SECTION 9

INTERNET THINGS AND LATEST TECHNOLOGY

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IDENTIFICATION OF DRONES IN A DEFINED TERRITORY

Annotation. Different modern methods of detecting drones, which are based on various physical principles of signal transformation and processing, are examined and analyzed. The system of identification of drones is proposed, the basis of which is the analysis of signals of vibration and oscillations of the body. The work of the system is based on the processing of signals in time-frequency, wavelet area. After the identification of the drone is given a method of creating interference and interception, to further eliminate it.

Key words: detection of quadcopter, neutralization of quadcopter, vibration of the body of the drone, identification of the drone.

Recently, more and more drones are being observed in airspace. Such unmanned aerial vehicles (UAVs) can bring both the benefits and the danger to the environment. With the help of such UAVs it is possible to monitor the environment, photograph the territory, determine the local areas of forest fires, conduct reconnaissance operations in military affairs, etc. However, on the other hand, the uncontrolled presence of airborne drones near airports, frontiers, military facilities, prisons, etc. may represent a certain danger. In view of this, a system for detecting and eliminating drones is required to prevent the presence of a UAV in the forbidden airspace. The main difficulty in detecting such devices is that they can operate locally at low altitudes and are not available to detect radar stations. Thus, other principles of detection should be used to roll the drones. In particular, it is advisable to carry out research on various physical characteristics of UAVs, such as vibration and vibration of the body, the creation of interference and the decomposition of control signals. Given that sensitivity of detection of a UAV reaches hundreds of meters, it is necessary to ensure that the received signals are filtered from the effects of various types of interference [1].

Thus, several directions can be classified to identify and eliminate drones. The first one is based on the assessment of vibration and oscillation of the body. The second is to create interferences and decompress control signals, the other to use the regular drones that can be in the air and destroy other UAVs. Sound approaches may be noisy by other sounds in noisy environments, have a limited range and are not can detect drone using noise reduction techniques [2]. Detection of UAVs related to the use of cameras requires high-quality lighting, high quality and ultra-high resolution support to detect long distances. Thermal and IR cameras for long distances are extremely expensive and have limited coverage, which leads to difficulties with their installation. Radio frequency methods based on the use of active radar, introducing constant radio frequency interference, which may interfere with the operation of other equipment. Geo-Fetching is useful for preventing the passage of unmanned aerial vehicles in fixed areas, known as prohibited, but it requires manufacturers to install the necessary software. Thus, each approach has its own peculiarities, advantages and limitations.

In the proposed work is considered the ability to identify the UAV on the basis of a mutual evaluation of the vibration of the droplet, which is due to the rotation of the engines, and the fluctuations of its body. After identifying the drones, an evaluation of the impact on the existing radio communication between the aircraft and its ground control controller is proposed. The system allows filtering non-informative noises and interruptions that simultaneously enter its input from other mobile wireless devices at a distance of up to hundreds of meters (depending on the type of antenna). In the case of the appearance of several drones in the airspace, the system also allows them to be identified.

Thus, the advantages of the proposed system for detecting drones are:

- use wavelet transformation area of both signals;
- the ability to efficiently filter and identify both signals;
- determination of the relationship between the signals of the vibration of the drone and the fluctuations of its body;
- the ability to detect the UAV at a distance of up to hundreds of meters using the appropriate antenna.

Since the change in the information signals due to vibration and oscillations of the drones body occurs both in frequency (scale) and in time (bias), in order to obtain greater information of such signals it is expedient to analyze them in the wavelet area [3]. The representation of such signals in the time-frequency domain must be carried out using the same basic wavelet functions. The representation of both signals in the wavelet of the region relative to one base function creates two groups of coefficients of wavelet transformations. In the future, on the basis of such transformations, the calculation of the mutual wavelet transformation is carried out. This representation of the transformation area provides efficient processing of the function of two variables and at the same time better reflects the characteristics of the signals in order to qualitatively and quickly recognize them [3]. The mutual wavelet function represented by the functions of both wavelet transformations is as follows:

$$W r_1\left(\frac{1}{S},\frac{t}{S}\right)=\frac{1}{c_g}\int_{-\infty}^{\infty}\frac{da}{a^2}\int_{-\infty}^{\infty}\left[W_g\, r_1(a,b)\right]\left[W_g{}^{*} r_1(Sa, Sb-t)\right]db,$$

Where a and b – the scale and displacement of the base wavelet function, respectively; S and – t – time scale and time shift in the mutual wavelet transformation.

Each estimate of the mutual wavelet of a function, defined by the value S and t determines the degree of similarity (affinity) between the scaled and offset version of one signal and the unmodified version of another signal. For additional assumptions, these levels of similarity have spatial placement, which allows you to create a spatial image. Thus, time and space measurements are inseparable in this structure, and in this case, a multidimensional spatial-temporal wavelet transform is constructed. The important thing for such a transformation is that it represents two two-dimensional functions in one two-dimensional so that the dimension does not increase in this case.

After identification of the UAV in the airspace, measures should be taken to eliminate it. You can use one of the following two methods for this. The first one is based on the creation of noise at frequencies that use drone. In this way, the UAV loses contact with the controller and can’t take any action. However, such a method can disable devices that fall within the range of such a system. The second approach is based on the UAV interception due to the influence on the control signal sent by the controller itself. When investigating the communication of the drone with its controller, the vulnerability was detected in the data transfer protocol between the software and the drone. This interface is called WEP (Wired Equivalent Privacy), which provides the exchange of packages for UAVs. WEP has virtually no security, so it can be attacked. After intercepting packets, the xBee processor processes and decrypts, substitutes the data that is responsible for the controller and sends these modified drone packets. Which in turn switches to the control of a given control device. In this case, the system manages the drones regardless of its initial controller, since now all packages will first get on the xBee processor, and then on the drone itself, which will allow the UAV to fail, or to dispose of it.

On the basis of the formed mutual wavelet space, a structure and computer simulation have been developed, the results of which indicate that such an approach to identifying drones can be widely used as it provides qualitative filtering of informative broadband signals, improvement of their resolution and increase of transmission coefficient in the spatial domain, which in turn allows you to quickly and with high probability to detect drone in the airspace.

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