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Methodology for Searching for the Dependence Between Data Defensiveness and Volume of Social Network Evolution

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Abstract: For the first time was researched the dynamic models of the data defensive system (DMDDS) in social networks (SN) from the volumes of development of social networks (VSNE) were investigated and the reliability of the data defensive system (RDDS), which indicates the academic achievements of this work.

Created DMDDS in CN from the conditions of RDDS. In the DMDDS, currently known opportunities, actions and technologies are involved, for which the modality of uncertainty is confirmed as a state of a defined condition on a time grid, and this relationship interprets the transformation of the previous state over time.

SN is a set of actors and their types of communications. Actors can be people themselves, their subgroups, associations, settlements, territories, continents. The form of interaction includes not only the transmission and reception of information, but also communication, exchange of opportunities and types of activities, including controversial points and views.

From the point of view of mathematics, a prototype of the DMDDS was developed on the basis of nonlinear differential equations (NDE) and its transcendental review was carried out. Transcendental review of dynamic models of DMSDD in SN proved that parameters of VSNE significantly influence data defensives (DD) at possible value values - up to one hundred percent.

The phase types (PT) of DD have been checked, which prove RDDS in the working volume of values even at the maximum values of negative excitations.

For the first time the research of the developed NDE systems was conducted and the quantitative values between the VSNE parameters and the DD values, as well as the RDDS, were shown, which indicates the theoretical and practical value of the scientific work and its significance for the further development of scientific research in the field of SN.

The proposed model will contribute to increasing the quality and reliability of DD in SN around the world.

Index Terms: Social Network, Evolution, Dynamic Models, Data Defensive System, Oscillation, Nonlinear, Reliability.

1. Introduction

The subject of the research is to study the DD based on the DMDDS. A DMDDS is revealed as intended if the parameters of the system are defined, which indicate its exact rank and the established relationship interprets the transformation of the previous state over time. The modification of the DD rank is shown by the original NDE. The position of the rank of the system and its parameters are interconnected, which allows solving the NDE with the specified parameters.

The goal of the research is to improve the methodology of data defensive[1] in SN taking into account the parameters of the VSNE, since there are currently no known researches in this field, there is a scientific problem that needs to be solved.

The purpose of the model is to form the necessary competence in the field of cyber security of SN by promoting and spreading the theory, practice and experience in the field of cyber security in the business sector, legal regulatory bodies and state institutions of other countries, as well as in scientific and educational institutions. This model can be adopted by other countries and institutes that suffer from a lack of experience in the field of cyber security of SN, since this problem is solved for the first time in scientific practice.

The closest in essence is work [1]. In this article, a research of the influence of the growth of the network volume[2] and other constituent parameters of the social network on the parameters of data defensiveness is carried out. It is proved that the model is nonlinear. In works [2,3,6-14] the process of expansion of social networks is considered depending on various factors. The work [4] research the growth and decline of social groups in social networks. In works [5,15] the dissemination of information in social networks is investigated.

In these works, the numerical dependences between the parameters of the actors and the network itself and the parameters of the DD are not described. This is the main drawback of these researches.

- survey of the quantitative correlation between parameters of VSNE and parameters of DD;
- survey of RDDS in SN from possible effects on the basis of PT.

Providing SN administrators with opportunities, actions and technologies to calculate the quantitative activity of the parameters of the VSNE on the parameters of the DD is an economic (applied) benefit.

Tracking anomalies in the amplitudes of DD and PT fluctuations will indicate the existence or non-existence of threats, their strength. This will enable SN defenders to take real actions regarding the parameters of the DD in the current moments of time.

2. Literature Survey and Problem Statement

The article [1] presents a model of social network growth with a graphical interpretation. In relation to the growth of social networks, this means that the higher the valence, the faster it increases. This is quite logical, since both in real and online communication, a person gets to know a large number of new people of interest to him per unit of time, the more contacts he has. Accelerated development presupposes the fundamental openness of the system, i.e. the constant joining of new vertices to the network, which indicates the non-linear nature of SN expansion.

In contrast to the classical approach to the protection of personal data, a system of linear differential equations has been developed that describe the SN protection system, taking into account the specifics of the parameters of the network itself and the parameters of the extension, which allow to investigate the protection indicator.

[1] Data defensive are strategies and processes that help an organization prevent data from being damaged, compromised, or lost.

[2] There are two irreconcilably different designs for creating degree divisions of possibilities. The first is based on self-organization into a dramatic situation that occurs in transparent unequal systems far from equilibrium. The second is related to the initial monolith city of the system and in the total event does not dictate either unevenness or the interaction of the system details among them. The final manifestation of the monolithic path is models of competitive growth, in which the change in the value of a component is simply proportional to its initial value. Intactness is used only at the level of estimating the generalized value of the system needed to divide its total growth between its components. Otherwise, it would be impossible to detect the influx of new components into the system and the increase of those already existing in it. This non-material hypothesis authorizes the construction of models that initiate broadly invariant systems on the basis of extremely accessible principles. Growth models of social networks, naturally, are developed according to the same scheme, using the provision of preferential inclusion. A network node is taken to create the next connection with a possibility proportional to its valence — the number of connections it has.

The conditions of the stationarity position of the system were found, the system of equations was solved by the "small deviations" method, graphical dependencies were obtained, and the iteration of the protection system oscillations was carried out. The application of the method of differentiation of the protection function made it possible to research the behavior of the system. The research proved the dependence of data protection on the size of the network expansion. The specified dependence is non-linear.

Further research of the linear model of protection in social networks showed that the oscillations of the SN protection system are described by a differential equation of the second degree and is the equation of a harmonic oscillator with a decaying amplitude. Also, fluctuations of the SN protection system in the pre-resonance, resonance and post-resonance zone are considered. Natural and forced oscillation frequencies of the system, period of oscillations, damping coefficient were obtained. The results of the oscillation iteration indicate the nonlinearity of the protection system in social networks. Taking into account the obtained results, further research of the nonlinear model of the protection system is necessary.

The disadvantage is that the non-linear model of defensive information has not been researched.

Work [2] presents a deterministic model for online social networks (OSN), based on transitivity and local knowledge in social interactions. In iterative local transitivity (ILT), at each time step and for each existing node x, a new node appears and joins the closed neighbor set x. The ILT model has been shown to satisfy a number of both local and global properties observed in OSNs and other real-world complex network settings, such as degree-law compaction, reduced average distance, and higher clustering than random graphs with the same average degree. Experimental research of social networks demonstrates poor extension properties as a consequence of the existence of communities with few inter-community ties, boundaries and a spectral gap is proven for both the adjacency matrix and the normalized Laplace matrix for graphs arising from the ILT model, indicating such poor extension properties. It is shown that the number of cops and dominance remain the same as on the graph from the initial time step G0, and the automorphism group of G0 is a subgroup of the automorphism group of the graphs created at all later time steps. The randomized version presents the ILT model, which exhibits a tunable degree-law thickening rate and retains several properties of the deterministic model. The scientific work shows the ways and some mechanisms of the expansion of social networks. The disadvantage is that the information defensive model has not been researched.

The article [3] notes that the structure of social networks is usually derived on the basis of limited sets of observations through appropriate network sampling schemes. It is well known in the literature that the use of degree constraints gives rise to methodologically undesirable features, as it discards information about network connections. The mathematical model of this sampling procedure is considered and analytical solutions are found to restore part of the lost information about the basic network. We obtain closed-form expressions for several network statistics, including the first and second moments of the degree distribution, network density, number of triangles, and clustering. The scientific work shows the ways and some mechanisms of the expansion of social networks. The disadvantage is that the information defensive model has not been researched.

The work [4] shows that when groups compete for members, the resulting dynamics of human social activity can be understood using simple mathematical models. The methods of dynamical systems and perturbation theory are applied to analyze the theoretical basis for the growth and decline of competing social groups. We present a new approach to the competition for supporters between religious and non-religious segments of modern secular societies and collect a new international data set tracking the growth of religious non-affiliation. The data indicate a special case of the general law of growth, which gives clear predictions about possible future trends in society. The scientific work shows the ways and some mechanisms of the growth and decline of competing social groups in social networks, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

In the article [5] it is noted that a social network is a social structure consisting of individuals or organizations called "nodes", which are necessary (connected) by one or more specific types of interdependence, such as friendship, kinship, common interest, financial exchange, treatment or disliking. Social network analysis is conducted, which examines social relationships from the perspective of network theory, consisting of nodes and links (also called edges, links, or connections). In this work, the authors tried to research the mathematical explanation of social networks. The research will provide guidance to researchers on how to optimize social networks settings. The scientific work shows the ways and some mechanisms of social relations from the point of view of network theory, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

The work [6] presents an analysis of the limiting behavior of the degree distribution of the model of partial duplication, the model of random growth of the network in the family of duplication and divergence, which is popular in the study of biological networks. The probability of choosing a model is the phase transition for the expected fraction of isolated nodes converging to 1. Asymptotic limits on the rate of convergence of the degree distribution are obtained. We consider a subgraph consisting of all non-isolated nodes contained in the networks generated by the partial duplication model and show that again is a phase transition for the limiting behavior of its degree distribution. The scientific work shows the ways and some mechanisms of the limiting behavior of the degree distribution of the model of partial duplication, the model of random growth of the network, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

The article [7] notes that social networks are very popular and their use is growing in many societies. This paper researches the structures of online networks, focusing on the growth mechanisms they influence, focusing on the growth mechanisms by which they develop. Growth models based on preferential attachment - the tendency of a node to connect to a node with a higher degree - are considered. Using Facebook as a dataset, a mechanism was developed to model the

Facebook network into a simple structure. The scientific work shows the ways and some mechanisms of the growth model of social networks based on preferential attachment - the tendency of a node to connect to a node with a higher degree, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

In [8], a new model of social network evolution is proposed. This model is based on the following assumptions: random joining of new vertices, preferential selection of vertices to create connections with existing vertices, and restriction of the other ends of these connections by neighbors with neighbors. The model generates a graph with a degree distribution of vertices. The indicator of the degree of distribution varies in a wide range. We give a quasi-linear description of the mean field for the model. This description allows us to argue for a significant tuning of the high-order vertices and to offer a number of approximations for the simulation results. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on the random joining of new vertices, the preferred choice of vertices to create connections with existing vertices, and the restriction of the other ends of these connections by neighbors of neighbors, which affects the mechanism of their expansion. The disadvantage is that the non-linear model of defensive information has not been researched.

The article [9] offers a description of a social network with indirect binding. This allows you to completely exclude the desired selection of nodes from the rules. The model built on this basis generates a sparse network with a degree-law distribution of node degrees. The formulas for the distribution index obtained from the quasi-linear mean-field approximation are satisfied with good accuracy. Their empirical characteristics are determined by simulation results. However, this approximation does not agree with the value of the distribution shift. This limits the applicability of the proposed approach. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on indirect binding, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

In the article [10], a mathematical model of dynamic networks was developed, which is based on closed rather than open sets. It seems appropriate for a social network to use the concept of neighborhood to establish these sets. Then the concept of continuous change is defined, that it has some properties related to the continuity of counting. Continuity is shown to be local, meaning that if a network change is discontinuous, it will be so at one point, and discontinuity will be evident in the immediate vicinity of that point. Necessary and sufficient continuity criteria are provided when the change involves only the addition or deletion of individual nodes or connections (edges). To illustrate the large-scale continuous changes, a practical process is chosen that reduces a complex network to its fundamental cycles, during which most of the triadically closed parts are removed. Finally, we explore several variants of the neighborhood concept and prove that the concept of fuzzy closure can be defined. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on the mathematical model of dynamic networks, which is based on closed rather than open sets, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

In the article [11], a mathematical model was developed to characterize the spread of the influence of an independent process of cascade diffusion in online social networks. For this, the "susceptible-infected-recovered" epidemic model from epidemiology was applied to characterize the independent process of cascade diffusion and derive the general mathematical structure. To approximate the complex spatial dependence between nodes in the network, a Markov model is proposed to predict the spread of influence. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on a mathematical model for characterizing the spread of the influence of an independent process of cascade diffusion, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

In the article [12] it is noted that the structures of social networks with degree laws have been widely studied. People have a great interest in the mechanism of generation, which does not change in scale. A simple model is introduced, that is, a heuristic probabilistic explanation of the appearance of the degree law. In particular, the proposed model can be used to explain the generative mechanism that leads to a scale-invariant distribution of degrees with the exponent τ>2. In addition, a stochastic model (a pure process of birth points) is used to describe the cumulative growth trend of the edges of a temporal social network. We applied our model to temporal online social networks and found that both the scaling behavior of the degree distribution and the edge growth law can be quantitatively reproduced. Further insight into the nature of the evolution of scale-invariant temporal social networks was gained through the empirical observation that the exponent τ gradually decreases and approaches 2 or less than 2 over evolutionary time. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on a mathematical model, a heuristic probabilistic explanation of the appearance of a degree law, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

The article [13] notes that in recent years a new class of social networks has appeared, which require going beyond the previously used representations of complex graph structures. A prime example is folksonomy, an online process where users share tags on resources to give structure to an undifferentiated database. A recent paper proposed a mathematical model that represents these structures in the form of three-way hypergraphs and identified the main topological quantities of interest. Additional metrics such as edge distributions, vertex similarity and correlation, and clustering are defined. Then we empirically measured these values on two real folksonomies: the popular photo-sharing site Flickr and the bookmarking site CiteULike. These systems were found to have similar qualitative characteristics to most complex networks previously studied. It is proposed that the described quantities and methodology can be used as a standard tool

in measuring the structure of tagged networks. A mathematical model representing social networks as three-way hypergraphs is extended, defining additional quantities such as edge distribution, vertex similarity and correlation, as well as clustering, and empirically measuring these quantities on two real folksonomy systems. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on a mathematical model that represents these structures in the form of three-way hypergraphs, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

In the article [14], it is noted that a social network is a social structure consisting of individuals (or organizations), called "nodes", which are connected by one or more specific types of interdependencies, such as friendship, kinship, common interest, financial exchange, likes or dislikes, or relationships of belief, knowledge or prestige. Social network analysis examines social relationships from the perspective of network theory consisting of nodes and connections (also called edges, connections). Nodes are individual actors in networks, and ties are relationships between actors. The resulting graph-based structures are often very complex. There can be many types of connections between nodes. Research in a number of academic fields has shown that social networks operate at many levels, from families to nations, and play a critical role in determining how people solve problems, manage organizations, and how successful people are in achieving their goals. In its simplest form, a social network is a map of given connections, such as friendship, between the studied nodes. The network can also be used to measure social capital – the value a person derives from a social network. In this work, the authors tried to investigate the mathematical explanation of social networks. This research will provide researchers with guidance on how social media pathways can be optimized. An analysis of the characteristics of social graphs, which were built based on the data of the social network Twitter, including elements of network expansion, was carried out. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on a mathematical model that considers social relations from the point of view of network theory, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been investigated.

In work [15], it is noted that the task of analyzing social networks in order to identify multifactorial dependencies for predicting the spread and perception of new information by network participants is relevant, with the subsequent identification of bifurcation processes both inside and outside the network. Solving this problem will create prerequisites for formalized management of the behavior of socio-economic systems by influencing the characteristics of certain key elements of social networks. The purpose of the article is to review models of social network analysis, taking into account the fact that social units do not act independently, but on the contrary, influence each other. Models based on graph theory, structural equivalence, and random graphs are considered, promising ways to improve them are revealed. The article focuses on the analysis of online social networks. The scientific work shows the ways and some mechanisms of the growth model of social networks, based on a mathematical model with the aim of identifying multifactorial dependencies for predicting the spread and perception of new information by network participants, which affects the mechanism of their expansion. The disadvantage is that the information defensive model has not been researched.

3. The Purpose and Problems of the Research

The goal of the research is to improve the methodology of data defensive in SN taking into account the parameters of the VSNE.

The closest in terms of content is the work: [1] – research of the influence of the growth of the network volume and other constituent parameters of the social network on data protection parameters and their effect on DD. It is proved that the model is nonlinear. The disadvantage is that the non-linear model of defensive information has not been researched. This work is aimed at solving this problem.

The analysis will take into account the correlation parameters between the VSNE parameters and the DD parameters in the research and optimization of the DD in SN.

Basic survey plan:

- survey of the quantitative correlation between parameters of VSNE and parameters of DD;
- survey of RDDS in SN from possible effects on the basis of PP.

In the future, components from (Table 1) were used in the expressions of the equations.

Reasons and Technologies of Experiments

The article is devoted to the development and research of DMDDS in SN with the research of its specific parameters and parameters of VSNE. DD based on fuzzy cognitive modeling is considered.[3]

[3] Cognitive modeling is modeling using a cognitive map. A cognitive map is a graph, the nodes of which concepts are the elements, concepts, characteristics of the system, and the arcs are relations (connections) between them. There are traditional cognitive maps and fuzzy cognitive maps.

The development and research were carried out on the basis of scientific dogmatism,[4] the idea of undefined regularities.[5] This made it possible to clearly form little-known operations.

To research DMDDS in SN, NDE systems that simulate DD have been created.

Applied: methods of extracting NDE results (reception of clippings,[6] batch search for adequate original equality,[7] etc.); parameter modeling in the MatLab system.

RDDS from influences on DD was studied by researching NDE and professional special scheme made in MatLab/Multisim.

Table 1. Components considered

Компонента	Опис компоненти
Z	indicator of DD
Q_Z	a parameter indicating plausible numerical indicators of RDDS action
T_v	a parameter indicating the rapidity of the quantitative modification of the transmitted data
T_k	a parameter that indicates the rapidity of the quantitative modification between the amount of data and its removal
n_i	the number of vertices in networks at time t,
x_i	the number of connections that the vertex of network has at the moment of time t,
V	data value in SN
T_{d1}	parameter indicating the action of DD before data deletion
T_{d2}	a parameter indicating the effect of the SN volume on the DD
D	linear components
J	linear components
V_0	linear components
R_0	linear components

4. Methodology

The researches cited are devoted to the dynamic nonlinear system of DD in SN from the specificity of its parameters and VSNE.

The main contribution of this manuscript is the proposed model consisting of two stages and a series of activities. Two stages are defined from the provisions of cyber security, as it is necessary to be able to calculate and forecast quantitative indicators of the impact of VSNE on DD in social networks, as well as to determine the stability of the protection system.

The first stage is devoted to determining the action of DD in SN in connection with the role of the parameter - VSNE. The second stage is devoted to the determination of the PT of the DD.

In the first stage, the methods of solving DMDDS are used: iterations[8], exceptions, the general definition of smooth dependence[9], the method of distinguishing random fixed ones[10].

In the second stage of determining the PT of DD, methods are used: solving the NDE of the second degree by creating an electronic map created in the MatLab system.

The specified model is described in a sequence with steps of how it should be implemented and benefited.

The implementation of the first stage with the corresponding steps will allow obtaining quantitative indicators of the action of DD in SN in connection with the role of the parameter - VSNE. This will make it possible to forecast the specified indicators and determine them in real time.

The second stage with the corresponding steps will allow obtaining the phase types of the indicator $Z = f(t)$ referring to the action of various types of threats, including their maximum values. What will allow to determine the

[4] Scientific dogmatism (from the Greek. thought, teaching, decision) is one of the manifestations of the metaphysical way of thinking, which is characterized by replacing the analysis of living reality with ossified, unchanging formulas.

[5] The idea of undefined regularities is a form of scientific knowledge that reflects connections, regularities of reality and is aimed at its transformation, and also combines true knowledge about reality and the subjective goal of its transformation.

[6] The method of exceptions or the Method of small deviations is used to analyze nonlinear systems when the deviations from the equilibrium state are small.

[7] Mathematical packages such as Mathematica, Maple, or MathSad1 can be used for analytical solutions. These programs allow you to find exact solutions to differential equations using symbolic computations.

[8] The iteration method or the simple iteration method is a numerical method for solving a system of linear equations of algebra. The essence of the method is to find from the approximate value the value of the next approximation, which is more accurate. Its main idea is that a given system of linear equations turns into an equivalent system of a special type, where one of the equations of the system contains all the unknowns, the second one has one unknown less, etc., the last equation is only one of the unknowns.

[9] The function $M(x, y)$ is said to be of uniform degree m (or dimension m) if $\forall t \neq 0$ the equality $M(tx,ty) = tm \cdot M(x, y)$ holds

[10] The method of distinguishing random constants is a method of solving differential equations, based on the transformation of the algebra of the original equation to the equality of two expressions that depend on different variables.

stability indicators of the DD system. and respond accordingly to situations in real time.

5. Proposed Methodology

5.1. The Action of DD in SN in Connection with the Role of the Parameter - VSNE

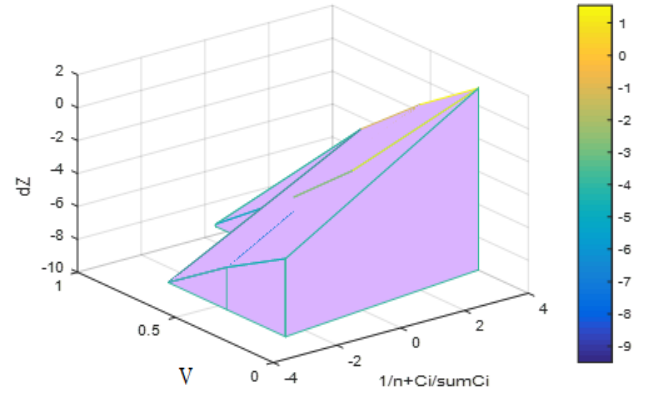
The purpose of the analysis is the development of the data protection methodology in SN, referring to VSNE, and this task has not yet been solved in [1-15], we will conduct a research of the system of equations in [1].

The research of illustrations of changes in the DD process [1] confirms its non-linearity. In connection with what was said in dependence (1), we will add nonlinear indicators (2):

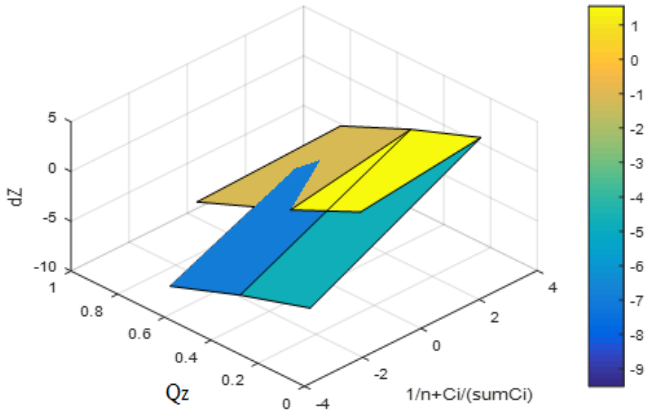
$$\begin{cases} \dfrac{dV}{dT} = Q_z Z + (T_v + T_K)V \\ \dfrac{dZ}{dt} = \dfrac{1}{n_1} + \dfrac{x_1}{\sum_{i=1}^{n} x_i} - V(T_{d2} + T_{d1}) \end{cases} \tag{1}$$

$$\begin{cases} \dfrac{dV}{dT} = Q_z Z + (T_v + T_K)V + D_2(V^2) + D_3(V^3) + \ldots \\ \dfrac{dZ}{dt} = \dfrac{1}{n_i} + \dfrac{x_1}{\sum\limits_{i=1}^{n} x_i} - V(T_{d2} + T_{d1}) + J_2(Z^2) + J_3(Z^3) + \ldots \end{cases} \tag{2}$$

The dependence of the DD and differential DD (Fig. 1) is illustrated.



(a)



(b)

Fig.1. (a) - the dependence of the DD differential on V and $\frac{1}{n} + \frac{C_i}{sumC_i}$ are illustrated; (b) - illustrated dependence of the differential DD on Q_z and $\frac{1}{n} + \frac{C_i}{sumC_i}$

Fig. 1a, b indicate a negative value of the differential of the defense indicator, which indicates the stability of the defense system according to Lyapunov's theorem, but there are insignificant areas that indicate a positive value of the differential of the defensive indicator, so the defensive system needs additional research on stability.

The non-linearity of the DD is small, this allows us to solve system (2) by the iteration method.

The research of Fig. 1 b shows that the RDDS has a small differential area with a positive value, which suggests a discrepancy with Lyapunov's theorem. Additional research is needed on the stability and reliability of DD.

$$V = V_1 + V_2 + V_3 ...$$

$$Z = Z_1 + Z_2 + Z_3 + ...$$

We assume that when:

$$dV = 0\,,\ \frac{dV}{dt} = 0\,,\ \text{та}\ dZ = 0\,,\ \frac{dZ}{dt} = 0$$

$$V = V_0 \operatorname{Sin} \omega t, Z = R_0 \operatorname{Sin} \omega t$$

The system of dependencies will be recorded:

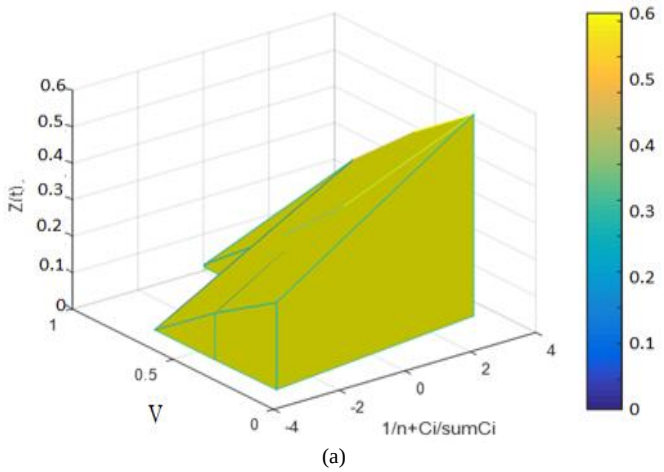
$$\begin{cases} \dfrac{dV}{dt} = Q_z Z + (T_v + T_K)V - D_2(V_0{}^2 \operatorname{Sin}^2 \omega t) - D_3(V_0{}^3 \operatorname{Sin}^3 \omega t) - ... \\ \dfrac{dZ}{dt} = \dfrac{1}{n_i} + \dfrac{x_1}{\sum_{i=1}^{n} x_i} - V(T_{d2} + T_{d1}) - J_2(R_0{}^2 \operatorname{Sin}^2 \omega t) - J_3(R_0{}^3 \operatorname{Sin}^3 \omega t) - ... \end{cases} \tag{3}$$

Let us present the dependencies in a more general form:

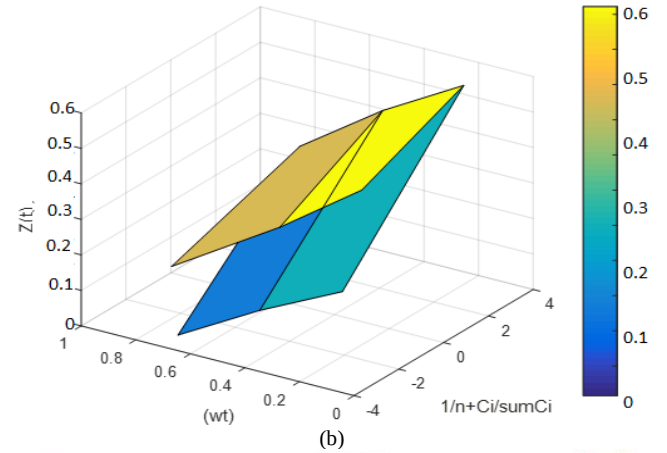
$$\begin{cases} \dfrac{dV}{dt} = \alpha Z + \beta_1 V - \sum_{k=2}^{\infty} D_k V_0^k \sin^k \omega t, \\ \dfrac{dZ}{dt} = \beta_2 V + \gamma - \sum_{k=2}^{\infty} J_k R_0^k \sin^k \omega t, \end{cases} \tag{4}$$

Де $\alpha = Q_z,\ \beta_1 = T_v + T_K,\ \beta_2 = -(T_{d2} + T_{d1}),\ \gamma = \dfrac{1}{n_i} + \dfrac{x_1}{\sum_{i=1}^{n} x_i}$

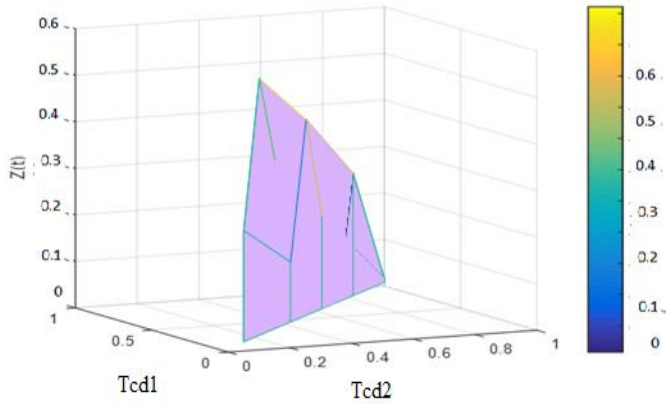
Illustrations for (4) are represented - Fig. 2



(a)



(b)



(c)

Fig.2. Illustrations by dependence (4): (a) $-Z(t)=f(V)$, $\frac{1}{n}+\frac{C_i}{sumC_i}$); (b) $-Z(t)=f(\omega t)$, $\frac{1}{n}+\frac{C_i}{sumC_i}$); (c) $-Z(t)=f(T_{cd1},T_{cd2})$

Graphical dependences in Pic. 3 show the significant influence of parameters, including the volume of development of social networks. As $\frac{1}{n}+\frac{C_i}{sumC_i}$ increases, Z increases, from zero to a value of 0.5, Fig. 2a, b. This indicates a significant dependence of Z on $\frac{1}{n}+\frac{C_i}{sumC_i}$. Additional researches of these dependencies are needed.

Let's apply the exception method:

$$\frac{dZ}{dt}=\beta_2 V+\gamma-\sum_{k=2}^{\infty}J_k R_0^k \sin^k \omega t \Rightarrow I=\frac{1}{\beta_2}\left(\frac{dZ}{dt}-\gamma+\sum_{k=2}^{\infty}J_k R_0^k \sin^k \omega t\right)\Rightarrow$$
$$\frac{dV}{dt}=\frac{1}{\beta_2}\left(\frac{d^2Z}{dt^2}+\frac{1}{\omega}\sum_{k=2}^{\infty}\left(kJ_k R_0^k \sin^{k-1}\omega t\cos\omega t\right)\right) \quad (5)$$

Substitute the value (5) into the first dependence (4):

$$\frac{1}{\beta_2}\left(\frac{d^2Z}{dt^2}+\frac{1}{\omega}\sum_{k=2}^{\infty}\left(kJ_k R_0^k \sin^{k-1}\omega t\cos\omega t\right)\right)=\alpha Z+\frac{\beta_1}{\beta_2}\left(\frac{dZ}{dt}-\gamma+\sum_{k=2}^{\infty}J_k R_0^k \sin^k \omega t\right)-$$
$$-\sum_{k=2}^{\infty}J_k R_0^k \sin^k \omega t \quad (6)$$

or:

$$\frac{d^2Z}{dt^2}-\beta_1\frac{dZ}{dt}-\alpha\beta_2 Z=-\frac{1}{\omega}\sum_{k=2}^{\infty}\left(kJ_k R_0^k \sin^{k-1}\omega t\cos\omega t\right)-\beta_1\gamma+\beta_1\sum_{k=2}^{\infty}J_k R_0^k \sin^k \omega t-$$
$$-\beta_2\sum_{k=2}^{\infty}D_k V_0^k \sin^k \omega t \quad (7)$$

Illustrations for (5) are represented - Fig. 3

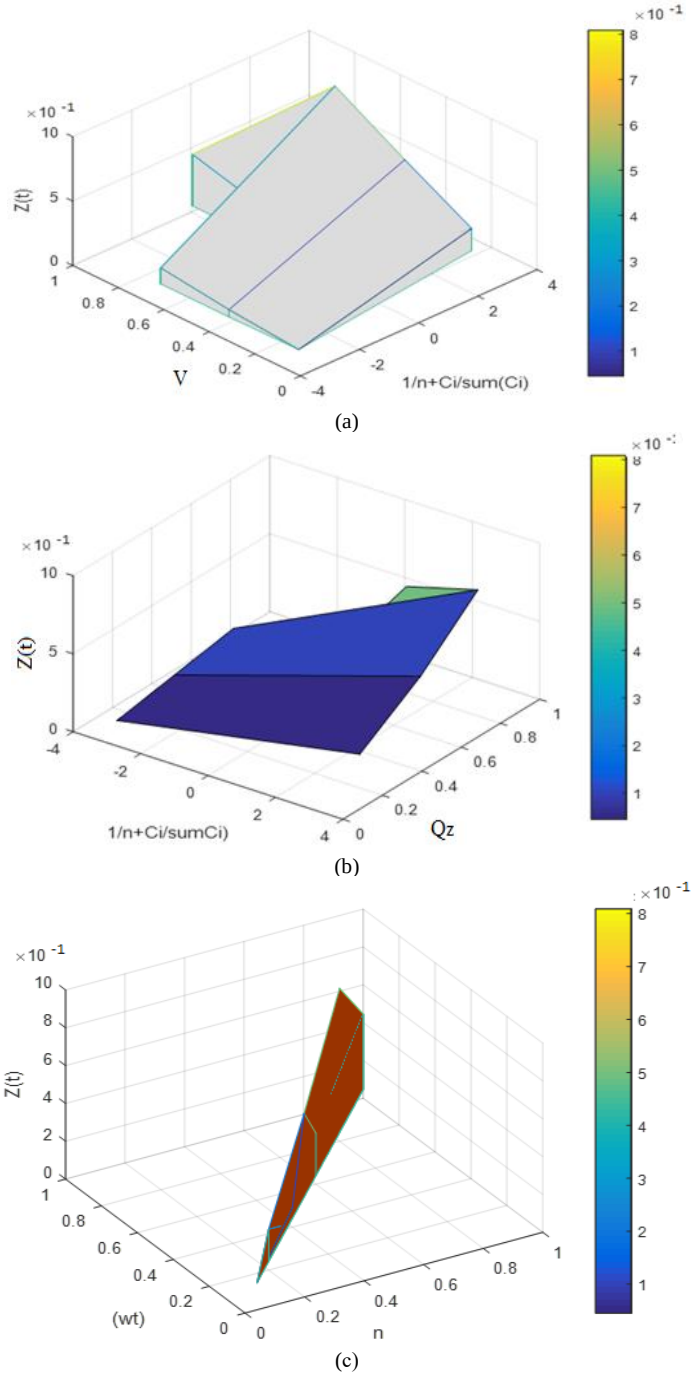
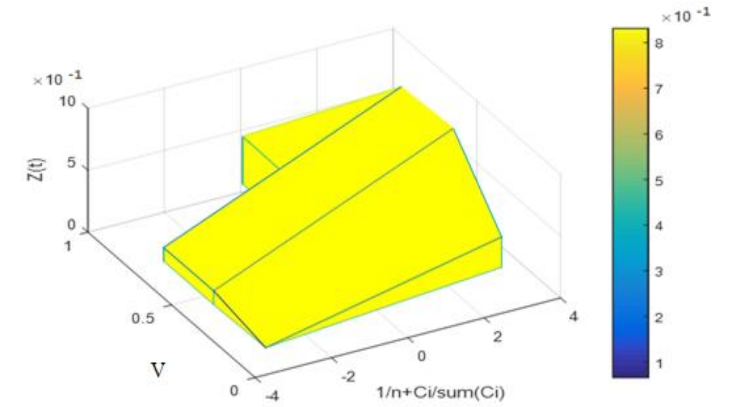


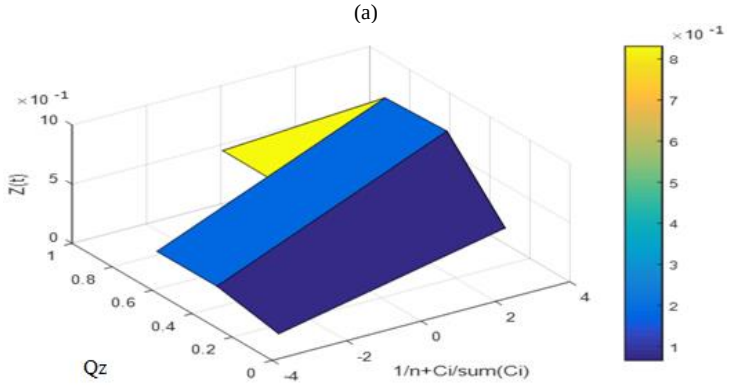
Fig.3. Illustrations by dependence (5): (a) $-Z(t)=f(V)$, $\frac{1}{n}+\frac{C_i}{sumC_i}$); (b) $-Z(t)=f(Qz)$, $\frac{1}{n}+\frac{C_i}{sumC_i}$ $\frac{1}{n}+\frac{C_i}{sumC_i}$); (c) $-Z(t)=f(\omega t,n)$

Graphical dependences in Pic. 4 show the significant influence of parameters, including the volume of development of social networks. As $\frac{1}{n}+\frac{C_i}{sumC_i}$ increases, Z increases, from zero to a value of 0.6, Fig. 3a, b. This indicates a significant dependence of Z on $\frac{1}{n}+\frac{C_i}{sumC_i}$. Additional researches of these dependencies are needed.

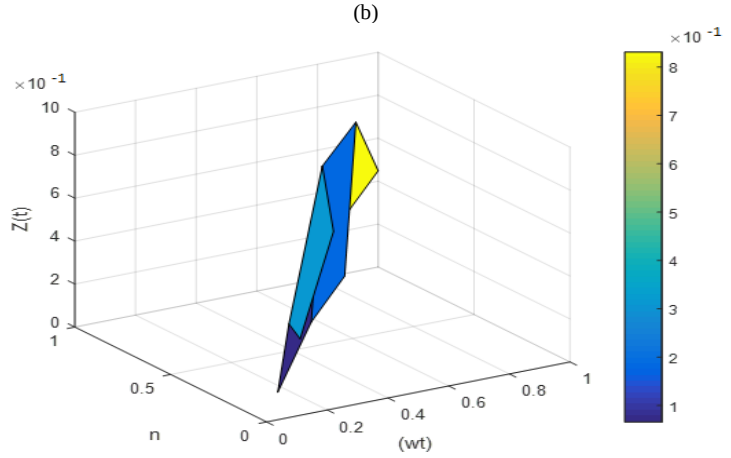
Illustrations according to (7) are represented - Fig. 4



(a)



(b)



(c)

Fig.4. Illustrations by dependence (7): (a) $-Z(t)=f(V)$, $\frac{1}{n}+\frac{C_i}{sumC_i}$); (b) $-Z(t)=f(Qz)$, $\frac{1}{n}+\frac{C_i}{sumC_i}$); (c) $-Z(t)=f(\omega t,n)$

Graphical dependences in Fig. 4 show the significant influence of parameters, including the volume of development of social networks. As $\frac{1}{n}+\frac{C_i}{sumC_i}$ increases, Z increases, from zero to a value of 0.6-0.7, Fig. 4a, b. This indicates a significant dependence of Z on $\frac{1}{n}+\frac{C_i}{sumC_i}$. Additional researches of these dependencies are needed.

General definition of homogeneous dependence:

$$Z''-\beta_1 Z'-\alpha\beta_2 Z=0 \tag{8}$$

A typical dependency will be written: $\lambda^2-\beta_1\lambda-\alpha\beta_2=0$. Let's analyze the positive discriminant of this dependence:

$$D=\beta_1^2+4\alpha\beta_2>0\Rightarrow\lambda_{1,2}=\frac{\beta_1\pm\sqrt{\beta_1^2+4\alpha\beta_2}}{2} \tag{9}$$

We will get:

$Z_{одн}(t) = c_1 e^{\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} + c_2 e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t}$ - compatible solution of homogeneous dependence.

We will evaluate the general definition of heterogeneous dependence by the method of delimiting random fixed ones: variables, and one of them is a function of the other. $Z_{одн}(t) = c_1(t)e^{\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} + c_2(t)e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t}$ $c_1'(t), c_2'(t)$ defined as:

$$\begin{cases} c_1'(t)e^{\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} + c_2'(t)e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} = 0, \\ c_1'(t)\dfrac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}e^{\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} + c_2'(t)\dfrac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} = N(t), \end{cases} \quad (10)$$

next:

$$N(t) = -\frac{1}{\omega}\sum_{k=2}^{\infty}(kJ_kV_0^k \sin^{k-1}\omega t\cos\omega t) - \beta_1\gamma + \beta_1\sum_{k=2}^{\infty}J_kV_0^k \sin^k \omega t - \beta_2\sum_{k=2}^{\infty}D_kV_0^k \sin^k \omega t \quad (11)$$

From dependencies (10, 11), we determine:

$$c_1'(t)e^{\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} = -c_2'(t)e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t} \Rightarrow$$
$$\Rightarrow c_2'(t)e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t}\left(-\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2} + \frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}\right) = N(t) \quad (12)$$

or:

$$c_2'(t)e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t}\sqrt{\beta_1^2+4\alpha\beta_2} = -N(t) \quad (13)$$

Next, we define:

$$c_2(t) = -\frac{1}{\sqrt{\beta_1^2+4\alpha\beta_2}}\int N(t)e^{\frac{-\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t}dt \quad (14)$$

$$c_1(t) = \frac{1}{\sqrt{\beta_1^2+4\alpha\beta_2}}\int N(t)e^{\frac{-\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}t}dt \quad (15)$$

Jointly researching (9,10,11) we will get:

$$Z(s) = \int_{t_0}^{t}\left(N(s) - e^{\frac{-\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}s}\frac{e^{\frac{\beta_1+\sqrt{\beta_1^2+4\alpha\beta_2}}{2}s}}{\sqrt{\beta_1^2+4\alpha\beta_2}}\right)ds - \int_{t_0}^{t}\left(N(s) - e^{\frac{-\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}s}\frac{e^{\frac{\beta_1-\sqrt{\beta_1^2+4\alpha\beta_2}}{2}s}}{\sqrt{s\beta_1^2+4\alpha\beta_2}}\right)ds \quad (16)$$

Illustrations according to (16) are represented - Fig. 5

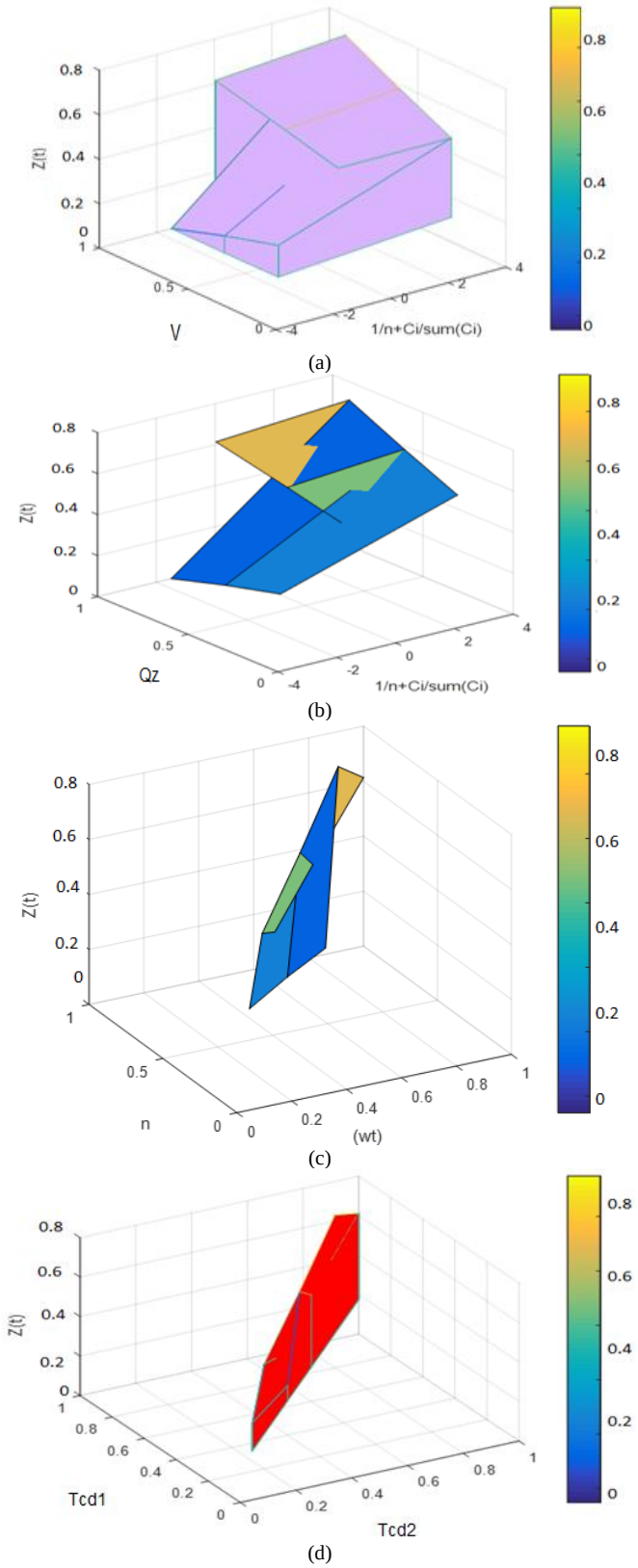


Fig.5. Illustrations by dependence (16): (a) $-Z(t) = f(V)$, $\frac{1}{n} + \frac{C_i}{sumC_i}$); (b) $-Z(t) = f(Qz)$, $\frac{1}{n} + \frac{C_i}{sumC_i}$); (c) $-Z(t) = f(\omega t, n)$; (d) $-Z(t) = f(T_{cd1}, T_{cd2})$

Graphical dependences in Pic. 6 show the significant influence of parameters, including the volume of development of social networks. As $\frac{1}{n}+\frac{C_i}{sumC_i}$ increases, Z increases, from zero to a value of 0.7, Fig. 5a, b. This indicates a significant dependence of Z on $\frac{1}{n}+\frac{C_i}{sumC_i}$.

5.2. Determination of PT DD

Primary formula:

$$\frac{d^2Z}{dt^2}-\beta_1\frac{dZ}{dt}-\alpha\beta_2 Z=-\frac{1}{\omega}\sum_{k=2}^{\infty}\left(kJ_kR_0^k\sin^{k-1}\omega t\cos\omega t\right)-\beta_1\gamma+\beta_1\sum_{k=2}^{\infty}D_kR_0^k\sin^k\omega t-$$
$$-\beta_2\sum_{k=2}^{\infty}J_kR_0^k\sin^k\omega t \qquad (17)$$

Dependency analysis is done in the Multisim system. An electronic map has been developed (Fig. 6).
The summary of the work of the system is illustrated - Fig. 7-10.
The illustrated phase views are ellipse-type figures, which indicates the reliability and stability of the DD system.
Illustration of elements of the electronic map to Fig. 6.
The map is intended for simulating the structural scheme of the differential equation (17) and its solution.

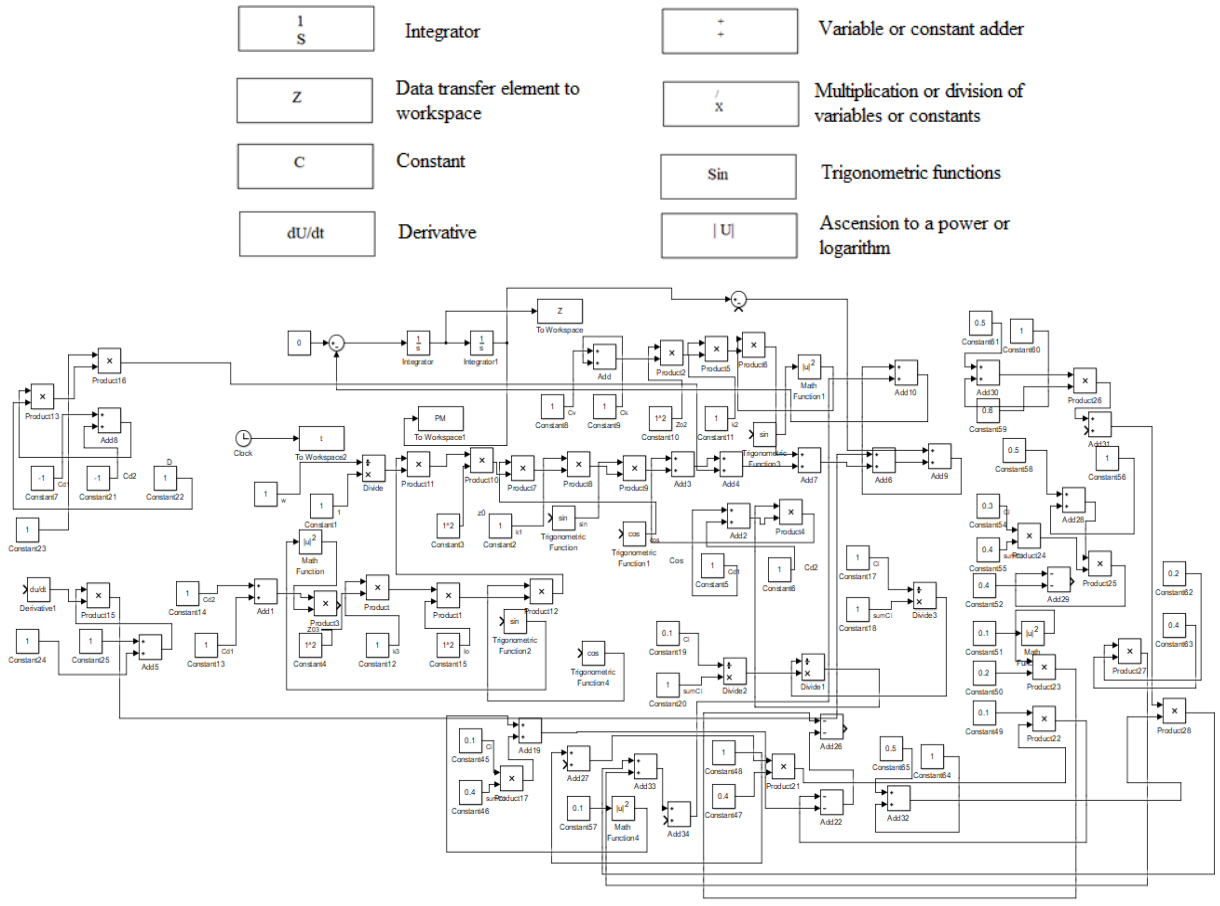


Fig.6. Electronic map of the researching of the phase type of DD taking into account possible threat

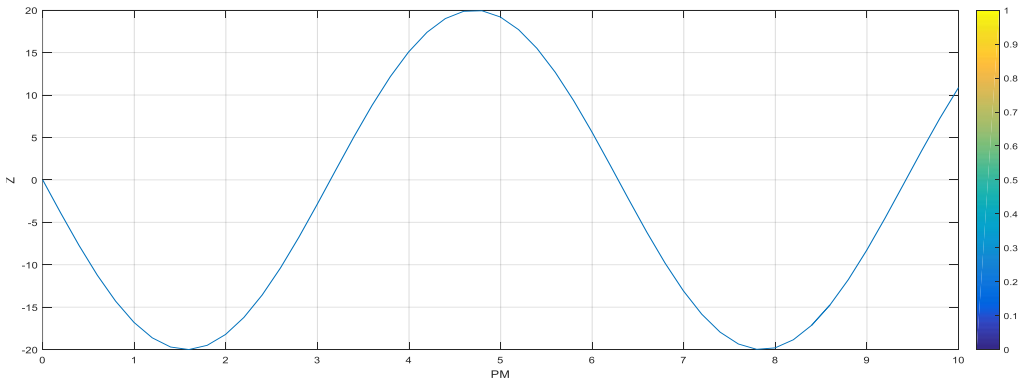


Fig.7. Fluctuations of indicator $Z = f(t)$

Fig. 7 indicates minor harmonic oscillations of the protection system in the absence of harmful effects on the system.

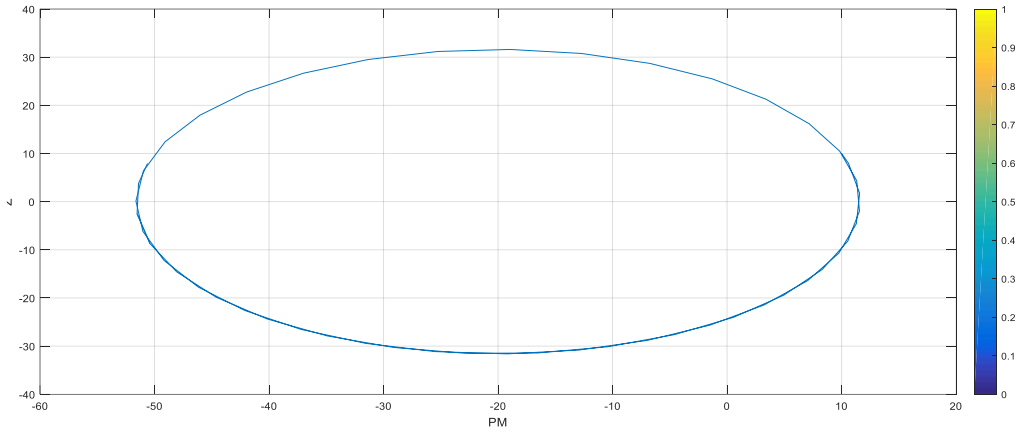


Fig.8. Phase view $Z = f(t)$ from the volume of evolution of social networks

Fig. 8 indicates the stability of the protection system according to Lyapunov's theorem, since the portrait of the protection system on the phase plane is a closed curve.

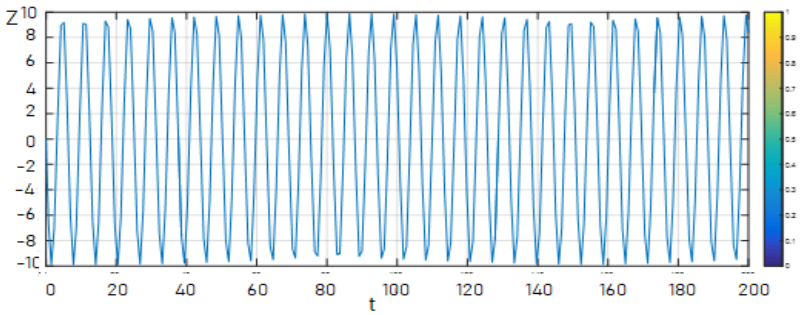


Fig.9. Fluctuations of indicator $Z = f(t)$ bearing in mind the maximum threats

Fig. 9 indicates significant inharmonic fluctuations of the protection system under the influence of harmful influences.

Fig. 10 indicates the stability of the protection system according to the Lyapunov theorem, since the portrait of the protection system on the phase plane is a closed curve without bifurcation points even in the presence of maximum threats.

The purpose of the model is to form the necessary competence in the field of cyber security of SN by promoting and spreading the theory, practice and experience in the field of cyber security in the business sector, lawful regulatory services and government institutions of other countries, as well as in scientific and educational institutions. This model can be adopted by other countries and institutes that suffer from a lack of experience in the field of cyber security of SN, since this problem is solved for the first time in scientific practice.

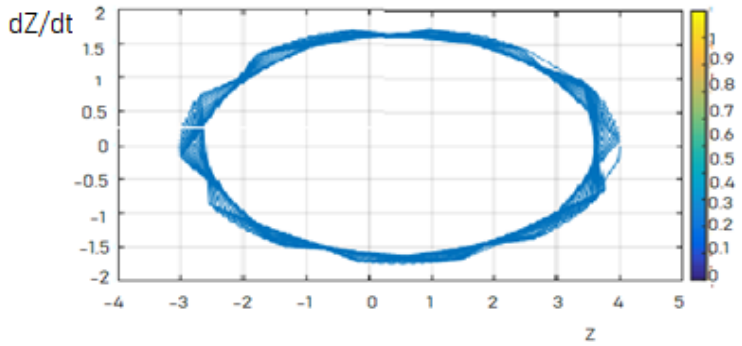


Fig.10. Phase view of the indicator $Z = f(t)$ bearing in mind the maximum threats

6. Exchange of Opinions on the Consequences of the Analysis of DD in SN, Taking into Account VSNE

The analysis of DMDDS with the use of probable parameters and parameters of VSNE resulted in obtaining quantitative indicators of the importance of isolated SN parameters, including VSNE on DD (1, 2, 4, 16) (Fig. 2-6). A well-founded symbolic foundation, a developed ideological plan, a model, which is confirmed by a simulated simulation[11] of the DD referring to the threats, approve the methodology.

The research of the reliability of DD (17) (Fig. 7, 9) and PT (Fig. 8, 10) notes the reliability and stability of DD.

The method allows to obtain numerical parameters of DD from SN and VSNE parameters. Today, the arbitrary method does not provide such an opportunity to obtain the specified gain.

It is true that DD is patient with the greatest possible loads, in particular, with VSNE.

Providing SN administrators with opportunities, actions and technologies to calculate the quantitative activity of the parameters of the VSNE on the parameters of the DD is an economic (applied) benefit.

Tracking the anomalies of the amplitudes of DD and PT oscillations will show the existence or non-existence of threats, their strength. This will enable SN defenders to take real actions regarding DD parameters in real time.

In our view, the possibility of further research consists in finding and applying other unique SN parameters to clarify their effect on DD.

7. Analysis of Results and Discussion

A system of unevenness differential equations (1-4) was obtained, which describes the defensive system of social network data taking into account their development volumes.

Imitation of an unevenness defensive system with registration of the influence of a set of parameters and parameters of the volume of development of social networks sanctioned obtaining numerical indicators of the effect of various parameters of social networks, including the volume of development of social networks on the indicator of defensiveness (4,5,16) (Fig. 2-5). The explanation is that during the modeling, the mathematical apparatus was correctly applied, the theoretical understanding was justified, and the general theoretical conclusions were verified with the conclusions of the simulation of the course of data defensiveness in social networks, taking into account the harmful effect on the system.

Taking into account (17), the stability of a unevenness system with the registration of the action of malicious objects was investigated. The analysis of the endurance of the defensive system in social networks without attacks and in the presence of attacks on the system allowed obtaining graphic dependences of the fluctuations of the defensive system over time (Fig. 7, 9) and the activity of the system in the phase plane (phase portraits) (Fig. 8, 10). If the extracted phase portraits are closed curves and do not contain bifurcation points, then according to Lyapunov's theorem, this indicates the endurance of the defensive system, taking into account the greatest impacts.

The properties of the obtained method and results are considered in the plane of obtaining numerical indicators of the defensiveness of data from the parameters of social networks, including from the parameters of the volumes of network development. Existing methods of analysis do not give a chance to obtain such data. The difference between the previous research and the obtained results is that the defensiveness of the data in SN is non-linear. It is argued that the defensive system of SN was able to withstand even maximum attacks.

Providing SN administrators with opportunities, actions and technologies to calculate the quantitative activity of VSNE parameters on DD parameters is an economic (applied) benefit.

Tracking the anomalies of the amplitudes of DD and PT oscillations will show the existence or non-existence of threats, their strength. This will enable PT defenders to take real actions regarding the parameters of the DD in the current moments of time.

[11] Imitation simulation is a research method in which the researched system is replaced by a model that describes the real system with sufficient accuracy, and experiments are conducted on it in order to obtain information about this system.

The new development of this research is considered in the application and demonstration of new factors and parameters.

8. Numerical Reasoning

Differential RDDS Fig. 2b shows that the RDDS has an insignificant region of the differential with a positive value, which suggests a discrepancy with Lyapunov's theorem. However, further analysis (Fig. 7-10) indicated the reliability and stability of DD.

The values of the DD parameters vary from 0 to 0.7, which indicates a significant influence of the VSNE parameters (Fig. 1a, 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b).

Acceleration of the DD vibration increases when the escalation of attacks increases (Fig. 7, 9).

The reliability and stability of DD are shown by continuous curves without branching spots (Fig. 8, 10), regardless of the change in the temperament of oscillations.

Research of the illustrations shows the great weight of SN parameters on DD parameters.

9. Conclusions

- The research of the model that describes the DMDDS made it possible to obtain numerical summaries of the effect of SN parameters and VSNE parameters on DD in SN and their interpretation. The parameters of the impact of VSNE on DD are identified up to one seventy percent, which made it possible to start research on RDDS.
- The method of formulating the RDDS in the SN in case of various threats to the DD was carried out using an electronic map, in the Multisim system. The analysis of illustrations from the fluctuations of DD and PT proves the RDDS under various threats.
- It is not forbidden to claim that the study of the effect of VSNE on DD is successful. The possibility of further research, in our view, consists in finding and applying other unique parameters of SN to clarify their effect on DD.
- Providing SN administrators with opportunities, actions and technologies to calculate the quantitative activity of the parameters of the VSNE on the parameters of the DD is an economic (applied) benefit.
- Tracking anomalies in the amplitudes of DD and PT oscillations will indicate the existence or non-existence of threats, their strength. This will enable SN defenders to take real actions regarding the parameters of the DD in the current moments of time.
- For the first time, quantitative dependencies between parameters of impacts, including VSNE and DD criteria, were obtained, which is an achievement of this work.
- The proposed model will be useful for the formation of competences in the field of cyber security of the SN, will contribute to raising the level of information security in the SN and raising the level of scientists, network administrators and other workers in the field of cyber security of the world.

The authors continue research in the field of SN. A scientific paper covering the complex of all parameters that influence and act on DD in SN is being prepared.

The advantages of the proposed model are explained in paragraphs 1-6 of this section.

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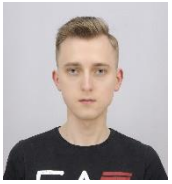

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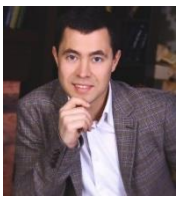

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