**(2 slide)**

Let us consider a chain of diffused connected and singularly perturbed nonlinear differential equations with a delay:

(1)

Also for it there are determined the following initial conditions:

(initial conditions for (1))

(functions f, g are smooth)

This system was described in the article of Glyzin, Kolesov, Rozov “Relaxation self-oscillations in neuron systems”

**(3 slide)**

In this article there were applied the following substitutions:

(substitutions)

where is a solution of this differential equation:

(equation)

and system (1) is transformed to the following system of ordinary differential equations:

(2)

It’s a system of equations with impulse influences.

**(4 slide)**

Let us consider a mapping with initial conditions:

(3)

is the first approximation of stable cycle for single oscillator of system (1). For this mapping there was proved this theorem:

(theorem 1)

In other words for research of relaxation cycles of system (2) we can just research stable points of mapping (3). They are the objects of my research.

**(5 slide)**

So the research of mapping (3) was carried out by means of special software written in C++.

All calculations are performed on a large number of independent streams. So the program uses the technology of parallel calculations OpenMP. To visualize data there was developed a special application using the framework Qt. Also there was wrote a script in Python to solve the problem of parsing data.

**(6 slide)**

An asymptotic analysis of this mapping shows that it has at least stable points with certain coordinates and zero point is stable for any values of . But we don’t except the existence of auxiliary stable points with coordinates, which aren’t determined by formulas in the article.

So my research task was the search of values of initial parameters, for which auxiliary stable points exist.

**(7slide)**

In the case of ( 2 singulary perturbed oscillators mapping (3) looks like this:

(mapping)

After the research by means of program, the results were coincided with the results in the article.

A feature of mapping (3) in one-dimensional case is the fact, that a decrease of parameter d gives a bifurcation of points andand, which are symmetric relative to the origin of coordinates. The trajectories are the sequentially connected start and end points of mapping (3). They are painted in special coordinate plane, where X-asis is and Y-axis is . On these graphs of mapping blue points are unstable and are stable:

(pictures)

**(8 slide)**

Here you can see screenshots of graphs for one-dimensional case, which were given by means of program

(pictures)

**(9 slide)**

In the case of ( 3 singulary perturbed oscillators mapping (3) looks like this:

(mapping)

An asymptotic analysis for two-dimensional case confirms that this mapping has 4 stable points with certain coordinates. But the research by means of program shows, that there exist the cases of 5, 6 and 7 stable points (or 1, 2 and 3 auxiliary stable points, respectively).

Also for two-dimensional case of the mapping there were researched the questions of existence, stability and asymptotic forms of relaxational periodic solutions due to a bifurcational analysis. The results were published in this article:

(article)

Let us consider more detailed analysis of results.

**(10 slide)**

In the case of 5 stable points, one of the most common cases, there was founded auxiliary stable point . On the left there is a phase portrait, where black lines are separatrixes and grey lines are some phase curves. On the right there is a screenshot of phase portrait, which was built by means of program.

**(11 slide)**

In the case of 7 stable points, the case with the largest number of stable points, there was founded auxiliary stable points ( and points and , which are located between the point with known coordinates).

(pictures)

It’s a phase portrait and a screenshot for this case.

Also by means of program, there were researched cases of multidimensional mapping (3) and found the values of initial parameters, when it has at least 1 auxiliary stable point with coordinates, which aren’t determined by formulas in the article.