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DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,
KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,
NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
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(54) Title: HARD-KILL SYSTEM AGAINST MINI/MICRO UNMANNED AERIAL VEHICLES

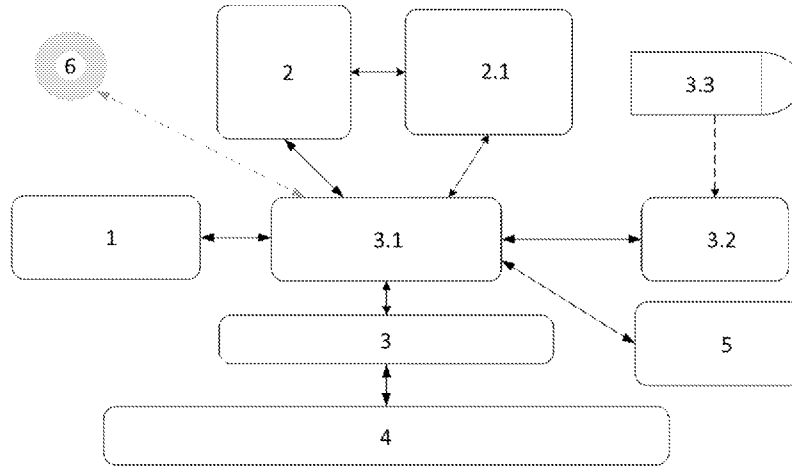


Figure 2

(57) Abstract: A weapon system that performs automatic target tracking with electro-optical sensors (2.1) against mini/micro UAV's and provides for the hard-kill of targets by using high-velocity airburst grenade (3.3). Ballistic calculations and target position estimations required for effective firing of the target are carried out with fire control algorithms in the fire control computer (3.1), using data from the meteorological sensor (5). The ammunition (3.3) is programmed before exiting the barrel and explodes at the programmed time, destroying the target with shrapnel-effect particle scattering.



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ZA, ZM, ZW.

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HARD-KILL SYSTEM AGAINST MINI/MICRO UNMANNED AERIAL VEHICLES

Technical Field

5 The invention relates to a weapon system that performs automatic target tracking with electro-optical components against mini/micro unmanned aerial vehicles (UAV) and provides hard-kill of targets by using high-velocity (HV) airburst grenade.

State of the Art

10 In the state of the art, a 40-mm HK AGL gun and RF fuse programmer are integrated on the Protector RS4 platform of Konngsberg firm and a system that provides effectiveness against mini/micro UAV targets and land targets behind the crest. In the system, time programming of the smart bomb launcher ammunition is carried out with RF. There is a risk that programming may not be performed in regions where electronic warfare measures are used.

15 US8833231B1 relates to an unmanned, range-programmable, airborne explosive weapon system for automatic tracking and destruction of targets at close range. An effective, autonomous weapon system against UAVs has been developed by using a time-programmed ammunition. The system comprises a weapon and an EO suite coupled to the weapon. The Protector RS4 platform and US008833231B1 do not have an independent electro-optical suite on the azimuth and elevation axes to ensure that moving targets do not fall off the video target tracking at the time of firing.

20 US20170122713A1 relates to an effective weapon system against small UAVs, where a 0.50-caliber machine gun and explosive ammunition are used, and which is manually guided by the gunner. According to target range from a laser rangefinder in the system, time calculation will be made for the ammunition to be destroyed in the air and the calculated time will be loaded into the ammunition before leaving the barrel. There is no mention of any electro-optical components to be used for target imaging and tracking functions in the application.

25 The present systems (Protector RS04, US008833231B1, US20170122713A1) do not have a meteorological sensor to dynamically change the angles of the ammunition against atmospheric effects after leaving the barrel. Atmospheric effects are known to cause deviations in the trajectory of the ammunition, especially for low-speed ammunition,

30 CN210070745U relates to a system that is effective against UAVs by launching a bomb containing net. In the system, thermal and day vision systems, laser rangefinder or tracking radar are used to track targets and drop a bomb containing net from the launch tubes to neutralize the targets. The bomb is detonated at the appropriate distance from the target, the net inside it expected to be effective against UAVs. In the application, effectors that can be effective at short ranges are

used or it is ignored that effectors can be affected by atmospheric conditions at long ranges. If it is to be used for long ranges, it is required to guide the optical and radar components independently of the launch tubes.

Therefore, due to the drawbacks described above and the inadequacy of the existing solutions
5 on the subject, it was deemed necessary to make an improvement in the relevant technical field.

Object of the Invention

The system, which is the subject of the invention, programs pre-fragmented smart ammunition before they exit the barrel and provides efficiency against mini/micro UAV targets with a cost-effective weapon that is frequently used in the inventory.

10 With target tracking sensors (electro-optical sensors), the system can be guided independently on the weapon elevation axis and semi-independently on the azimuth axis. Thus, gun safety is increased, and target tracking performance is optimized.

Ballistic calculations and target position estimations required for effective firing of the target are carried out with launch control algorithms, using data from the meteorological sensor.

15 The system can operate independently or connected to a higher-level command and control system with a search radar.

The system can be easily deployed to the desired operation area by being towed on a single axle trailer.

20 The structural and characteristic features of the invention and all its advantages will be understood more clearly by means of the figures given below and the detailed description written with reference to these figures.

Description of Figures

Figure 1 is view of the weapon system which is the subject of the invention.

Figure 2 is schematic view of the weapon system which is the subject of the invention.

25 Figure 3 shows the flow chart of the weapon system which is the subject of the invention.

Drawings are not necessarily to scale and details not necessary for understanding the present invention may be omitted.

Description of Part References

1. User interface
- 30 2. High Accuracy Stabilized Gimbal
 - 2.1. Electro-optical sensor

3. Gun turret
 - 3.1. Fire control computer
 - 3.2. Programming unit
 - 3.3. High-velocity (HV) airburst grenade
- 5 4. Two-wheeled trailer
5. Meteorological sensor
6. Higher echelon control system

Detailed Description of the Invention

10 In this detailed description, preferred embodiments of the invention are explained only for a better understanding of the subject and without causing any limiting effect.

The hard-kill system against mini/micro UAVs, which is the subject of the invention, places the targets detected by a higher echelon control system (6) under automatic video tracking and fires at them with user control at the appropriate range value. The system is responsible for the defense of critical facilities/campuses against mini/micro UAV threats. The system receives the power it
15 needs from the higher echelon control system (6) or directly from the utility grid. The power converters located at the base of the gun turret (3) convert the received external supply voltage to the voltage level required by the system. The system is automatically directed to the engagement information coming from the higher echelon control system (6), to which it is connected, the engaged target is video-tracked by the user via electro-optical sensors (2.1), and
20 the target is fired at by the user when the firing conditions are met within the effective range.

The system comprises a high accuracy stabilized gimbal (HASG) (2) that enables the electro-optical sensors (2.1) to be precisely directed to the target to be video-tracked, and a gun turret (3) such as a gun turret, that provides for the stabilization of the gun at the time of firing. Ballistic and dynamic interception calculations are made with the software running on fire control computer
25 (3.1) located in the gun turret (3) to fire at the tracked target. Based on this, line of fire is directed in accordance with the calculated interception angles. The system enables the weapon to be armed and also performs tasks such as firing the weapon and programming the ammunition.

For effectiveness against the target, 40-mm high-velocity (HV) airburst grenade (3.3) is used as a power factor. According to the calculated target and impact point, the ammunition is
30 programmed before it leaves the barrel. The fuse explodes at the programmed time, and the pre-fragmented high-velocity (HV) airburst grenade (3.3) disintegrates, creating a particle cluster with shrapnel effect on the target.

The fire control algorithm uses data received from the meteorological sensor (5) to correct the interception angles according to the deviations that may occur in the flight trajectory of the ammunition due to atmospheric effects. In this way, the system can be used in all weather conditions.

- 5 The high accuracy stabilized gimbal (2) comprises electro-optical sensors (2.1) having a day TV camera, an IR camera and a laser range finder, and performs the functions of target search, target detection and target tracking under day and night conditions.

With two-wheeled trailer (4), the system is towed by tactical wheeled military trucks and performs the transport function.

- 10 With the control unit and panel computer that form the user interface (1) of the system, the user performs all the functions of the system via remote operation.

By means of the advanced electro-optical sensors (2.1), fire control algorithms and programmable 40-mm high-velocity (HV) airburst grenade (3.3), the system is effective against mini/micro UAV target set at a range of up to 700 meters.

CLAIMS

1. A weapon system that tracks and destroys mini/micro UAVs, characterized by comprising:
- 5 • electro-optical sensors (2.1) that perform target search, detection and tracking, video recording of the target and calculate the distance to the target in day and night conditions,
 - high accuracy stabilized gimbal (2) that directs the electro-optic sensors (2.1) to the target according to engagement information coming from higher echelon control system (6),
 - 10 • fire control computer (3.1), which makes the necessary ballistic and dynamic interception calculations to fire at the tracked target, directs and fires the gun in accordance with calculated interception angles,
 - user interface (1), where the user issues the fire command to the fire control computer (3.1),
 - 15 • programming unit (3.2), which programs high-velocity (HV) airburst grenade (3.3) before exiting the barrel,
 - high-velocity (HV) airburst grenade (3.3) that fragments at the programmed time and destroys the target with shrapnel-effect particle scattering.
2. The system according to claim 1, characterized by comprising a meteorological sensor (5), which collects meteorological data and supplies the data as input to the fire control computer (3.1) for correction of interception angles according to deviations that may occur in the flight trajectory of the high-velocity (HV) airburst grenade (3.3) caused by atmospheric effects.
3. The system according to claim 1, characterized in that the electro-optic sensors (2.1) are day TV camera, IR camera and laser rangefinder.
- 25

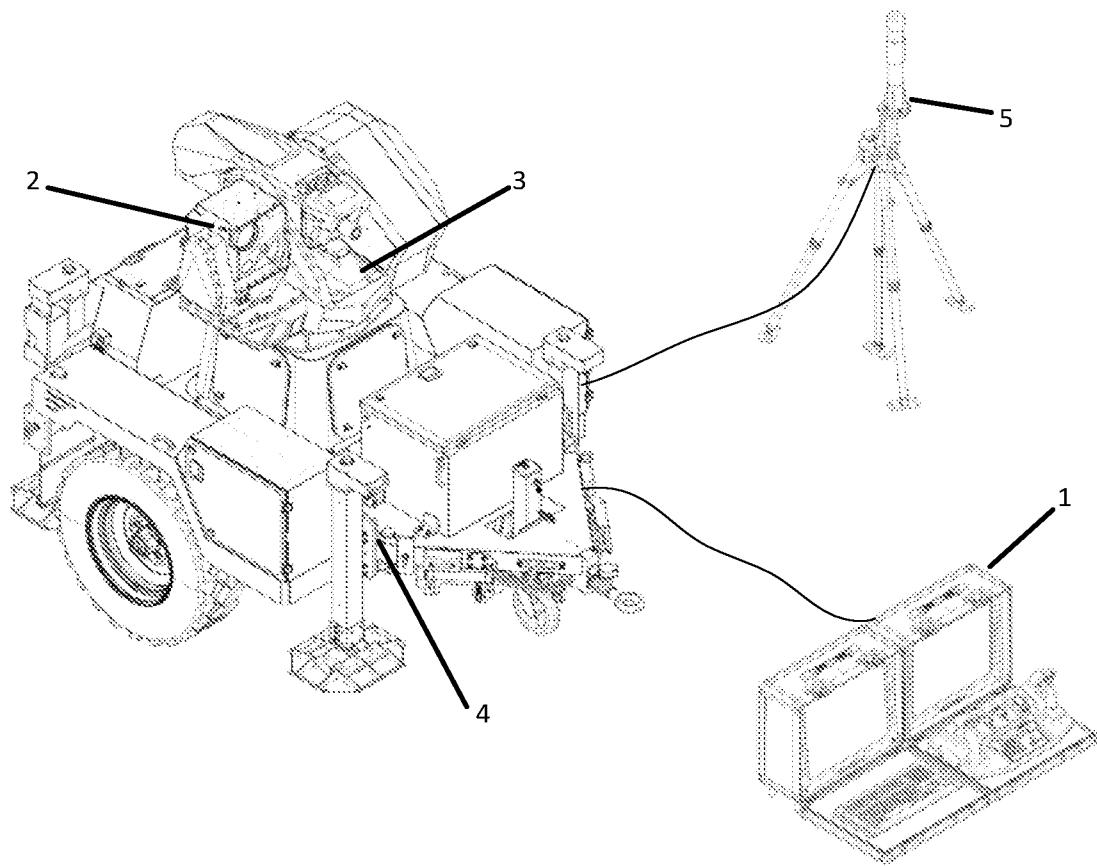


Figure 1

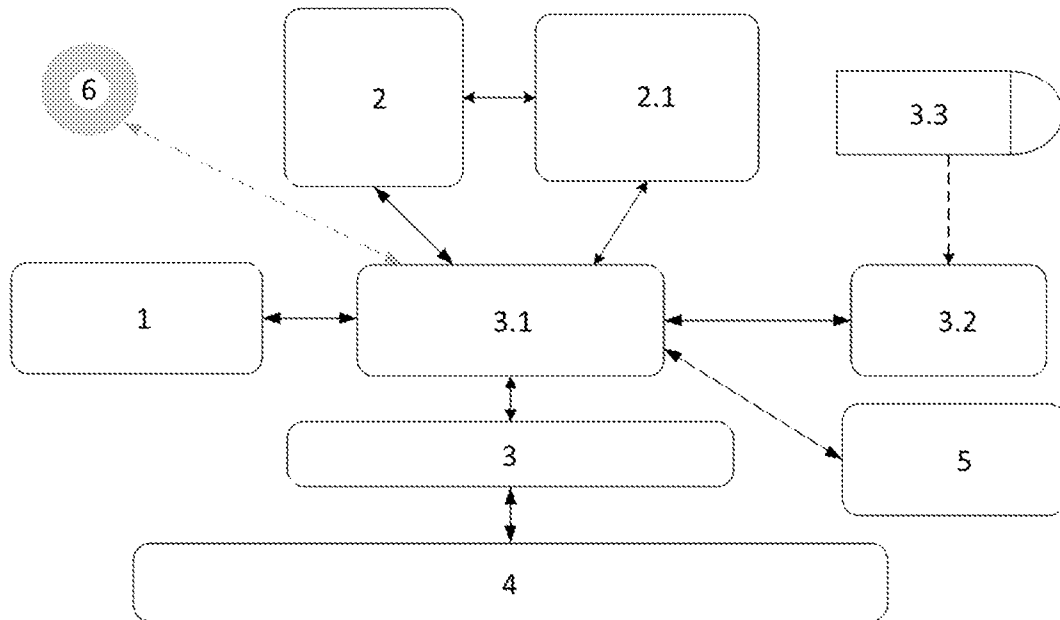


Figure 2

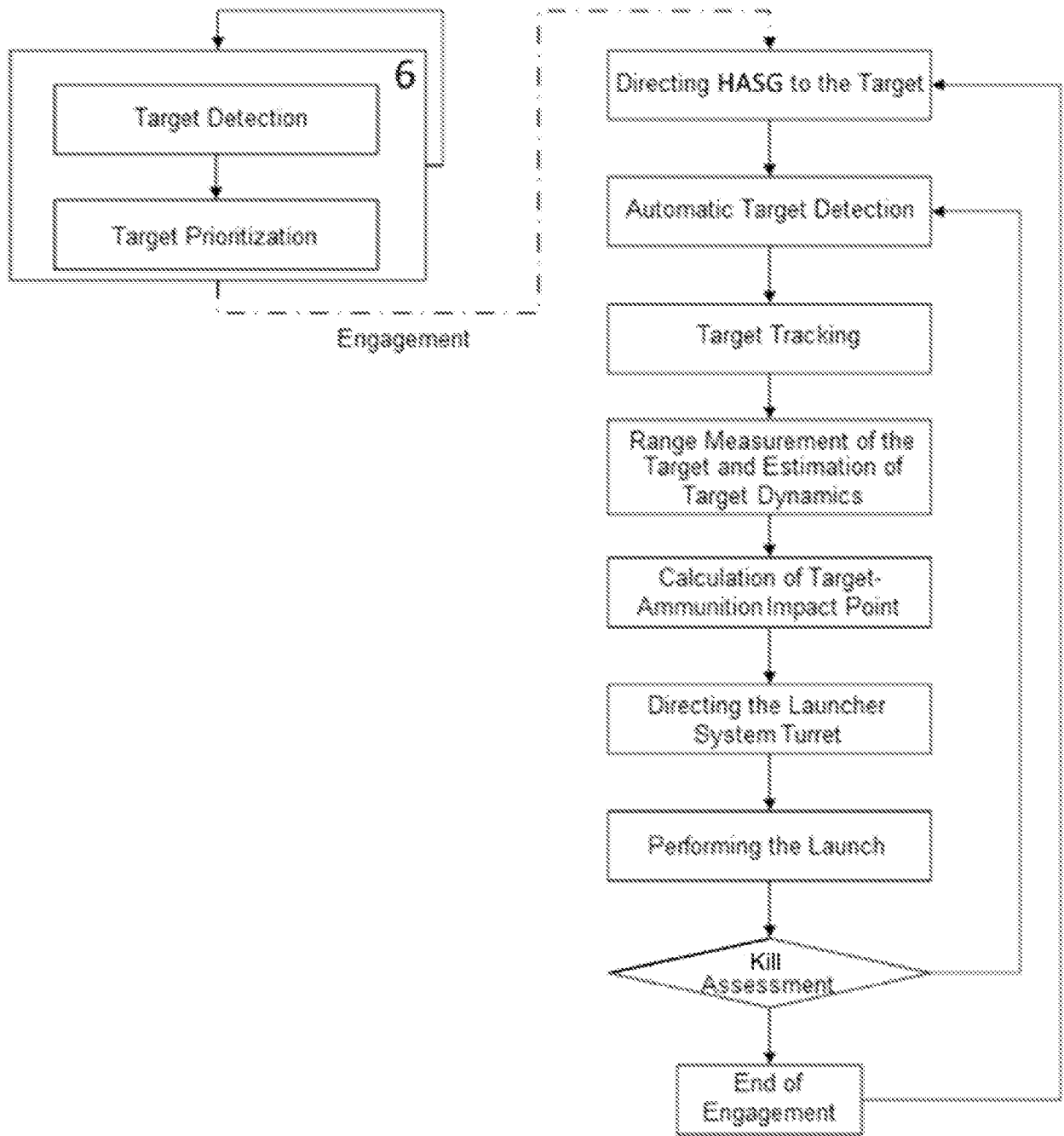


Figure 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/TR2023/050341

A. CLASSIFICATION OF SUBJECT MATTER					
INV.	G01S17/86	G01S17/42	G01S17/08	G01S17/66	G01S17/88
	F41A23/36	F41G3/06	F41G3/08	F41G5/14	F41H11/02
	F42B12/20	F42B12/32	F42C11/06	F42C17/04	F41G5/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols) G01S F41G F42D F41A F41H F42B F42C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 8 833 231 B1 (VENEMA BENJAMIN JOSEPH [US]; RAYTHEON CO [US]) 16 September 2014 (2014-09-16) cited in the application abstract column 1, line 1 - column 8, line 31; figures 1-3, 5	1-3
Y	US 2017/122713 A1 (GREENWOOD MARTIN WILLIAM [US]) 4 May 2017 (2017-05-04) cited in the application abstract paragraphs [0002], [0027], [0032] - [0038]; figures 1, 2	1-3
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer van Norel, Jan
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INTERNATIONAL SEARCH REPORT

International application No
PCT/TR2023/050341

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2004/050240 A1 (GREENE BEN A [AU] ET AL) 18 March 2004 (2004-03-18) abstract paragraphs [0001], [0031], [0054] - [0140]; figures 2-4 -----	1-3
A	US 2009/139393 A1 (QUINN JAMES P [US]) 4 June 2009 (2009-06-04) abstract paragraphs [0013], [0030]; figures 1,4,5 -----	1-3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/TR2023/050341

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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