

# A New Electronic Jamming Method Inspired From Bionics System

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**Abstract**—With the development of electronic countermeasures, traditional jamming methods have been unable to meet the current development of electronic countermeasures. Combined with the transmission characteristics of epidemic viruses, it has LPD (low probability detected), high infectivity, low amount of information, strong destructive or destructive, and active evolution or mutation during the transmission process. And other characteristics, so that it can quickly be widely spread among humans around the world. Through the study of "viral transmission characteristics", the process of biological jamming with the human immune system is transferred to the field of electronic jamming, and a method based on "cognitive electronic jamming" is proposed to make up for the defects of existing electronic jamming. In this paper, through the detection of radar detection signals and the adaptive sensing method of the surrounding environment, the jammer can realize the real-time environmental awareness and complex electromagnetic jamming function of the active detection radar, so as to improve the survivability of the jammer in electronic warfare. Finally, simulations verify that the electronic jamming method has excellent characteristics in terms of propagation, concealment, autonomous environment perception and evolution.

**Keywords** - Cognitive Electronic Jamming; Environmental Perception; Latency; LPD (Low Probability Detected)

## I. INTRODUCTION

Traditional electronic jamming methods are mainly divided into two methods: suppression jamming and deception jamming. The suppression jamming is mainly through high-power jamming to the intercepted signal, so that the effective signal is completely annihilated in the suppression noise, resulting in the effective signal cannot be detected. Deception jamming is deceived individually or jointly by distance, speed, etc. through digital radio frequency memory (DRFM) modulation, forwarding and other modulation methods to achieve the jamming effect on the target signal of the receiver. However, with the development of anti-jamming technology, electronic jamming with a single characteristic can no longer meet the needs of modern jamming systems. Under certain prior information, the transceiver signal source has been able to identify the jamming with a single characteristic with a high probability and target the jamming characteristics. Electronic jamming and anti-jamming technology are developing all the time. Combining the transmission characteristics of the new

coronavirus that broke out in humans around the world which with the characteristics of rapid transmission, strong infectivity, long incubation period, non-infection characteristics, small amount of information, strong destructiveness, and ability to evolve and learn independently. Therefore, it is necessary to develop a brand-new "cognitive jamming" model [1-2] with autonomous and evolutionary functions to solve the shortcomings and weaknesses of the existing electronic jamming by combining the bionics with the transmission characteristics of the new coronavirus to achieve the best jamming effect of electronic jamming.

## II. TRADITIONAL ELECTRONIC JAMMING METHODS

Traditional electronic jamming methods mainly include two methods: suppression jamming and deception jamming. The schematic diagram is shown in Figure 1 [3].

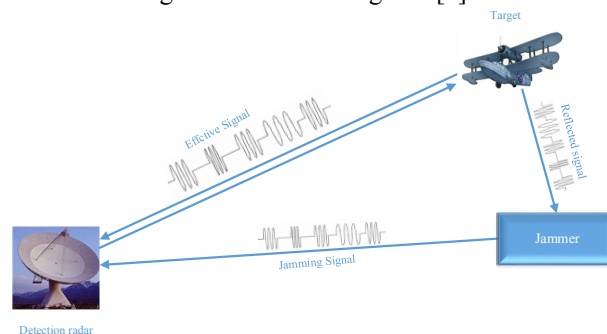


Figure 1. Electronic jamming system model

The suppression jamming mainly uses the reconnaissance system to perform high-power pulse or noise jamming on the received signal, so that the effective signal in the system is annihilated in the suppression jamming noise, and the radar receiver cannot identify the effective signal from the received signal. Figure 2 shows the types of suppression jamming.

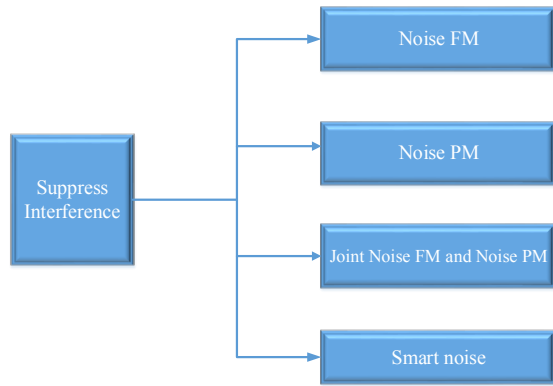


Figure 2. Types of suppression jamming

The deception jamming mainly uses jammers to modulate and forward the active detection signal received by the jammer to achieve the jamming effect on the target signal, and finally jam the quality of the effective signal received by the radar receiver, thereby achieving the purpose of deception. Figure 3 shows the types of deception jamming.

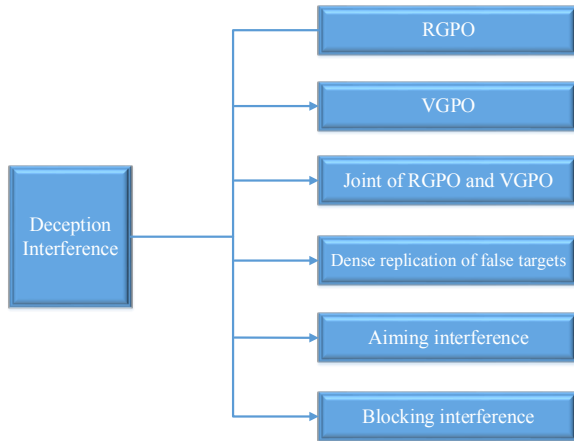


Figure 3. Types of deception jamming

### III. CHARACTERISTICS OF NEW JAMMING MODEL

Traditional jamming methods usually use a single feature for jamming. With the development of anti-jamming technology, it has been possible to identify the jamming type mode and parameters, and after identifying the jamming, the radar transmitter signal transmission strategy changes and decisions are made. Therefore, in the complex In the electromagnetic countermeasure environment, it is necessary to find a more effective new cognitive electronic jamming method to make the jamming effect more concealed and better.

#### A. Analysis of Virus Characteristics

Coronavirus is a type of single-stranded RNA (ribonucleic acid) virus that exists widely in nature[4]. It is named after the shape of this type of virus is observed under the electron microscope, which is similar to the corona-like spinous process or crown. Coronavirus can cause human and

animal respiratory tract, digestive tract, liver and nervous system diseases, and some coronavirus infections can cause zoonotic diseases[5-7].

Coronavirus has a great destructive effect on the human immune system, and its characteristics mainly include the following aspects[8-10]:

(1) Long incubation period: The incubation period of the new coronavirus is relatively long, up to about 2 to 14 days, which makes the immune system difficult to detect and has strong concealment;

(2) Highly contagious: The new coronavirus is relatively contagious, mainly spread by droplets or aerosols.

(3) Actively Evolution: The RNA chain of the virus can evolve autonomously with the host environment changing.

#### B. Cognitive Jamming System

The in-depth understanding of the working mechanism of the new coronavirus can make better use of its biological characteristics. The five points summarized in Section 3.1 are the remarkable transmission characteristics of the coronavirus, electronic jamming and the new coronavirus. The action process and purpose of the system are the same. The ultimate purpose is to infect (interfere) the attacked system and cause the attacked system to be paralyzed or unable to work normally. Based on the transmission characteristics of the new coronavirus, using the principle of bionics, learning the biological characteristics of the virus, and migrating it to the field of electronic jamming, to realize the design of a new cognitive electronic jamming system based on "viral-like transmission", so that the jamming system have certain autonomous perception and adaptability, cognitive characteristics[11-13]. The jamming system with cognitive characteristics is shown in Figure 4.

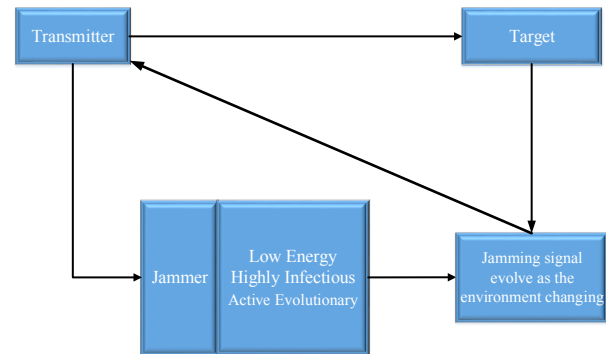


Figure 4. Electronic jamming system with cognitive characteristics

Figure 4. is a jamming system model with cognitive characteristics. After the jammer intercepts the effective signal transmitted by the radar transmitter, it sends a very similar signal to the receiver. The main characteristics of the signal are: relatively low energy and strong concealment It can quickly enter the core system after entering the receiver system. It is also highly destructive, and can evolve independently according to the target environment, so as to achieve "harmonious coexistence" with the target environment, and finally achieve efficient jamming and devastating strikes on the interfered target.

#### IV. COGNITIVE JAMMING SYSTEM DESIGN

##### A. Cognitive Jamming Adaptive Energy-aware

This article uses the intrusion process model of the virus to destroy the human immune system to effectively interfere with the target object against deceptive jamming. At the same time, under the premise of the limited power of the jammer itself, with the goal of saving resources, the power used by the interfered object should be used as much as possible. It may be small, and the goal of optimal jamming decision-making is accomplished at the least cost. Figure 5 is a flow chart of dynamic perception and real-time feedback of the received signal environment during the cognitive jamming process.

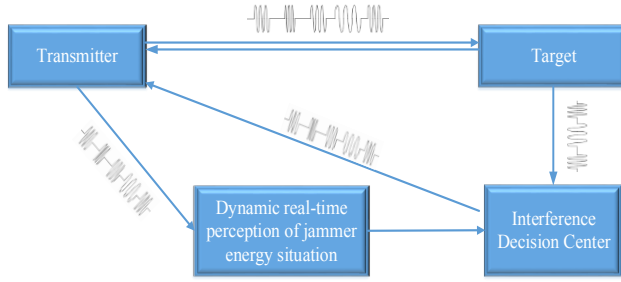


Figure 5. The dynamic real-time perception process of the jammer's energy situation

The radar transmits the signal, and the power of the received target echo signal is shown in the following formula:

$$S = \frac{P_t G_t^2 \sigma \lambda^2 L_t}{(4\pi)^3 R_t^4} e^{-2\alpha R_t} \quad (1)$$

The power of the jamming signal received by the radar is as follows:

$$J = \frac{P_j G_j \lambda^2 G_t(\theta)}{(4\pi R_j)^2} \cdot \frac{B_r}{B_j} L_j r_j e^{-2\alpha R_j} \quad (2)$$

The signal jamming ratio is shown in the following formula:

$$\frac{S}{J} = \frac{R_j^2}{4\pi R_t^2} \cdot \frac{B_j}{B_r} \cdot \frac{P_t G_t}{P_j G_j} \cdot \sigma \cdot \frac{G_t}{G(\theta)} \cdot \frac{L_t}{L_j r_j} \cdot \frac{e^{-2\alpha R_t}}{e^{-2\alpha R_j}} = A \quad (3)$$

The jammer energy sensing system dynamically evaluates the power of the received signal and changes in the corresponding parameters in real time through the perception of the transmitter environment and the transmitted signal, and sends the optimal jamming strategy and jamming signal after the decision to the radar receiver[14-16]. At the same time, it needs real-time sensing of whether the transmitted signal stops target detection. When the transmitter stops transmitting the signal, if the jammer continues to transmit the jamming signal[17-18], it will expose itself and lead to serious consequences of being destroyed.

##### B. Cognitive Jamming Evolute from Learning Environment

Based on the characteristics of "low energy, long incubation period, and autonomous evolution", cognitive jamming has the characteristics of autonomous learning goals, high concealment, and low energy. It will play a huge role in future electronic countermeasures. After being processed by the jammer, the jamming system enters the receiver of the other party. In the receiver, the corresponding parameter or modulation mode can be changed according to the adaptive change of the receiver environment to achieve a longer latency characteristic. During the incubation period, the characteristics of energy or modulation parameters can be changed autonomously according to the adaptation of the receiver environment, so as to achieve the false judgment of the target source by the receiver, so as to achieve the effect of deception and jamming.

Cognitive jamming based on self-learning evolution can be lurking in the receiver system for a long time, and dynamically adaptively sense and match the radar signal received by the receiver, so as to achieve the feature similarity fusion effect with the target signal, and finally achieve Realization of the fidelity jamming of false targets makes it difficult for the receiver to judge the true and false targets, so as to achieve the jamming effect on the effective signal in the receiver[19]. The entire dynamic cognitive jamming process and trend are shown in Figure 6.

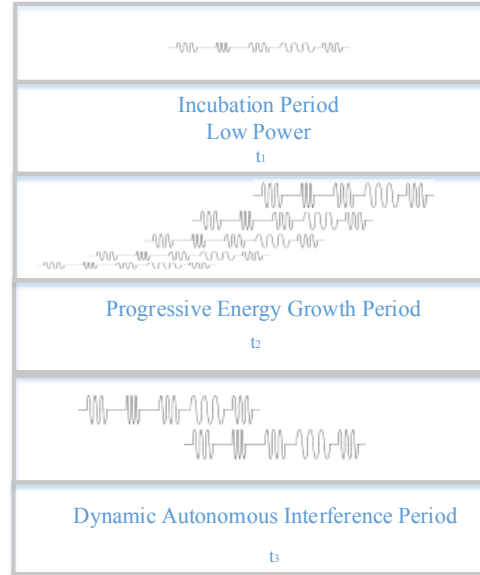


Figure 6. The jammer dynamically perceives the environment and cognitive decision-making process in real time

In the cognitive jamming process, the radar transmitter and the jammer signals are in a game of mutual competition. Therefore, the jammer needs to dynamically and real-time perceive the energy changes of the transmitted signal, environmental noise and other characteristics and

corresponding modulation parameters to deal with the resistance of the radar transmitter. Jamming measures to achieve real-time dynamic perception of the environment and rapid decision-making capabilities.

## V. SIMULATION AND ANALYSIS OF NEW COGNITIVE JAMMING

### A. Cognitive Jamming Dynamic Change of Energy

Under normal circumstances, the signal power transmitted by the radar transmitter is stable, but the radar signal with stable power or energy usually does not have anti-jamming performance. Modulated signals with periodic energy fluctuations can use methods such as constant modulus algorithms. The energy amplitude of the signal received by the machine identifies and suppresses the jamming signal.

In special anti-jamming situations, the energy of the transmitted signal will undergo a dynamic and periodic change process. The effective signal transmitted by the transmitter set in this article is a signal with a staggered energy change with a period of 5, and the modulation type is linear frequency modulation ( LFM ) signal, a start frequency  $F_0 = -5$  MHz, the bandwidth  $B = 10$  MHz, the pulse width of the  $PW = 20\mu s$ , the pulse repetition period of the  $PRI = 100\mu s$ , the sampling frequency  $F_s = 200$  MHz, the energy change process staggered in table 1 shown.

Table 1. The process of signal energy change

No.	PW/ $\mu s$	PRI/ $\mu s$	Energy/dB
1	20	100	0
2	20	100	3
3	20	100	5
4	20	100	4
5	20	100	1

The effective energy staggered modulation signal transmitted by the transmitter is shown in Table 1. When the signal-to-noise ratio is 10dB, the receiver receives the echo signal of the detected target, and at the same time, the jammer will detect the target of the effective radar signal received. The power of the echo signal falls within the range of the environmental noise power, making it annihilated in the noise, so as to realize the concealment and low discovery of the jamming signal. The signal received by the radar receiver is shown in Figure 7.

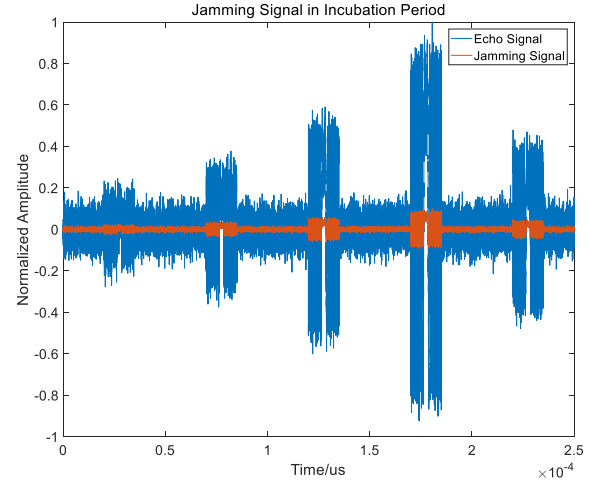


Figure 7. Energy distribution of the jamming signal in the receiver during the latency period

In the Figure 7, the energy of the jamming signal in the radar receiver is lower than the ambient noise power, and the signal patterns are consistent, so its low probability detected ( LPD ) character can be achieved. At the same time, after a period of latency, the jammer is effective. The parameters of the radar signal are estimated and mastered in detail, and then enter the period of gradual energy growth. Meanwhile, the jammer dynamically detects whether the radar transmitter is sending effective signals in the current environment.

### B. Cognitive Jamming Simulation and Analysis

The cognitive jammer can perceive the environment and the energy of the signal in real time, and make corresponding dynamic adjustment strategies at different stages. In the initial stage, the jamming signal is in the latency period, and its energy power is suppressed by the Gaussian white noise in the environment, which is concealed. The jamming state during the incubation period is shown in Figure 8.

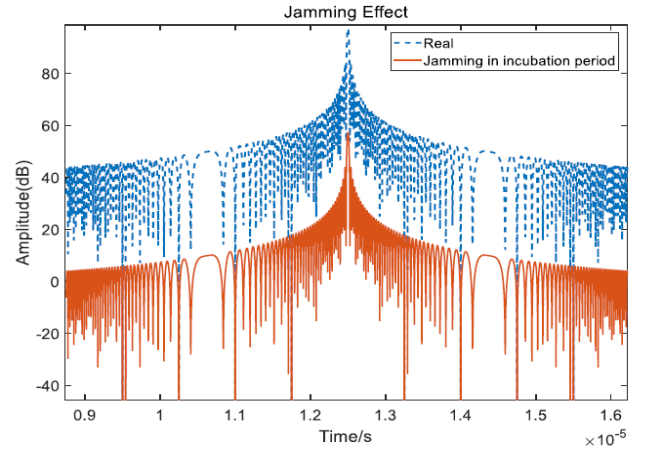


Figure 8. Jamming effect during the incubation period



Figure 8 is the jamming effect diagram of the jamming signal in the latency period. At this stage, the peak value of the jamming signal after pulse compression is still lower than the side lobe of the radar echo signal, which has a low probability detected (LPD). At this stage, the jamming signal can "survive" in the echo signal without a problem. After the jammer fully learns the characteristics of the radar signal, the jammer autonomously perceives the surrounding environment and implements the optimal jamming strategy. During the rising phase of the jamming energy, according to the state of the detected target, the jamming signal is uniformly accelerated in the direction of the target, and its energy gradually increases as the relative distance decreases.

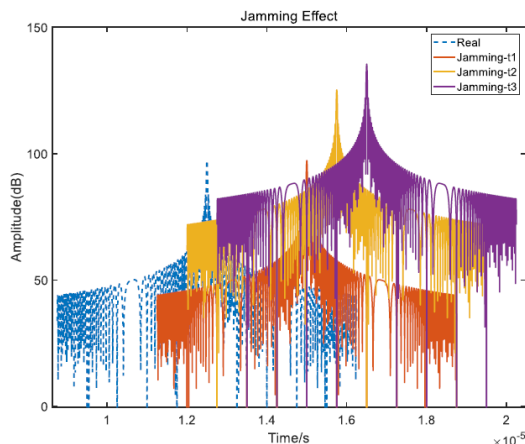


Figure 9. Jamming effect at different stages

The jamming effect is shown in Figure 9. The blue curve in Figure 9 is the echo pulse compression diagram of the original effective signal. The orange, yellow and purple curves are the pulse matching effects of the jammer jamming signal at different stages. The orange curve is the jamming energy effect at time  $t_1$ . It can be seen from the figure that the jamming signal at this time is basically equivalent to the original signal energy, but the jamming signal has the function of target referral at this time, and its relative distance has deviated from the real target. The yellow and purple curves are the jamming energy effect diagrams at  $t_2$  and  $t_3$ . It can be seen from the figure that the energy of the jammer has suppressed the real signal at this time, and the deception distance is gradually increasing. At this time, the radar receiver will capture and track the false target, thereby realizing the deception function of the active detection radar.

## VI. SUMMARY

The traditional electronic jamming system has a sudden change in energy during the jamming process, which is easy to be identified and detected, and due to insufficient environmental awareness, the corresponding strategy cannot be changed in time when the enemy stops detecting and the effective signal modulation method changes. This article propose a new cognitive electronic jamming method combined with the characteristics of "SARS-Cov-19"

coronavirus which could achieve a real-time perception of the surrounding energy environment and the ability to adjust the jamming method autonomously.

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