GUIDELINES FOR IMPROVING LASER TARGETING DEVICE IN MILITARY

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Abstract: The invention of the laser can rightfully be considered one of the most significant discoveries of the 20th century. At the very beginning of the development of this technology, they already predicted a completely universal applicability, from the very beginning the prospect of solving various problems was visible, even though some tasks were not even visible on the horizon at that time. Monochromatic laser radiation can be obtained in principle at any wavelength, both in the form of a continuous wave with a certain frequency and in the form of short pulses lasting up to fractions of a femtosecond. Focusing on the studied sample, the laser beam is subjected to nonlinear optical effects, which allows researchers to perform spectroscopy by changing the frequency of light, as well as to perform coherent analysis of processes by controlling the polarization of the laser beam. Lasers were initially limited more to scientific research and military applications. The report examines the use of laser targeting. Today there are several areas in which the introduction of laser technology in the military industry follows: air, ground and underground location, communications, navigation systems, rifles, missile defense systems. In the report let's present some of the applications of lasers, as well as protection of them.

Keywords: laser locators, laser systems, military, application, weapons, laser device, laser safety, targeting, laser beam, optical.

1. Introduction

Currently, it is almost impossible to imagine a branch of industry in which at least some of the laser technology doesn't use. Today, several decades after the demonstration of the first laser in 1960 by T. Maiman, the progress of laser technology has been developed and improved not only for civil but also for military purposes. Lasers throw intense beams of energy at the object, powered by a chemical fuel, electricity, or a stream of electrons [1].

The report examines the use of laser targeting. In civilian life there are many devices with laser guidance – thermometers, tape measures, laser lines, laser guidance of jigsaws, bar-code readers, electronic translators and more. The military industry is no exception. Today there are several areas in which the introduction of laser technology in the military industry follows: air, ground and underground location, communications, navigation systems, rifles, missile defense systems. The largest funding and state support for laser technology there are in the United States, Britain, France, Switzerland and Germany. Lasers revolutionized as accessories to high-energy weapons. This technology serves as a powerful tool for war fighters when used for battlefield lighting, rangefinders, communication systems, energy beams or active remote sensors, and more [2].

Over the years, laser technology has sufficiently matured to provide cost-effective, energy efficient, high-speed and wavelength flexible systems that can be used for a variety of military operations such as commutation, remote sensors, directed energy weapons, etc. [3].

2. Methods

Laser location – this is a part of optical electronics that deals with the detection of various objects using electromagnetic waves emitted by lasers. The objects of discovery are usually tanks, missiles, ships, industrial and armed facilities, as well as satellites. It is based on several basic characteristics: such waves can bounce objects and have a great ability to detect. They can also propagate in a straight line, is a laser beam can carry a target. The laser beam propagates at the same speed, which allows to determine the distance to the target.

Ground-based laser locators became the first laser equipment introduced into the military industry. Their first tests were conducted in 1961 in Vietnam. This was the XM-23, which was later adopted by American forces. This locator is designed for deployment in the ground forces [4].

The Swedish laser rangefinder is designed to be deployed in air naval and coastal artillery. It is particularly robust, which allows the use of this rangefinder in difficult conditions. No less successful is the test of the Norwegian laser rangefinder LP-4, which can operate at distances from 200 meters to 3 kilometers [5].

There are also many portable rangefinders for infantry and artillery. Particularly popular among them is the rangefinder in the form of binoculars, the electronic components of which are made of integrated circuits. Thus, the total weight of it together with the battery is about 2 kilograms. Of great interest to the US military is the tank rangefinder. In the United States, AN/VVS-1 laser was even developed for the M60A tank. Its main feature is that it can be introduced into the fire control system of a combat vehicle and thus the measurement of the range can be performed not only by the gunner but also by the tank commander [6].

The active development of ground-based laser systems, which are designed to track missiles in the early stages of flight, as well as satellites and aircraft, is also underway. Great importance is given to locators included in the missile defense system. Thus, the laser radar "OPDAR" is designed to track missiles in the active part of the flight. A gas laser is installed on this locator, which works continuously. The locator can operate at 30 meters to 30 kilometers. As a rule, it is located at 1 kilometer from the rocket. The use of this locator in conjunction with the ability to make accurate measurements of the characteristics of the movement of missiles allows to calculate the exact location of its fall.

Laser locators are often used in aviation in the United States and NATO. With their help, a more accurate measurement of height and range is made. Such lasers are usually small in size and therefore integrated into the fire control system. With their help, several other tasks are performed: guidelines and indication of the goal. Such lasers are commonly used in airplanes, helicopters and unmanned aerial vehicles. They can be active or semi-active. Laser systems are used in such types of ammunition as surface-to-air missiles, bombs and naval torpedoes. There will be an active struggle between developed countries for the right to own such developments. A few years ago, it was reported in America that one of the American companies, called Rocky Mountain Instrument, was selling military secrets to foreign countries, in particular Russia, Turkey, China, and South Korea. In 2005–2007, this company was engaged in the export of optics, prisms, and technical military information without the appropriate permission of the United States Department of State [7].

Defensive countermeasures. It applies to low power lasers to high power laser systems. IR countermeasures use lasers to confuse the guidance device of IR missiles.

Disorientation. The Optronics Division of the THALES Group, headquartered in Glasgow (Scotland, United Kingdom), has designed a range of laser based non-lethal electro-optical countermeasure systems which can be used to defend against a wide variety of threats whether they be on land, at sea or in the air. These systems can be used to defend against opposing forces and

critical points such as facilities, checkpoints and convoys. They are designed to enhance the safety and capability of forces in peace-keeping operations and especially in areas where civilians and insurgents are difficult to differentiate. Some weapons simply use a laser to disorient a person. One such weapon is the Thales Green Laser Optical Warning" (G.L.O.W.), it is shown in the **Fig. 1** [6]

Fig. 1. The G.L.O.W. dazzler can be fitted with a proprietary mount offering a side-folding stock, a pistol grip and an interface for instinctive optical sights for Stand-Alone use [6]

Target ID. It is a low power laser for designating a target for launching a missile primarily from an aircraft. Guidance outlines your flight path to the target. The laser beam has a pulse frequency that is set to the guided munition. Laser guidance can be on the target from aircraft or infantry troops. These lasers are mostly infrared lasers, so the enemy cannot easily detect the directed laser light.

Firearm. A laser is often used on firearms to improve aiming. For example, the laser sight, usually a visible light laser mounted on a weapon and aligned to emit a beam parallel to the barrel. Because the laser beam has low divergence, the laser light appears as a small point even at great distances. In the **Fig. 2** there is an example.

Fig. 2. A laser sight used by the Israeli [8]

Lasers aimed at the eyes. A non-lethal laser weapon was developed by the US to temporarily disrupt the capability of opposing forces or otherwise threaten enemy forces. The laser device illuminates the enemy with a low-powered laser light, blinding or disorienting a person. Several types of camouflage are available and some have already been used. Deliberate permanent blinding of the enemy is prohibited by the rules of war and international law [9].

Fig. 3 shows a ZM-87 [10]. It is a Portable Laser Separator is a Chinese electro-optical counteracting neodymium laser device. The ZM-87 is designed primarily for blind people but has also been reported to damage photovoltaic cells in laser rangefinders, camcorders and rocket detectors. Approximately 22 of the devices were manufactured by Norinco before production ceased in 2000 as a result of 1995. The United Nations Laser Weapons Blind Protocol.

Fig. 3. ZM-87 [10]

3. Results

Laser weapons emit beams of neon green or purple light. A large percentage of the lasers produced by the military industry are invisible to the naked eye. These advanced weapons project megawatts of energy into targets. The technology holds promise for future successes beyond its current use for targeting to improve weapon effectiveness. A major focus for laser-developed systems is their integration into weight-sensitive aircraft, warships, and ground equipment. Delivering a laser beam to the target is another challenge in the military industry. This is to compensate for atmospheric turbulence that otherwise absorbs and scatters light energy. Adaptive optics is a technological solution to beam control. Ground-based lasers would also be easier and cheaper to maintain than space-based lasers. A range-based laser system called the Evolutionary Aerospace Global Laser Engagement System can provide global, 24-hour coverage of missile launch sites. Chemical lasers are advanced laser systems, but they are stored and mixed on board the machine, which would pose a safety hazard to the formations. The proposed solution is a solid-state laser. It is powered by an electrical source and is compact, making it more suitable for infantry vehicles and aircraft [11].

4. Discussion

There are some challenges in laser targeting in the military:

– lethality. Fire control and management is an important feature in achieving success;

– atmospheric compensation. A directional laser encounters air turbulence, scintillation, and other atmospheric barriers that must be compensated for to deliver a beam to the target;

– modeling and simulation. Simulations need better beam precision and good performance;

– deployable optics. The laser industry must evolve into large, lightweight, deployable optics for high-power space applications;

– solid state lasers. Laser beam combining research, design and manufacture of reliable diode lasers, thermal control, and power output scaling of weapon systems;

– chemical oxygen-iodine laser. Lasers must be made lighter and suitable for space and tactical operations;

– beam control;

– optical components.

– free electron lasers. It is necessitated by a focus on reducing the size of the system and increasing its power.

5. Conclusions

This paper presented a review of state-of-the-art laser technologies and discussed their deployment avenues in different application domains, particularly in the military sector. The paper also covered a holistic overview of diverse laser-based projects of the last decade, besides proposing an application-oriented taxonomy for laser-based systems, coupled with future research directions and corresponding military initiatives to bridge these research gaps. Laser technology has shown strong potentials to revolutionize modern-day battlefield scenarios, through multifaceted supportive, defensive, and offensive/destructive applications. In a supportive role, the lasers serve as a very powerful device for the militaries when employed as range finders & target designators, power beamers and long range, high speed, and secure communication systems. In the domain of defensive countermeasures, laser technology offers large bandwidth and good angular resolution, required for countering laser-jamming or deceiving laser-navigators.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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