DOI: https://doi.org/10.32836/2521-6643-2019-2-58-12
UDC 004.04:355.40

A. S. Spitzer, PhD, assistant, Assistant of Specialized Computer Systems Department, Lviv Polytechnic National University
A. V. Mashchak, PhD, Senior Lecturer, Senior Lecturer of the Theoretical Radio Engineering and Radio Measuring Department, Lviv Polytechnic National University
T. I. Tkachuk, PhD, assistant, Assistant of Specialized Computer Systems Department, Lviv Polytechnic National University
I. V. Kulyk, PhD, Senior Lecturer, Lecturer of the Theoretical Radio Engineering and Radio Measuring Department, Lviv Polytechnic National University

INCREASING EFFICIENCY OF INTERACTION BETWEEN THE OBJECT AND SURROUNDING TARGETS USING POSITIONING METHODOLOGY

In this article the idea of the theoretical model of the object (O) positioning in space is discussed. The space object positioning takes place on the basis of the enemy targets (ET) and friendly targets (FT) locations. The effective location criterion is determined – the maximum number of ET and the minimum number of ET which falls into the damage zone. Also, in the article the analysis of object own safety is carried out. Proposed model expands the criteria for assessing the characteristics of the object in relation to the environment in which the object is located.

Key words: *positioning methodology; space object positioning; enemy targets locating; friendly targets locating.*

У сучасних бойових діях технічні комп'ютеризовані системи виконують все більш важливу й критичну роль. Це передбачається необхідністю підвищення ефективності ведення війни – забезпечення максимальних ворожих втрат за мінімальних власних втрат. Засоби ведення бойових дій стають складнішими та досконалішими, це спричиняє підвищення їхньої економічної вартості та фізичної цінності. Проте порівняно з технічними засобами цінність життя і здоров'я військовослужбовців і цивільних осіб займає найважливіше місце. Наразі для розв'язання таких проблем використовуються

моделі та підходи, які насамперед орієнтовані на характеристики та параметри об'єктів бойових дій. Фактори впливу навколишнього середовища або ігноруються (як малозначущі), або оцінюються людьми на основі їхнього досвіду (експертне оцінювання) та теоретичних знань без належного системного підходу.

Отже, у прийнятті тактичних рішень людський фактор став визначальним, що може призвести до помилкових незворотних рішень. В епоху цифрових технологій існує потреба в адекватності та ефективності математичних моделей, які могли б автоматизувати процеси тактичного планування в реальному часі. Такі моделі мають містити критичні вимоги до оцінювання середовища, в якому перебуває об'єкт. Тому необхідно розробити теоретичну й математичну модель (яку можна алгоритмізувати), це дасть змогу максимально знизити ризик для дружніх цілей та підвищити ефективність озброєння і боєздатність військовослужбовців.

Однією із найважливіших вимог до цієї моделі є автоматизація процесу тактичного планування й управління. Однак, незважаючи на військове спрямування цієї моделі, вона може бути успішно використана для іншої мети, наприклад для планування в економічній сфері. Адже ця модель може знаходити не тільки ворожі цілі чи дружні об'єкти, але й більш успішно планувати бізнес-стратегії та визначати конкурентів на ринку.

Результатом цієї статті є вербальний алгоритм і теоретична математична модель, яка потенційно може підвищити ефективність управління об'єктами (у військовій, економічній та інших сферах). Запропонована модель розширює критерії оцінювання характеристик об'єкта щодо середовища, в якому перебуває об'єкт.

Ключові слова: *методологія позиціонування; розміщення космічних об'єктів; розміщення цілей противника; дружнє розміщення цілей.*

В статье обсуждается идея теоретической модели позиционирования объекта (O) в пространстве. Позиционирование космического объекта происходит на основе расположения вражеских целей (ET) и дружественных целей (FT). Определяется критерий эффективного местоположения – максимальное количество и минимальное количество ET, которое попадает в зону повреждения. Проведен анализ собственной безопасности объекта. Предлагаемая модель расширяет критерии оценки характеристик объекта по отношению к среде, в которой находится объект.

Ключевые слова: *методика позиционирования; позиционирование космического объекта; определение местоположения вражеских целей; определение местоположения дружественных целей.*

Problem formulation. In modern wars, technical computerized, often self-assembled systems become more and more important and critical. It also provides the need to increase the effectiveness of warfare – maximum hostile loss at minimum own losses. The means of warfare become more complex and more advanced therefore more expensive and more valuable. Equally, the value of human resources and lives of civilians takes the first place. At the moment, to solve such problems, models and approaches are used and primarily focused on the characteristics and parameters of the object. Environmental factors are mostly ignored or evaluated by people based on their experience (expert assessment) and theoretical knowledge, without proper systematicity approach.

Thus, when making tactical decisions, a human factor takes place as significant part that can lead to false/incorrect decisions. In the era of digital technology, there is a need for the models that could automate the tactical planning processes, in a real time. Such models have to acquire the critical requirement to evaluate the environment in which the object is located. Therefore, it is necessary to develop a theoretical, mathematical model (which can be algorithmized), will maximize risk reduction; increase the effectiveness of weapons and the combat capability of soldiers. One of the most important requirements of this model is the automation of the tactical planning and management process.

However, despite of the military deviation of this model, it can be successfully used for other purposes, such as economic field. After all, this model allows more successfully plan the business strategies, to define competitors, as well as ET, as well as FT.

Main material. The main problem is to calculate the location of the object in the space and damage points, based on the target zone of the targets (fig. 1).

Object means a transport or other which initiate interaction with targets by a certain algorithm.

Target – transport or other, exposed to the object influence.

Characteristics – a set of the targets' and objects' parameters. The characteristics include size, position in space and time, manoeuvrability, interaction zone, type of interaction, aggressiveness, own safety.

Types of interaction – positive and negative – distinguish two types of interaction on target.

Friendly target – the target that positively interacts with the object (an aggressive object can interact negatively with such targets, neutral – neutrally, and not aggressive should interact only positively). For such targets, it is necessary to maximize the positive impact of the object and minimize the negative.

Enemy target – the target that negatively interacts with the object (an aggressive object should interact negatively with such targets, neutral and not aggressive – can interact neutrally). For such targets, it is necessary to minimize the positive effect of the object and maximize the negative.

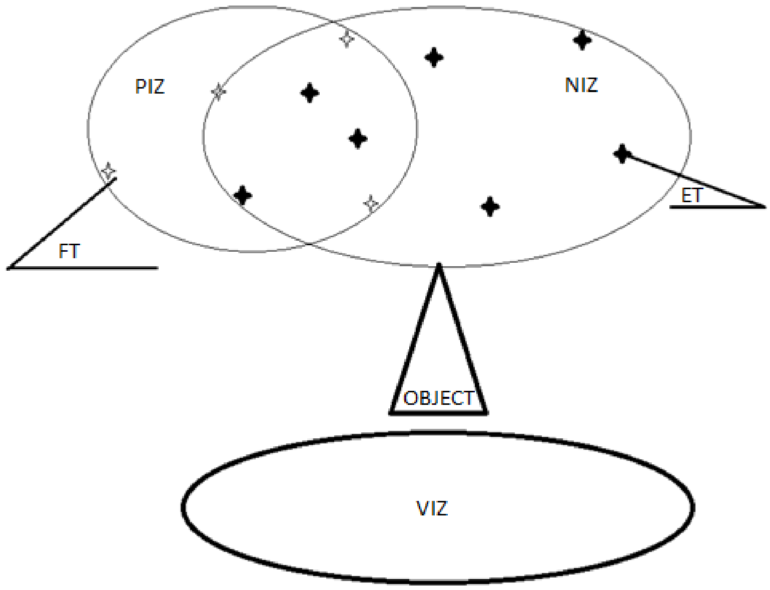

Fig. 1. Object targets and zones

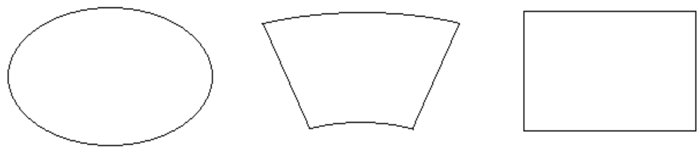

Fig. 2. Typical interaction zones

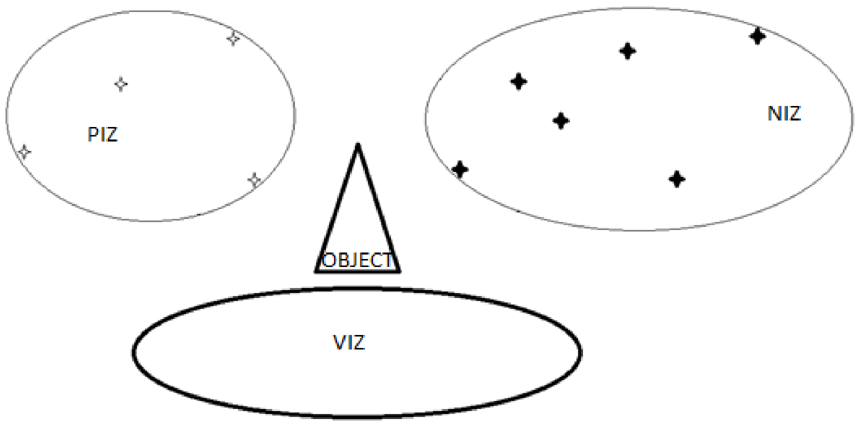

Fig. 3. Ideal case where all zones are clearly separated

Interaction zone (IZ) – zone, where object interacts with targets without changing their position and other characteristics (fig. 2). Distinguish positive zones (PIZ), negative interaction (NIZ) and zone of the object's vulnerability (VIZ). In most cases, the zones of positive and negative interaction completely coincide or one of them is absent.

The positioning of the object in its basis is based on the theory of games [1–6].

Ideally, when the zones of interaction with friendly and enemy objects are separated in space (fig. 3), the object is easily positioned by the following rules:

• The PIZ is located in the largest congestion of FT;

• NIZ is located in the largest concentration of ET;

• VIZ is located in the smallest accumulation of ET.

In case that it is impossible to reach the ideal state, or the zones coincide, the priority of the above rules is determined as follows:

• For an aggressive object, the definition of a NIZ is of a higher priority than the definition of the PIZ and vice versa;

• For a high-security entity, the definition of the VIZ has a higher priority than the definition of the PIZ or NIZ and vice versa.

In this paper, an algorithm for calculating zones is considered. However, the algorithm for positioning the object based on the calculated zones is not considered. The algorithms do not take into account the accuracy of the object interaction with the targets. This will be discussed in the further articles.

To determine the PIZ and NIZ the algorithm is applied the same only with inverse logic – FT changes the values from ET.

The same algorithm is used to determine the VIZ, but the FT objects are not taken into account.

Since the algorithm uses the same one only with inverse logic, there is a need to enter additional definitions.

<u>Algorithm terms.</u>

The calculation zone (CZ) is one of three zones for which the algorithm is used (given by the characteristics of the object) [7].

Target objects (TO) – objects that should be covered by the calculated zone as much as possible [8].

Non-target objects (NO) are objects that should not fall into the calculation zone, or their number should be minimized [9].

The calculated zone of the target objects (CZT) is the area equal to the CZ in terms of size and form, in which the largest number of TOs is accumulated [8–10].

The calculated zone of non-target objects (CZN) – a zone equal to CZ in size and form, in which the largest number of NO is accumulated.

The calculated zone of minimum non-target objects (CZM) is a zone equal to the CZ in size and form, in which the smallest number of NO is accumulated within the bounded area of target objects [11].

As a result, we obtain the following algorithm propositions:

1) calculate the location of the settlement zones by the TO and NO location;

2) calculate CZ, based on the condition that the CZ should coincide with the CZT, as much as possible but not include CZN;

3) repeat second point for all areas of the object;

4) establish the object for maximum coverage of the calculated zones.

This algorithm is valid both for stationary and for dynamic entities or objects. The only difference is that dynamic entities and computing objects must be real-time.

Conclusions and further researches directions. The result of this article is a verbal algorithm description of the theoretical model is shown. The mathematical model, which potentially can increase the object effectiveness (either military, economic and oth.). Proposed model expands the criteria for assessing the characteristics of the object in relation to the environment in which the object is located. Present paper show the main idea on positioning the object based on friendly/enemy targets.

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