communication

In [1], by employing a transfer function of the form $f(t) = \sin t + b$, we simply adopt $f(t) = t + b$. Since this approach enables theoretically unbounded transmission rates in noisy environments, there is no need to consider noise immunity during modulation, and AM modulation [2] can be used to reduce bandwidth occupancy. Compared with angle modulation, the method in [1] is inherently unaffected by noise, eliminating the need to sacrifice bandwidth efficiency for noise immunity.

In the time domain, $s(t) = m(t)\cdot c(t) = m(t)\cdot \left[A_c \cos(\omega_c t + \varphi_c) + \frac{1}{2}(\max(m(t)) + \min(m(t)))\right]$. In this manner, a modulation method for unbounded-rate transmission in a noisy environment with low power and low frequency-band occupancy is achieved in the time domain. In the frequency domain, the corresponding Fourier spectrum of s(t)$s(t)$ is given by

$$\begin{aligned} S(f) &= M(F) * C(f) = M(f) * \frac{A_c}{2}\left[\delta(f-f_c) + \delta(f+f_c)\right] + \pi * \delta(max(m(t)) + min(m(t))) \\ &= \frac{A_c}{2}\left[M(f-f_c) + M(f+f_c)\right] + \pi * \delta(max(m(t)) + min(m(t))) \end{aligned}$$

. At the receiver, demodulation can be performed using conventional analog communication methods, such as envelope detection.

IV. Conclusion

Reference [1] proposed a method for error-free transmission with unbounded rates in noisy environments. However, in practice, achieving truly unbounded or even infinite-rate error-free transmission faces many limitations. In contrast to classical information theory [3],In this paper, an AM-based modulation scheme derived from that method is presented, which can leverage frequency-division techniques to more effectively realize rate enhancement, ultimately overcoming the upper-limit constraints of error-free information transmission in noisy environments.

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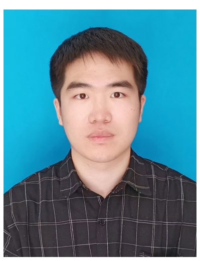

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