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## Method of morphological analysis of patent information for the construction of forecasting statistical model of dynamic type protective devices development

*Наведений метод патентних досліджень з використанням статистичної обробки патентної інформації, що відрізняється від відомих застосувань статистичної моделі прогнозу розвитку захисних пристроїв динамічного типу, побудованої за допомогою морфологічного аналізу.*

**Ключові слова:** *метод морфологічного аналізу, патентна інформація, захисні пристрої динамічного типу, технічні рішення, озброєння і військова техніка.*

*Рассмотрен метод патентных исследований с использованием статистической обработки патентной информации, отличающийся от известных применением статистической модели прогноза развития защитных устройств динамического типа, построенной с использованием морфологического анализа.*

**Ключевые слова:** *метод морфологического анализа, патентная информация, защитные устройства динамического типа, технические решения, вооружение и военная техника.*

**Problem statement and literature review.** Currently different means of dynamic type (DT) are used for the protection of armored vehicles, they are enough analyzed, for example, in works [1, 2, 7, 10, 11], but all these works consider existing technical solutions (TS) that are technically implemented in completed samples of military equipment.

Taking into consideration the tendency of development and quality changes of the means of destruction, the forecasting process of the development of dynamic type protective devices (DTPD) becomes very important. It can be traced by analyzing patenting information on technical solutions that were not technically implemented.

Dynamic protection is a kind of protection of combat armored vehicles (tanks), which proved its effectiveness during the combat actions in ATO area. Taking into consideration the development of antitank weapons, existing level of armored protection, including DTPD, can not fully ensure the protection of tanks.

The analysis of patenting information on the DTPD means of weapon and military equipment shows the intensity of patenting activities in the course of the years (Fig.1) both in our country and abroad – Russia, Israel, US, Germany and Great Britain.

The need for dynamic protection was demonstrated with the emergence of Israeli tanks with «reactive» («explosive») armor during Lebanese war in 1982, this armor revolutionized the principles and methods of armoring of armored combat vehicles (ACV) [1].

Analyzing the dynamics of patenting curve, it is easy to claim that in the given time interval dynamics of patenting is not a monotonically increasing function, and there are jumps (areas of rapid growth), which, in its turn, associated with military actions (activity) and ACV employment (tanks).

Thus, given intensity of DTPD patenting from year to year demonstrates that the biggest quantity of patent documents have been submitted in the course of following military actions : 1996-1998 – conduction of military operations of the Russian Federation in the Chechen Republic, 2001-2006 – The beginning of US combat operations in Iraq and conflicts in the Middle East. Protective means provide increased resistance of armored combat vehicles (tanks) in 2-3 times and it was proved during the war against Georgia in South Ossetia, at the beginning of the war in Syria (2008–2013), moreover, combat actions during antiterrorist operation on the territory of Donetsk and Luhansk regions (mid of 2014 to the present) also demonstrate the urgent need for the development or modernization of DTPD samples.

Given patenting dynamics determines the amount of inventions and patenting activity from year to year and it does not allow forecasting the directions of further development of samples.

Analysis of the patenting dynamics curve, shown in Fig. 1, of the investigated technical direction allows concluding that this way to improve protection at the expense of DTPD is under development stage. It is possible to conclude that after a certain period of time, equal to the production period and implementation of technological solutions (direction), submitted documents (obtained patent documents) will

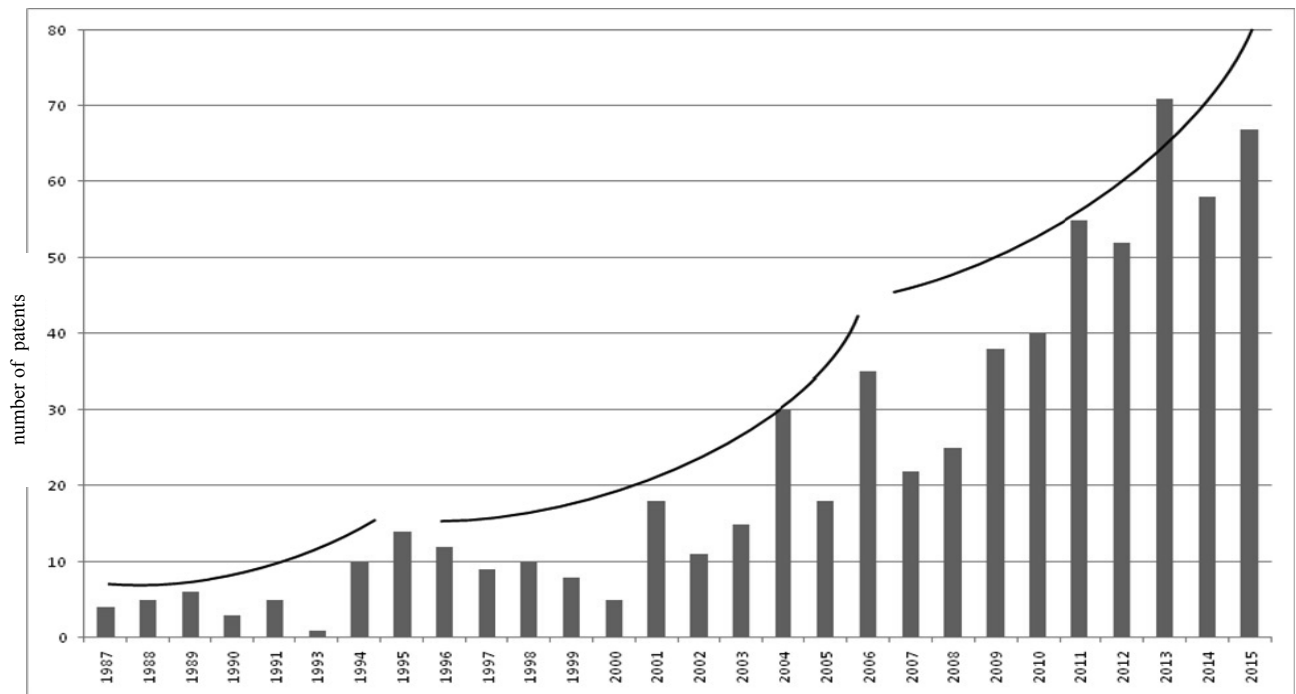


Fig. 1. Intensity (dynamic) of the patenting activities in the course of the years

occupy a dominant position in the production followed by the trend of progressive development.

The tool for forecasting of the development of new models, that ensures patentability and non-infringement of patents, is conduction of researches throughout the life cycle of WME sample using technological level estimation method. Widely used method of the technical level assessment includes a statistical analysis that based on the chronological study of quantitative indicators (volumes of DTPD patent information (documents) ) can identify differences between sample and prototype, leading countries and companies, informative analysis of technical solutions that show specific ways of development and give an objective assessment of the technical level. However, this method does not allow to assess qualitatively the probability of occurrence of qualitative stage – the appearance of fundamentally new technical solutions based on the examination of the development of DTPD properties, and to formulate requirements for effective characteristic parameters of DTPD.

Thus, **the object of study** is the process of forecasting of DTPD development and the **subject of the study**, based on domain, is the patent research method (PRM) of statistical processing of patent information with the application of morphological analysis (MA).

Therefore, the development of methods of forecasting of DTPD development is driven by the need to solve (objectively existing in DTPD means) contradiction between the use of statistical methods for processing patenting information, on the one hand, and predictive estimate of properties development, on the other hand, the solution of which will help to consider properties and, consequently, to predict and to offer DTPD technical implementation.

Based on the purpose of the study, **the scientific objective** of the study is the development of PRM by using

statistical processing of patenting information with the application of a statistical forecasting model of DTPD development, constructed using morphological analysis.

Defined contradictions in the science and practice allow determining following critical **tasks of research**:

- baseline study of forecast methods of DTPD development;
- analysis of the existing PRM with the use of statistical analysis;
- theoretical studies of statistical forecast model of DTPD development using MA;
- PRM development and experimental research taking into account statistical forecast model of DTPD development using MA;
- implementation of the proposed method using forecast of the DTPD development as an example.

Fig. 2 shows the classification of methods that are used in development forecasting [3]. Each classification level is characterized by its classification feature [4]. At the first level all methods are divided into three classes on the basis of “information base” (fact graphic, combined, expert). Further, these classes are divided into subclasses based on «principles of information processing» (statistics, analog, with feedback, advanced, direct). For the forecast of assessment mentioned classification suggests that following forecasting methods with the use of mathematical apparatus formed the base of application: extrapolation and interpolation, regression and correlation, factor models, mathematical analogy, historical analogy, art search and others.

In our case, the art search is conducted, as a rule, with the help of following methods: general determining tables; ratio analysis of the completeness of the art; method of expert estimates. Currently these methods are used at the Central Research Institute of Weapons and Military Equipment

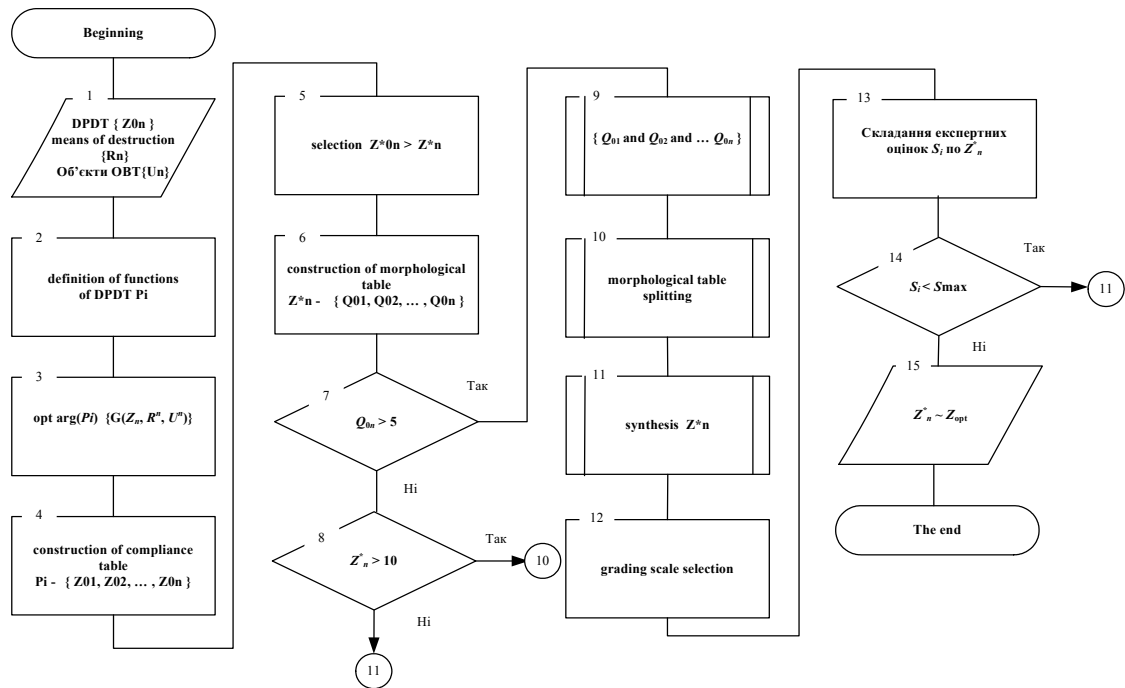


Fig. 2. Classification of forecasting methods [4]

of the Armed Forces of Ukraine for evaluation of the WME technical level. When analyzing patent information, mathematical and technical analogies are used due to invention growth model. The above mentioned classification shows that forecast estimate methods are used more often.

Problem could be solved by using the method of morphological analysis (MMA) as one of the methods of analysis of technical systems, which can help to solve contradictions and can be forecasting tool of not yet developed inventions, including DTPD and it is one of the means that describes DTPD optimal parameters, needed for the task execution (WME protection). This MMA allows to take into account the properties and, accordingly, to predict and construct a forecasting model.

The main stages of methodical approach with the usage of MMA during DTPD development forecasting are following:

task definition and DTPD complex definition (classification of the means according to standard principles of action or design features), needed for task performance (WME protection);

determination of morphological characteristics (MC) of DTPD (essential elements that define its basic functions and change which leads to the creation of a new type of LLTP);

development of morphological model  $n$  in the form of folded and unfolded matrices). All possible options for matrix implementation are defined for each MC;

definition of criteria for evaluating the effectiveness of various option of implementation of the chosen DTPD characteristic parameters;

analysis of the simulation results  $n$  terms of identifying MC excessive components and DTPD MC determination (characteristic parameters), suitable for the search of new options of DTPD TC;

synthesis of possible combinations of states of selected characteristic parameters that define the structure of DTPD implementation by choosing one element from each row of the morphological matrix and their combinations;

detection of combinations of the characteristic parameters which are not described in patent documents and technical literature;

evaluation of the effectiveness of new combinations of characteristic parameters (comparison) and a selection of those that should be developed in the future.

Specified methodical approach allows identifying the main features possible options of their implementation and evaluating the effectiveness of different options, to accomplish synthesis of possible characteristic parameters.

Based on this methodical approach, the work presents (maps out) functional diagram of morphological analysis algorithm that allows forecasting (selecting) optimal DTPD characteristics taking into account PI for improving DTPD elements and changes of tactical and technical characteristics of means of destruction, shown in Fig.3 as “Morphological analysis algorithm.”

Based on the analysis of characteristics of modern DTPD and patenting information on DTPD morphological analysis algorithm it is possible to solve a scientific problem – to develop requirements for optimal DTPD performance that will provide an appropriate level of WME protection.

## Conclusion

1) For the first time we presented the dynamics of patenting activity intensity from year to year both in our country and abroad, which is associated with the trends in the development of samples and world events.

2) Forecasting methods were analyzed.

3) Suggested method of morphological analysis allows predicting development assessment of DTPD properties.

4) The paper defined the main stages of the methodological approach when forecasting DTPD development.

5) Applied algorithm of morphological analysis allows forecasting of optimal characteristic parameters to improve DTPD elements and to create new sample taking into account patent information.

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