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# A multi-agent computer program for automatic investigation the behavior of a nonlinear dynamic system in real-time

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**Abstract:** In continuation of construction of the general concept of automatic investigation of dynamic systems [1], the general scheme and computer system of the analysis of behaviour of nonlinear dynamic system in real-time are developed. The computer system of multi-agents are implementing functions of an interface with user, an processing of data, a scheduling and a control of calculation, a control of time and special functions of recognition. The specification of the multi-agent system, its agents and database, the structure, functions and operation of the system are presented and are discussed.

**Keywords:** The dynamical systems, the periodic and quasi-periodic orbits, the regular behaviour system, multi-agent computer system

## 1. Introduction

The task of building a multi-agent system (MAS) for automation research and detection of the behaviour of dynamic systems is a modern and difficult task. It is necessary to investigate and predict the behaviour of a nonlinear autonomous multi-parametric dynamic system based on graphical information, which is obtained in real time. The difficulty of solving this problem is that, it is poorly formalized and can be attributed to the problems of artificial intelligence. For example, conducting separate studies of Poincare sections is not enough to solve the initial problem. Also for the construction of Poincaré sections, an unfixed time is required to calculate the cross-sections. Short time - does not allow you to build adequate cross-sections, long time - allows you to accumulate errors. The problem is complicated by the fact that the dynamic system is very parametric. Depending on the parameters, it may have opposite properties: be well predicted or not. To solve these problems, it is proposed to use multi-agent-oriented technology and develop an appropriate multi-agent system for predicting the behaviour of a nonlinear dynamic system in real-time [2].

As is known, in modern research of artificial intelligence systems, agent-oriented technologies are increasingly used. These technologies can be considered as a new paradigm for the analysis, design, development and implementation of complex software systems in the intellectual direction. In agent-oriented technologies, agents are complex computer programs that can act autonomously to solve tasks according to the chosen behaviour strategy. However, more and more tasks require the use of several different strategies, as well as several agents. In multi-agent systems, agents must interact cooperatively with each other and produce more adequate cooperative solutions. Multi-agent intelligent systems have more significant advantages over classical artificial intelligence systems and are able to solve more complex problems, such as search, recognition and prediction.

## 2. Results and Discussion

So, the aim of this work is to develop a multi-agent system based on the use of the method of distributed artificial intelligence and designed to predict the behaviour of a nonlinear dynamic system in real-time. For this, we have done the following: describe the general scheme of solving the problem; design system agents, describe their roles and functions; develop the structure of the system database; describe the general architecture and technical aspects of the implementation of the developed multi-agent system.

The multi-agent system had the following requirements: autonomy; operation in real-time; recognition of different types of trajectories on graphical representations of the model under study; regulation of the calculation time of each individual trajectory; determination of starting points for calculating trajectories; optimization of the recognition process by adjusting the number of components of the system involved in it; minimization of recognition errors by using many autonomous recognizers; maintaining a database that contains a description of the detected trajectories of the dynamic system.

The developed scheme of the multi-agent intelligent system is implemented as part of the application software. This software solution is used to increase the efficiency and automation of certain activities related to the study of models of dynamic systems.

The obtained program has the following advantages: full automation of the process of finding trajectories; high efficiency of trajectory recognition due to the use of many recognizers of statistical data accumulated during the study; availability of self-regulation mechanisms to minimize the error in calculating trajectories and optimize the consumption of system resources.

## References


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