# UAV-BASED DISTRIBUTED ECM SYSTEMS

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## Abstract

*With regard to the state of the art of UAVs and the trend and operational requirements of distributed ECM systems, ECM systems are based on various single-functional, configurable modules, which are integrated and installed on UAVs to meet future operational needs. This UAV-based distributed EW system is recoverable and upgradable, and can perform reconnaissance, jamming and training missions.*

## 1 Introduction

It is unrealistic to maintain expensive, expendable distributed ECM systems for the purpose of increasing the probability of winning a war. In addition to the issue of cost, sufficient decoys are required for training operators. Also, shortcomings such as long response time and difficult effectiveness assessment make the operational application of expendable distributed ECM systems a big challenge.

An unmanned air vehicle (UAV) that can be launched and recovered at any time represents a solution to that problem. Such UAV shall be small and portable. To reduce the frequency of launch and recovery, its endurance shall be at least 3 to 4 hours. If the UAV only serves the purpose of ECM, its cost may be a big problem. If it can carry other payloads for multiple missions such as beyond-visual-range targeting, ship-based cannon fire support and reconnaissance, and communication relay, the overall cost would be reduced, and it would be cost effective to deploy multiple UAVs.

## 2 Recoverable Distributed ECM System

UAVs, when used as platforms for radar jamming, have 2 striking advantages: 1)improved jamming results with a reduced jamming power due to approach jamming at a short distance with a high gain; 2)capability of jamming frequency-agile radars. As long as the jamming frequency is aligned with the instantaneous frequency of the radar signals in a timely manner, the jamming power can be significantly increased by means of targeting jamming.

UAV-based reconnaissance platforms cannot be easily detected by the enemy, so they can fly over its ground. This reconnaissance has 4 remarkable advantages: 1)the limit of reconnaissance range as affected by the curvature of the earth is reduced; 2)by "approach" reconnaissance, some radiation source signals of small transmission power can be detected such as hand-held walkie-talkies as well as communication devices that are deployed and hidden behind mountains; 3)sensitivity requirements are reduced for reconnaissance equipment to make it simpler; and 4)casualty is avoided.

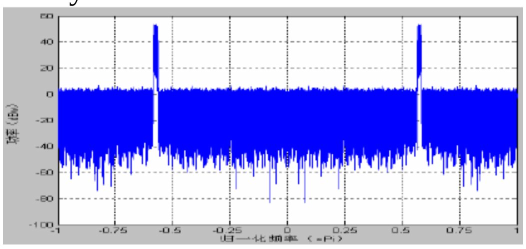

Fig. 1 Frequency spectrum of an individual jammer

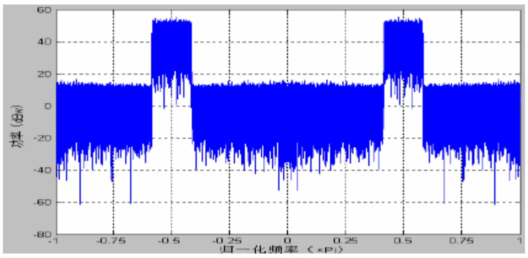


Fig. 2 Frequency spectrum of jammer group

A distributed ECM system is launched with the cooperation of UAV. It can continuously keep alert for sustained jamming. With regard to the fact that it is difficult to make wide-band noise sources when their size and weight are strictly controlled, it is natural to consider an option of covering a wide frequency range with multiple miniature jamming units that cover different frequencies while relaxing the requirements for the transmission bandwidth of each. Following is a demonstration by simulation. There are 11 frequency bands that are connected one after another. Each represents a noise jamming unit of 3MHz that covers a bandwidth of 33MHz with the central frequency of 100MHz. It is assumed that each unit has a power of 1mW.

The frequency spectrum of individual jammers is as shown in Fig. 1, and that of jammer group is as in Fig. 2, with a sample frequency of 400MHz and a simulation duration of 1ms. It can be seen that, in terms of frequency spectrum, it is feasible to combine narrow-band noise into wide-band noise. Thus, frequency-agile radars can be jammed.

The EW effectiveness can be assessed by monitoring the signal level and azimuth measured by the airborne ECM. The ECM effectiveness can be reliably determined by combining the measured signal attenuation and azimuth drift with the signal enhancement and azimuth stability produced by the distributed ECM system.

## 3 Modeling and analyzing based on MATLAB

### 3.1Radar jamming

Radar-jamming UAVs are capable of continuous electronic suppression and escort jamming. By deploying multiple UAVs that carry jamming equipment in the airspace near the target area, they can generate extensive suppressive jamming in the designated target area in an automatic or controlled manner. Also, several UAVs can be used in formation with attack aircraft to jam the enemy air defense and build a jamming corridor. By advanced deployment or escort, they can draw the fire of the enemy air defense and cover the attack aircraft when passing the area of interception.

Radar jammers consist of suppressive and deceptive mission systems.

Suppressive mission systems can track the radiation sources and suppress the threat radars with approach jamming. With intensive, smart and suppressive jamming, the signal and data processing system of the radars is saturated, thus greatly reducing their capability of detecting, intercepting and tracking the real targets, even making them paralyzed.

Suppressive jammers do not simulate the radar return waves and flight tracks of combat aircraft. For UAVs, duration and range are more important than speed and height.

Deceptive mission systems simulate accurately the flight track of combat aircraft and the amplitude, frequency and phase of the radar return waves at all frequencies. By preprogramming, high-fidelity radar target return waves with the characteristics of all combat aircraft are produced, enemy air defense radars and their integrated network are deceived to make wrong decisions and consume their defense resources.

Deceptive mission systems impose high requirements for UAVs. In terms of speed, height and range, they must come up to a flight state experienced by the simulated aircraft in combat. As a rule, the cruise speed shall not be less than 500km/h.

### 3.2 Satellite signal jamming[1]

GPS/GLONASS/BD signals are extremely weak at the surface of the earth. They are prone to jamming in current complex EM environment. C/A code signals of GPS are particularly prone to jamming. With the emerging navigation warfare, GPS/GLONASS/BD jamming has become an effective way of controlling navigation resources.

There are many ways of jamming GPS/GLONASS/BD, including suppressive and deceptive jamming.

Suppressive jamming involves suppressing the normal satellite signals at the front end of the GPS/GLONASS/BD receiver by transmitting some level of jamming signals so that the receiver cannot receive any satellite signals.

Deceptive jamming involves transmitting false signals that have the same parameters and different codes compared to the GPS/GLONASS/BD signals. There are many specific jamming methods, including wide-band Gaussian noise, continuous wave, scanning continuous wave, pulse continuous wave, and narrow-/wide-band FM signals.

GPS/GLONASS/BD jammers are small in size, light and energy-saving. With a small jamming power and a long effective range, they can be easily installed on UAVs[2].

## 3.3 Reconnaissance

As reconnaissance platforms, UAVs are suitable for battlefield reconnaissance due to their small size, small radar reflection cross-section, low manufacturing cost, and without having to consider human safety. When performing reconnaissance missions by carrying electronic reconnaissance devices in the enemy's heavily guarded dangerous areas, UAVs can download data and intelligence to ground control stations in real time. The data can also be replayed and analyzed after the UAVs are recovered.

## 4 Conclusions

A Wolf sensor is imbedded in each UAV, the engine of which can serve to charge the cells of the sensor. The WolfPack portable EW system developed in USA is a distributed, networked, comprehensive EW system. The "Wolf" sensors can be converted into AirWolf, which is a small vertical takeoff and landing UAV with a diameter of 1.22m. Its cells are charged during flight. It is moved to a hot spot and can be recovered. The AirWolf can tilt during flight to fly like an airplane to increase its speed and range. BAE Systems will produce this platform, maybe starting in 2009. At least 3 Wolf sensors are required to locate the enemy transmitter, with a current specification of positioning accuracy of 10m. The WolfPack covers a frequency range from 30MHz to 20GHz, within which both communication and radar fall. The WolfPack can cope with some enemy radars that are difficult to detect, and can be used to counter cellular communication[2].

The unit cost of recoverable ECM systems is no doubt much higher than that of expendable ones. But it is offset by the advantages of the recoverable ECM systems: they can be deployed at the optimal positions against missiles; their mission time lasts hours instead of minutes and little reserves are required for technical or tactical training in wartime; and most importantly, early EW soft killing evaluation can save resources for hard killing, thus improving the survivability of the fleet.

## References

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[2] [2] Feng Wanding, Networked EW Weapon: WolfPack System, Communication Countermeasures，Feb. 2005

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