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UDC 539.122.2; UDC 681.586.5

ALGORITHM FOR WORKING THE SENSOR OF PANORAMIC DETECTION OBJECTIVES AND DESTRUCTION OF ENEMY ON MODULATED LASER BEAM IN 3D - SPACE “LADOGA-1M”

Grigoryev-Friedman Sergey Nikolayevich
Joint-stock company Research and production enterprise “Polyot”

Abstract. The article is devoted to solving the urgent task of improving the performance and accuracy of bearing, detecting target and destroying potential enemy. The purpose of the work is to develop algorithm for the operation of the sensor for panoramic target detection and destruction of enemy in the 3D-space “LADOGA-1M”.

Аннотация. Статья посвящена решению актуальной задачи повышения производительности и точности пеленга, обнаружения цели и уничтожения потенциального противника. Цель работы — разработка алгоритма работы датчика панорамного обнаружения цели и уничтожения противника в 3D-пространстве “ЛАДОГА-1М”.

Key words: algorithm, sensor; panoramic detection; destruction enemy; telescopic target coverage angle; irradiation; modulated laser beam; optical range; radio silence mode; semiconductor laser diode; solid-state laser pumped by laser diode; photon; electromagnetic wave; photo-sensor; phototransistor matrix; laser radiation; wavelength; signal frequency.

Ключевые слова: датчик; панорамное обнаружение; уничтожение противника; телескопический угол охвата цели; облучение; модулированный лазерный луч; оптический диапазон; режим радиомолчания; полупроводниковый лазерный диод; твёрдотельный лазер с накачкой лазерным диодом; фотон; электромагнитная волна; фотодатчик; фототранзисторная матрица; лазерное излучение; длина волны; частота сигнала.

Introduction

In the technical literature [1—3, 7—12] there are significant number of analogues containing various types and types of laser systems for constant, round-the-clock, all-weather tracking of satellites and special targets of potential adversary both in open space and in dense layers of the Earth’s atmosphere, dense fog, rain, snow, various gases, ozone and the like. All these analogues have common drawbacks consisting in very great complexity, bulkiness, excessive weight and external dimensions, incorrect operation during intense cloud cover due to use of very powerful laser systems, which in order to “break through” thick and optically dense layers of the Earth’s atmosphere, ozone and other media are forced to reduce the frequency, that is, to increase length of transverse electromagnetic wave during induced coherent emission of photons in lasers. Thus, exact coordinates of location, length and frequency electromagnetic wave of laser systems for guiding and holding detected target and irradiating the potential enemy with telescopic beam, on which modern devices are used for direction finding, target detection and destruction of potential enemy by modulated laser guidance beam, are obtained.

With previous methods of laser detection, tracking and destroying target for preventive strike against potential enemy or aggressor, huge amount of consumed electric energy is consumed, due to which cost of such direction finding is order of magnitude higher than when using classic antenna-feeder form of direction finding. Therefore, this type of direction finding of target and detection of potential enemy is not very effective and not economical.

The article develops the idea of Russian scientists in the field of applied special laser technology in aviation and navy, proposed for first time in the world, in [4—6]. The relevance of this idea lies in the fact that the system of laser communication, direction finding, detection and destruction of potential enemy has been used in open space for relatively long time and successfully, but its use in dense layers of the Earth’s atmosphere posed significant technological difficulties, and was also little studied theoretical basis.

Analysis and recommendations for solving the problem

To aim rocket at target, an intruder or unmanned aerial vehicle (drone - reconnaissance), special device is used in modern air defense and missile defense systems — laser target designator. Such devices include proposed sensor for panoramic target detection and destruction of enemy by modulated laser guidance beam in 3D-space “Ladoga-1M”, emitting modulated laser beam, consisting of narrow coherent photon flux. The principle of guiding rocket or artillery shell is very simple: a laser beam is directed at object, which, being reflected from detected target, is captured by photo-sensors of their self-guidance head. Modulated beam — “holds” rocket or projectile in right direction and ensures accurate hit in detected target. The laser beam is received by homing missile, which sends signal to missile control system. For effective use of preemptive missile, target must be illuminated by laser beam for several seconds so that homing head of missile itself captures its reflection. Once preemptive missile is fired, target must still be illuminated to ensure accurate hit. It must be remembered that intended goal is most often moving.

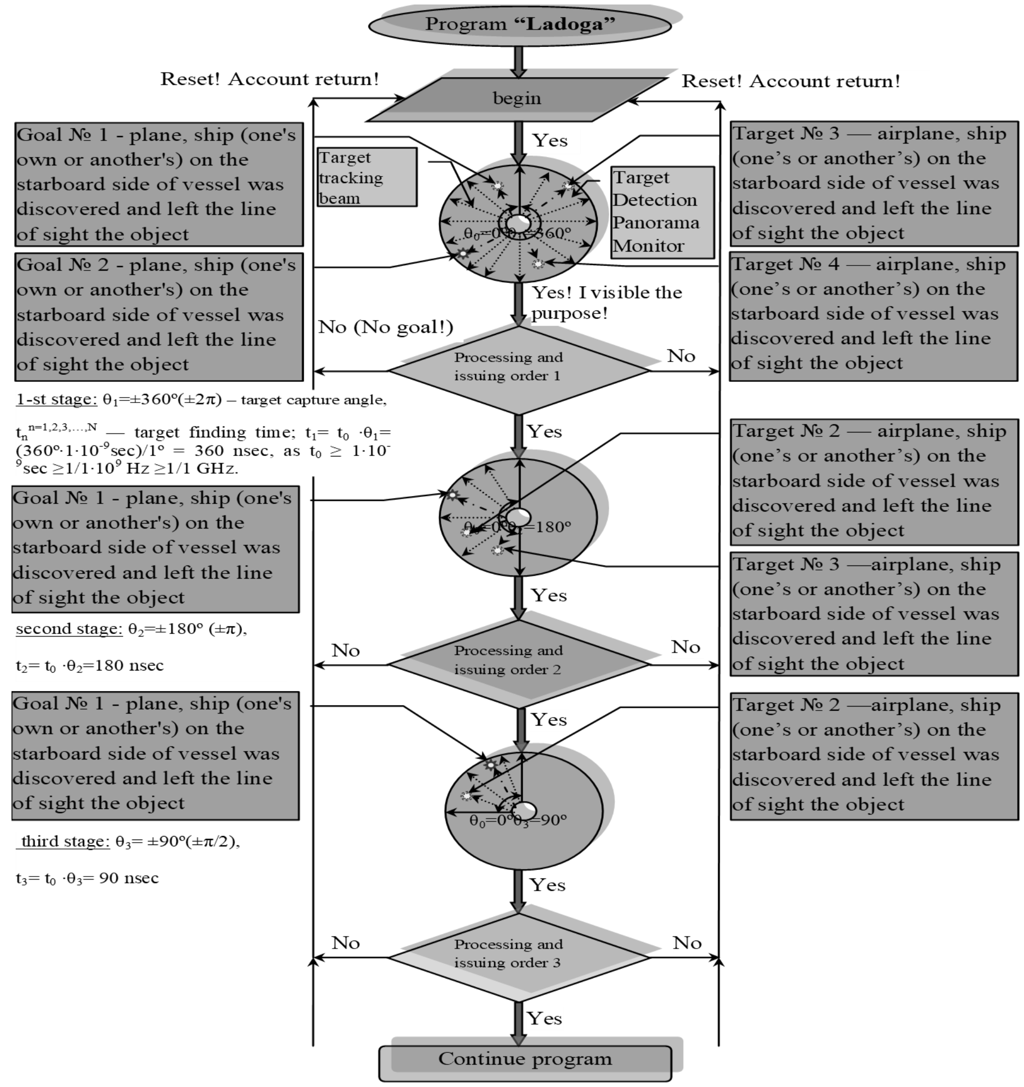

Fig. 1

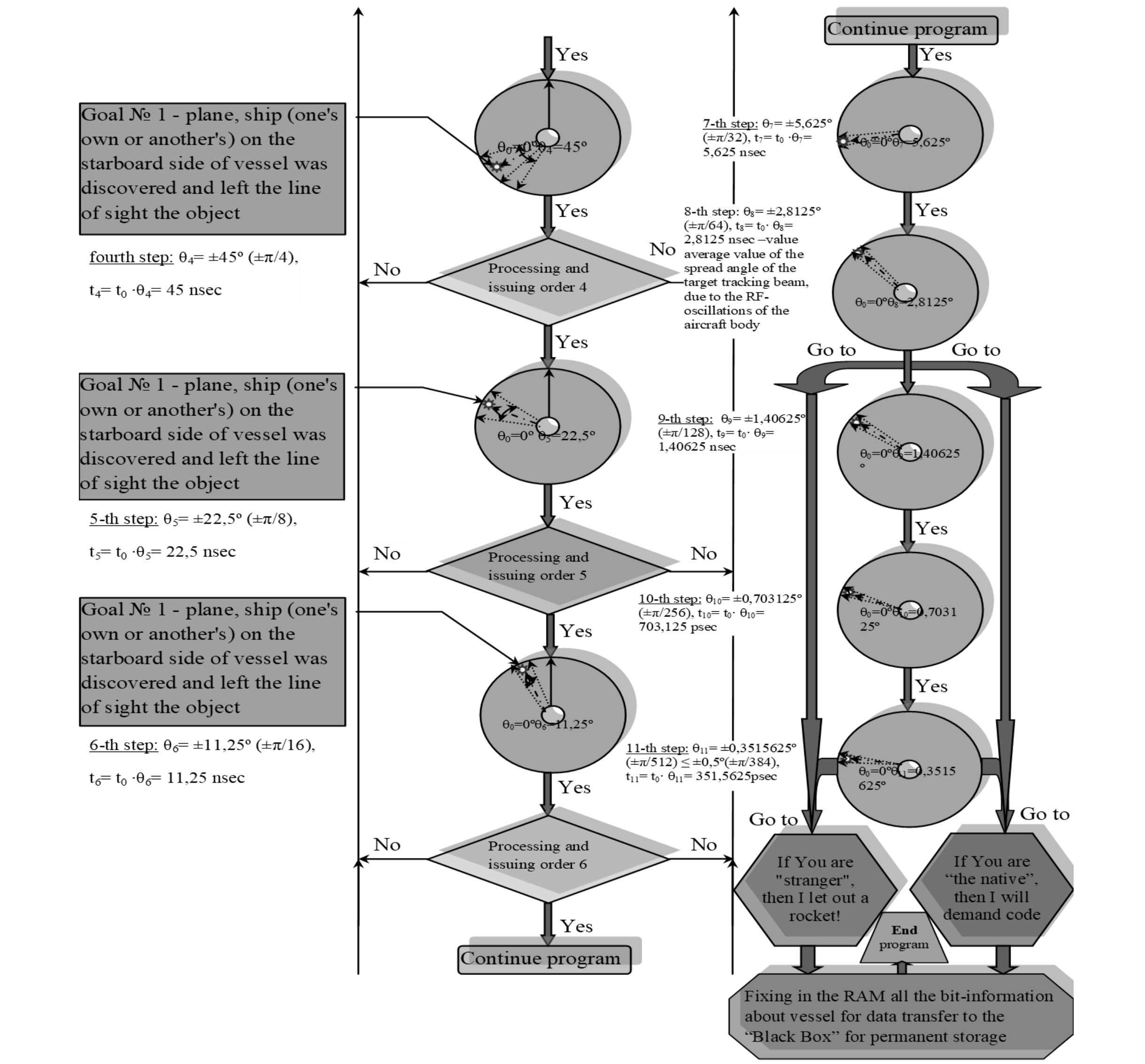

Fig. 2

The limited power of target illumination systems leads to restrictions on the use of laser weapons in ranges of up to 30 km and altitudes up to 10 km. The laser designator is usually located on carrier aircraft or on spotter aircraft. In both cases, the target aircraft is limited in maneuver and vulnerable to air defense systems and enemy missile defense systems. Combat maneuvering and subsequent dive of aircraft lead to disruption of target capture and missed target's destruction system [1—3, 7—12].

The main distinguishing feature of proposed Ladoga-1M sensor design, unlike Russian and foreign counterparts, is the ability to successfully use monochromatic coherent radiation of modulated narrow-beam laser beam at frequencies of so-called "transparency windows" of the Earth's atmosphere, where efficiency exposure to photons of target is maximum. It is made on the basis of semiconductor laser diode or solid-state laser pumped by laser diode instead of conventional, flat, TEM-type electromagnetic wave in airspace emitted by conventional aviation or other army antenna in modern radar systems for near and long-range enemy detection.

The closest in technical essence and achieved result to proposed invention is the "Device of beam guidance of controlled object", protected by patent [7], taken as closest analogue (prototype). The disadvantage of this device is technological complexity, large mass and dimensions, relatively high energy consumption, high cost of laser bearing sessions, target detection and retention of enemy in telescopic angle when it is irradiated with modulated laser beam, significant difficulties when working in conditions of intense cloudiness, various precipitation, smoke, dense layers of the Earth's atmosphere, etc. When creating "Ladoga-1M" sensor based on semiconductor laser diode or solid laser pumped by laser diode, these disadvantages are eliminated.

In figures 1 and 2 show algorithm of the "Ladoga-1M" sensor. A circular laser homing missile or projectile constantly keeps detected target in the area of full, all-encompassing (360°) telescopic angle and monitors behavior of detected target. From the "Ladoga" software package, through block of analog-to-digital converter — digital-to-analog converter (ADC – DAC), signal is sent to laser missile homing head to reduce telescopic coverage angle of detected target by 2 times (180°). After several divisions (iterations) on the occasion crushing angle of coverage identified target by exactly half, in the end get exact coordinates of target. The total time of bearing and target retention in telescopic angle is 750 nsec.

The design of the "Ladoga-1M" sensor implies efficient operation of at least two modulated laser beams moving synchronously relative to each other, one clockwise and other counterclockwise, which provides efficient and fast radio direction finding for target detection and destruction [4—6].

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