The Method of Infinite Channel Capacity for Single Channels

Jian Sun[1,*]

[1*]QingHua New Energy Automobile Co., LTD, Tsinghua University Yangtze River Delta Research Institute, , 314000, ZheJiang, China.

Corresponding author(s). E-mail(s): 18816269268@163.com;

Abstract

In modern communication systems, increasing channel capacity has always been a central objective. Since channel capacity is positively correlated with bandwidth and signal-to-noise ratio (SNR), it is generally bounded for a fixed bandwidth and fixed transmit power. In this paper, a novel theory aimed at breaking the conventional capacity limit of a single communication channel is proposed. The approach employs multiple transmitters at the sending end and a single receiver at the receiving end. By leveraging sets of sequences with distinct subset sums and sinusoidal transmission schemes, it is shown theoretically that the channel capacity of a single link can be increased indefinitely.

Keywords: information theory, channel capacity, communications

1 Introduction

In information theory [1], increasing the channel capacity is a problem of fundamental importance. Conventional approaches to capacity optimization have predominantly focused on enhancing the signal-to-noise ratio (SNR). In this paper, we propose a novel communication scheme employing multiple transmitters and a single receiver. By integrating the concept of sets with distinct subset sums with sinusoidal transmission techniques, we demonstrate that the conventional capacity limit of a single communication link can, in theory, be surpassed, potentially allowing the channel capacity to be increased indefinitely.

2 Principles of Mathematics

2.1 Sets with Distinct Subset Sums

We need to simultaneously use n transmitters to transmit n ($n \to \infty$ binary numbers. We only need to find a set of n numbers: $N = \{a_1, a_2, ..., a_n\}$,which must satisfy that the sums of elements in all subsets of N are distinct. That is, for any two subsets A and B of N, $\sum_{a \in A} a \neq \sum_{b \in B} b$.

To obtain such a set N, it is necessary to ensure that each element in the set grows sufficiently rapidly. One may choose a set where the k-th element is greater than the sum of the first k-1 elements, namely, $N\{k\} > \sum_{i=1}^{k-1} N\{i\}$. It is straightforward to see that each new element is larger than the sum of all previous elements. Therefore, after adding it, every new sum will be greater than any previous sum, and all sums will be distinct.

2.2 Sinusoidal Function Transmission Method

The sine function $f(t) = \sin t + b$ is selected. When n sine functions are simultaneously transmitted over a single channel, the signal received at the receiver is $F(t) = n \sin t + b_{total}$, where $b_{total} = \sum_{i=1}^{n} b_i$.

3 Principles of Communication

We use n transmitters to send signals to a receiver. When the spacing between transmitters is sufficiently small, it can be assumed that the n transmitters share the same channel when transmitting information.

For simplicity, we consider the case where n = 3. A set $N : \{a_1, a_2, a_3\} = \{1, 2, 4\}$ with the property that the sums of all its subsets are distinct is selected. The collection of all subsets of N forms a set $Ns : \{\{\phi\}, \{a_1\}, \{a_2\}, \{a_3\}, \{a_1, a_2\}, \{a_1, a_3\}, \{a_2, a_3\}, \{a_1, a_2, a_3\}\}$, and the set of sums of all subsets forms a set $Nsum : \{0, 1, 2, 4, 3, 5, 6, 7\}$. Suppose the transmitters send the sequence 101 at a certain time instant. Then:

Transmitter 1: $f_1(t) = \sin t + b_1$, where $b_1 = 1 \times a_1 = 1$;

Transmitter 2: $f_2(t) = \sin t + b_2$, where $b_2 = 0 \times a_2 = 0$;

Transmitter 3: $f_3(t) = \sin t + b_3$, where $b_3 = 1 \times a_3 = 4$.

Thus, the total signal on the channel at this time instant is $f_{total}(t) = 3 \sin t + b_1 + b_2 + b_3 = 3 \sin t + 5$. After receiving the signal at this instant, the receiver obtains b = 5. By mapping to N_s and N_{sum} , it can be determined that 5 corresponds to $\{a_1, a_3\}$, namely, $a_1, a_3 = 1$, $a_2 = 0$, and the decoded sequence is 101.

By combining the method based on sets with distinct subset sums and sine functions, three transmitters are used to send three sine waves of the same frequency and phase, each carrying a different y-axis offset. After overlapping on the same channel, the signals are decoded at the receiver for all three transmitters. At this point, according to the channel capacity formula $C = Blog(1 + \frac{S}{N})$, since the three signals overlap, the signal energy is enhanced by a factor of three, while the noise on the channel remains unchanged. Thus, the signal-to-noise ratio (SNR) is improved by a factor of three. When $n \to \infty$, the SNR is improved infinitely, and the channel capacity can approach infinity. The cost required for this is that the set N and the corresponding N_s and N_{sum} will expand accordingly and tend to infinity.

4 Conclusion

By using a set with distinct subset sums and the sine function transmission method, simultaneous transmission of multiple signals from multiple transmitters to a receiver on a single channel is achieved. Furthermore, it is demonstrated that this method increases the channel capacity, theoretically allowing the channel capacity to approach infinity.

References

[1] C. E. Shannon, "A mathematical theory of communication," *Bell Syst. Tech. J.*, vol. 27, no. 3, pp. 379–423, Jul. 1948.