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Concept of Hidden Oscillations

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Perspective

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PERSPECTIVE

The mathematical modeling of the dynamics and determination of stability in technical systems is that the most relevant direction within the scientific and technological development of any state that seeks to occupy a number one position within the times. The study of limiting dynamic regimes (attractors) and stability is important both in classical theoretical and in actual practical problems. Regulators had to make sure the transition of the dynamics of the control object to the operating mode and therefore the stability of the operating mode relative to the initial deviations and external perturbations. A classic example is that the Watt regulator, wont to maintain a given constant speed of rotation of a turbine shaft. The event of the idea of absolute stability, the idea of bifurcations, the idea of chaos, theory of strong control, and new computing technologies has made it possible to require a fresh look at variety of well-known theoretical and practical problems within the analysis of multidimensional control systems, which led to the emergence of the idea of hidden oscillations, which represents the genesis of the fashionable era of Andronov's theory of oscillations. The idea of hidden oscillations is based on a replacement classification of oscillations as self-excited or hidden. While the self-excitation of oscillations are often effectively investigated analytically and numerically, revealing a hidden oscillation requires the event of special analytical and numerical methods and also it's necessary to work out the precise boundaries of worldwide stability, to research and reduce the gap between the required and sufficient conditions for global stability, and distinguish classes of control systems that these conditions coincide. Within the general case, for the sensible use of regulators, it's necessary to spot during a closed system all stable stationary and oscillatory regimes, also as their basins of attraction. The tasks of analyzing multidimensional control systems and obtaining the required and sufficient conditions for global stability, including those guaranteeing the absence of chaotic oscillations, showed the need for further development of the idea of oscillations of Andronov and therefore the creation of latest analytical and numerical methods for the analysis of stability and oscillations.

At this stage of the study of oscillations, the engineering concepts of the transition process and retention are closely associated with the likelihood of a numerical analysis of limiting oscillations. Within the general case, an oscillation can generally be easily numerically localized if the initial data from its vicinity within the space cause a long-term behavior that approaches the oscillation. Such an oscillation (or set of oscillations) within the space of phase space is named an attractor. The classical engineering analysis of stability and oscillations during a system consists in determining stationary states, analytically determining their local stability, and then numerically analyzing the behavior of the system with the initial data in the vicinity of unstable stationary states. Such an analysis allows us to point out the attraction of trajectories from an area of unstable equilibrium states to stable equilibrium states: to trivial attractors (such as the attraction of trajectories to a trivial attractor within the mathematical pendulum model), or to reveal on trivial (oscillatory) attractors. During this approach, the matter of the existence of attractors within the system to which trajectories from the vicinity of equilibrium states aren't attracted remained open. The concept of an attractor allows us to generalize the ideas of Andronov on the correspondence between steady periodic oscillations and limit cycles of dynamical systems also for steady non-periodic oscillations (arbitrary oscillations, counting on their basins of attraction, can similarly be classified as self-excited or hidden relative to unstable stationary states).Thus, for the primary time the terms hidden attractor and hidden oscillation were introduced and their mathematical definitions got. The proposed classification is consistent with the experimental approach to the analysis of the occurrence of oscillations and numerical procedures for checking out attractors, reflects the difficulties of solving variety of actual engineering problems and well-known scientific problems, and has also become a catalyst for the invention of latest attractors in well-known systems. The idea of hidden oscillations may be a modern stage within the development of the idea of oscillations of Andronov. It's in demand in many theoretical and relevant engineering problems during which hidden attractors (their absence or presence and location) play a crucial role.

The importance of identifying hidden attractors for control systems is said to the classical problems of determining the precise boundaries of worldwide stability, analyzing the gap between the required and sufficient conditions for global stability and their convergence, and identifying classes of control systems for which these conditions coincide. In practice, the transition of the state of the system to the hidden attractor mode caused by external perturbations results in undesirable operating regimes and is usually the cause of accidents and catastrophes.