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**AUTOMATED CONTROL SYSTEMS FOR UNMANNED OBJECTS. GENERAL PRINCIPLES**

Modern unmanned vehicle management systems that operate in various physical environments are characterized by the extensive use of integrated computer technologies and the increasing automation of the control process.

The development of control systems for small-scale intelligent unmanned objects becomes an extremely important task, especially in conditions of uncontrolled disturbances and obstacles in motion, possible rapid changes or loss of specified trajectories. Effective management requires flexible solutions in the areas of assessment, forecasting, optimization, and recovery of defined trajectories, and involves the application of intelligent technologies. Therefore, a key aspect of such unmanned objects and their control systems is the system of intelligent motion support [1].

Based on the results of the analysis of previous research, significant interest has been identified in the development, improvement, and further advancement of intelligent systems for controlling moving objects in various physical environments. In general, for small-scale moving objects, the following main directions of intelligent control system development can be distinguished [2]:

* utilization of modern component base (microelectromechanical systems, microcontrollers, vision systems, wireless data transmission systems);
* improvement of methods and algorithms for autonomous orientation and navigation;
* development of methods and algorithms for adaptive control, control under conditions of uncertainty, and limited information;
* planning, execution, and recovery of object trajectories based on situational control and artificial intelligence methods;
* improvement of information collection, storage, and transmission systems;
* development of visualization systems for object positioning and their trajectory;
* design and enhancement of object technical condition monitoring systems, alignment with control process models and their physical implementation;
* advancement of multi-class recognition systems for processes and objects in the surrounding physical environment.

Among the tasks mentioned above, many practical applications of control systems require the extraction of complex trends from noisy signals. Such tasks may arise when reconstructing the lost trajectory of a moving object in conditions of its complex motion, when approximating complex algorithms in adaptive control systems with abrupt changes in trajectory or motion conditions, and when altering the output signals of sensors or executive elements in control systems.

In works [3] and [4], an additive mixture of the useful signal and noise was used for modeling and wavelet transformation. The formation of the useful signal was based on a complex model of a one-dimensional process that includes practically all types of elementary signals. Stationary Gaussian noise and harmonic signals were considered as the noise sources. Wavelet filtering utilized wavelets from the Daubechies family, Haar wavelets, as well as Symlets and Coiflets due to their orthogonality and signal reconstruction capabilities. The best results in terms of the determined mean square deviation and maximum error value were shown by the Haar wavelets and Symlets.

The research has shown that to identify a complex trend against a background of noise, it is sufficient to use signal decomposition into two or four levels of wavelet analysis. Additional low-amplitude harmonic noise has little to no impact on the effectiveness of extracting the useful signal.

The conducted research confirms the effectiveness of using wavelet transformations for processing complex and non-stationary signals in various technical fields. Importantly, it allows for the development of fast and efficient algorithms for extracting complex trends from noisy signals. This approach is relevant for further improving systems for the intelligent support of multi-target moving objects.

**Literature**

1. Н. І. Бурау, О. М. Павловський та К. А. Мішура, “Системи інтелектуальної підтримки руху безпілотних об’єктів”, у *Інтегр. інтелект. робототехн. комплекси (ІІРТК-2022)*, Київ, Україна, 17–18 трав. 2022. Київ: Нац. авіац. ун-т, 2022, с. 25–27.
2. К. А. Мішура, “Огляд стану досліджень щодо розробки систем інтелектуальної підтримки руху”, у *Погляд у майбут. приладобудування*, Київ, Україна, 14–15 черв. 2022. Київ: Нац. техн. ун-т України “Київ. політехн. ін-т ім. Ігоря Сікорського”, 2022, с. 22–24.
3. Н. Бурау і К. Мішура, «ВИОКРЕМЛЕННЯ СКЛАДНОГО ТРЕНДУ СИГНАЛІВ У СИСТЕМАХ ІНТЕЛЕКТУАЛЬНОЇ ПІДТРИМКИ РУХУ ОБ’ЄКТІВ», *Bull. Kyiv Polytech. Inst. Ser. Instrum. Mak.*, вип. 64(2), с. 5–11, Груд 2022.
4. К. Мішура та О. Павловський, “Віртуальний прилад в середовищі NI LABVIEW для очищення сигналу траєкторії руху безпілотного об'єкта”, *Вчені зап. ТНУ ім. В.І. Верн. Серія: Техн. науки*, т. 34 (73), № 3, с. 184–189, 2023.