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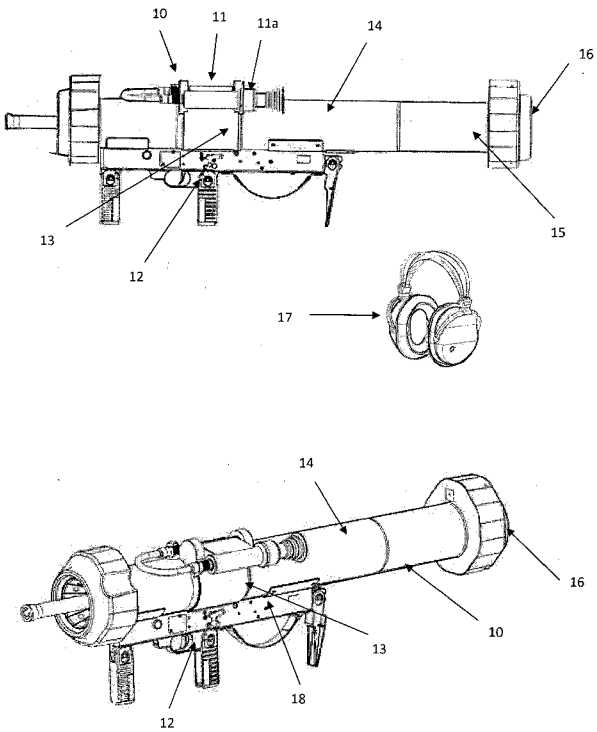
(54) Title: MOBILE TRAINING DEVICE AND SYSTEM FOR MAN-PORTABLE WEAPON

FIGURE 1



(57) Abstract: The invention refers to a mobile training device and system for man-portable weapon which requires no additional display, power or communication means but the ones integrated in and on the weapon mockup. The training device is suitable for all man-portable weapons which have incorporated an optical aiming device and a trigger. The training device is a functional combination of a weapon mockup, which is an exact replica of an actual weapon or a shell of an actual weapon, customized computer hardware, motion tracking sensor, customized virtual reality environment software and miniature monitor; all integrated into a single device. All hardware components are placed inside the housing of a weapon mockup, or preferably integrated in the frame, in a way that electromagnetic waves of individual hardware components do not interfere with the performance of a motion tracking sensor. A miniature monitor is built into the housing of the actual aiming device and displays virtual reality environment. A triggering device is modified in such way that triggering of the weapon is communicated to the integrated computer. In this way the training device enables aiming, selecting targets, preparing for shot and firing of weapon mockup at a target in the virtual reality environment from a plurality of trainee's positions, without any additional video display means, except those integrated in and on the weapon mockup.

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MOBILE TRAINING DEVICE AND SYSTEM FOR MAN-PORTABLE WEAPON

FIELD OF THE INVENTION

The present invention pertains to mobile training solutions and systems in the military industry. More particularly the present invention refers to a new functional combination of military weapon mockup, computer hardware and virtual reality environment display, where trainee's actual physical orientation and activities are reflected in a virtual reality environment.

BACKGROUND OF THE INVENTION

Existing training systems for man-portable weapons utilize large projection screens and / or domes placed in dark rooms. These systems allow training of man-portable weapon handling procedures from weapon inspection, preparation, loading, reloading, aiming and firing. However, utilization of large screens and domes significantly raises the cost of the system and reduces the functional usage capabilities as such systems are difficult to relocate and are expensive to maintain.

For example, in a WO213/111146 patent application a system for providing training process during weapon training in a virtual environment is disclosed. The system comprises one or more combat stations, one or more motion tracking devices for tracking body movements of the trainee with dummy weapons, one or more processing units and one or more display systems wherein the display system is comprised of one or more projectors and screens surrounding operational field of view, which projects the virtual human combatant and provides immersive display of the virtual environment. The combat stations are networked permitting the virtual human combatant to be mapped to one or more trainees in different combat stations.

Another example of existing solutions is disclosed in a patent application WO 2014/018561 where a user is equipped with a head mounted display device which wirelessly receives real-time video signals transmitted by a radio transceiver linked to a computer which is separated from the weapon and the trainee. The computer generates the real-time video images which are transmitted to the head mounted display device by wireless connection.

Thus a need is demonstrated for a highly mobile training device and system allowing fast deployment, securing easy installation and low cost maintenance.

SUMMARY OF THE INVENTION

The objective of the present invention is to provide a mobile training device for man-portable weapons, hereinafter referred to as the training device, allowing fast deployment, easy installation and low cost maintenance.

Further objective of the present invention is to track trainee's real-world rotations and transfer them into virtual-environment relevant data, which can then be used to calculate virtual-reality environment and real-time ballistics, and display the virtual environment to the trainee.

Yet another objective is to enable multiple trainees on the same or different physical locations, to be trained at the same time in the same or various virtual-environments. This is achieved by connecting several training devices into a system.

These objectives and advantages are realized by the training device and system according to the invention. The training device is suitable for all man-portable weapons which have incorporated an optical aiming device and a trigger. The training device is a functional combination of a weapon mockup, which is an exact replica of an actual weapon or a shell of an actual weapon, customized computer hardware, motion tracking sensor, hereinafter referred to as the motion sensor, customized virtual reality environment software and miniature monitor; all integrated into a single device.

All hardware components, including integrated custom built computer, hereinafter referred to as integrated computer, are placed inside the housing of a weapon mockup; preferably are integrated in the frame, which may serve also as a cooler if the frame is made of metal, preferably aluminum. The frame can optionally serve also as a carrier for other components, i.e. the motion sensor, battery housing and a separate cooler. All hardware components are placed inside the housing of a weapon mockup, or preferably integrated in the frame, in a way that electromagnetic waves of individual hardware components do not interfere with the performance of the motion sensor. A miniature monitor is built into the housing of the actual aiming device and displays virtual reality environment. A triggering device is modified

in such way that triggering of the weapon is communicated to the integrated computer. In this way the training device enables aiming, selecting targets, preparing for shot and firing of weapon mockup at a target in the virtual reality environment from a plurality of trainee's positions, without any additional video display means, except those integrated in and on the weapon mockup.

The motion sensor does not track the translation movements of the trainee and the weapon mockup; it tracks only the rotations of the training device around at least one axis, preferably around three axes.

Optionally, by adding a Wi-Fi connectivity hardware to the training device, the connection to a server computer is enabled, whereby a server computer is used to track and save exercise for subsequent repetition or analysis, or to change parameters of the virtual environment during an exercise. In addition, multiplayer communication software integrated into the virtual reality environment software enables multiple trainees each with its own training device to be trained at the same time in the same virtual-environments on the same or different physical locations.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described hereinafter with the reference to the drawings, wherein:

FIG. 1 shows a training device for man-portable weapons according to the invention;

FIG. 2 shows the main components which are integral part of the training device of the present invention;

FIG. 3 shows a schematic illustration of the motion sensor according to the present invention;

FIG. 4 is a schematic illustration showing how various components are connected together to form fully functional integrated computer of the present invention;

FIG. 5 is a perspective illustration a virtual-reality environment as seen by a trainee;

FIG. 6 is a schematic illustration of a system according to the present invention where multiple training devices are connected into a network when executing a multiplayer exercise.

DETAILED DESCRIPTION

As shown on FIG. 1 and 2, a training device is built in a weapon mockup 10 which is an exact replica of an actual weapon or a shell of an actual weapon. The integrated computer 13 is placed inside of the weapon mockup 10, preferably in the frame 20, which is custom made so as to fit into the weapon mockup 10. The frame 20 may serve as a cooler if made of metal, preferably aluminum. The miniature monitor 11a is integrated in the housing of the aiming device 11 and connected to the integrated computer 13. As trainee looks into the aiming device 11, he actually looks at the miniature monitor 11a displaying the virtual-reality environment 33, generated by the integrated computer 13.

Triggering device 12 is also an exact replica of an actual trigger of the weapon; however the triggering device 12 is connected to the integrated computer 13 and is modified in such way that triggering of a weapon is through sensors 43 communicated to the integrated computer 13. The triggering device 12 has an integrated power button 18, which serves only for the activation of the training device. The motion sensor 14 is positioned in or on the weapon mockup 10, preferably is mounted on the frame 20, and is connected to the integrated computer 13. A battery 15 is the only source of power for all electrical components of the training device and allows for power independency of up to 4 hours. The battery 15 is placed in the weapon mockup 10, preferably on the frame 20 at the rear side of the weapon mockup 10. The battery 15 may be inserted through an insertion slot into a battery housing 19, allowing easy and fast battery replacement.

An additional cooler 21 may be placed on top of the frame 20, preferably in its central part and is designed to coordinate a proper airflow to ensure adequate cooling of the components. A trainee may be also equipped with headphones 17 connected to the integrated computer 13, to ensure even better immersion into the virtual-reality environment 33 via aural stimuli.

The motion sensor 14 may be any sensor known in the state of the art capable of detecting rotations around at least one, preferably three axes. As shown in Figure 3, in the preferred embodiment a motion sensor 14 is composed of at least one, preferably three individual sensing elements, analog to digital sampling unit, and computation and output block 23.

Each individual sensing element detects rotation around one axis, so combination of three sensing elements detect exact orientation 22 of the weapon mockup around axes "X","Y" and "Z". The "X" axis represents rotation around horizontal longitudinal axis of the weapon mockup 10 held by the trainee, "Y" represents rotation around horizontal axis perpendicular to the weapon mockup 10, and "Z" represents rotation of the weapon mockup 10 around vertical axis.

The motion sensor 14 sends the data to the integrated computer 13. When a trainee moves the weapon mockup 10, the motion sensor 14 detects the rotations of the weapon mockup 10 in the real-world and communicates them to the integrated computer 13 where these rotations are translated into the virtual-reality environment 33 which is shown in the miniature monitor 11a.

The analog to digital sampling unit converts the analog signal of individual sensing elements into digital signal of high integrity and accuracy. The analog low pass filter ensures elimination of errors due to aliasing, high frequency noise, minimizes inter-channel delays and eliminates high frequency components. The digital low pass filter is applied to prevent aliasing of signal while down-sampling the signal in the digital domain.

The computation and output block 23 performs accurate numerical computation of the integrated quantities of angular velocity and acceleration with coning and sculling error compensation. The motion sensor 14 is integrated in/on the frame 20 and needs not to be worn on a trainee's person for detecting the trainee's orientation.

Figure 4 shows how various components are connected to the integrated computer 13, and secondly, how the integrated computer 13 is structured in the preferred embodiment of the invention.

The integrated computer 13 is composed of a main board 25, handle board 30, charger board 27, USBI board 28, computer board 26, video board 31, computing board 29 and connector board 32.

The main board 25 is connected to the motion sensor 14, the battery 15, computer board 26 with a small cooling fan, charger board 27, USBI board 28 and handling board 30. The integrated computer 13 and battery 15 may be built out of commercial-of-the-shelf components and preferably mounted on the frame 20. The components must be positioned in a way that electromagnetic waves of individual hardware components do not interfere with the performance of a motion sensor 14.

The main board 25 controls all components to ensure full functionality of the integrated computer 13, such as rendering and calculating virtual-reality environments 33 and simulations.

The charger board 27 enables charging of the battery 15 while the battery is connected to the main board 25.

The computer board 26 is connected to the computing board 29 which is handling all computing procedures in order to properly calculate orientation and rotational position of the weapon mockup 10 in real-world and translates it into the virtual-reality world. It also handles all calculation procedures of the virtual-reality environment software, such as simulation of physics, ballistics, etc. The computer board 26 is also connected to the video board 31, which is handling all display calculations for miniature monitor 11a. The video board 31 is further connected to the connector board 32, which is handling the actual display of the virtual reality in the miniature monitor 11a.

The handle board 30 may be divided into two parts due to space limitations. The handle board 30 is also connected to the power button 18, sound peripherals, in preferred embodiment headphones 17, and the sensors 43, one of which detects the triggering action of the trigger on the triggering device 12. Other sensors 43 may be used to detect the weapon's safety lock and various other states of the weapon related to the triggering action. The USBI board 28 enables connectivity of the integrated computer 13 with periphery, such as keyboard, mouse or others, needed for maintenance of the training device.

The virtual-reality environment software application is designed so that in real-time all needed simulations such as projectile ballistics, artificial intelligence, sound effects, visual effects, object physics, destructive physics and trainees position and orientation are calculated.

In one of the preferred embodiments, a weapon mockup 10 is a man-portable rocket propelled grenade launcher. It includes all the above mentioned components and additionally may have at the back side of the weapon mockup 10 an ultra-sound blast sensor 16 to detect obstacles and / or persons in the rear, which is also the case in the real weapon.

Figure 5 shows a virtual-reality environment 33 as seen by the trainee in the miniature monitor 11a integrated in the housing of the aiming device 11 and connected to the integrated computer 13. The miniature monitor 11a, which is a video display, demonstrates the perspective of the trainee when he is in a position in the virtual-reality environment 33. In a preferred embodiment a reticule 34 of the aiming device 11 is replication of the rocket propelled grenade launcher aiming device reticule. On the representation image, the weapon is pointed at the target 35 placed in the virtual-reality environment 33.

To add variety of training possibilities of a training device, optionally a Wi-Fi network card 40 is connected to the integrated computer 13 via USBI board 28. In a preferred embodiment a Wi-Fi network card 40 is a mini card with 2.4 and 5 GHz band range, 802.11 ac/a/b/g/n certificate and PCI, CISP, FIPS, FISMA compatibility. Via the Wi-Fi network card 40 the integrated computer 13 and a virtual-reality environment software communicate with a server computer 36 which is also acting as a main training control station enabling instructor to manipulate in real time various virtual-reality environment parameters such as visibility, weather, wind, location, targets, and load and / or unload particular scenarios and to perform a comprehensive After Action Review (AAR).

A training system is presented on Figure 6 enabling multiple trainees each with its own training device to be trained at the same time in the same virtual-environments on the same or different physical locations. In a preferred embodiment up to four weapon mockups 10 can be connected via Wi-Fi network to a server computer 36, which is a laptop or a desktop computer. With a Wi-Fi network card 40 connected to the integrated computer 13 and a

multiplayer communication features added to the virtual reality environment software, the connection to a server computer 36 is enabled. The server computer 36 has a monitor 37 having a video screen 38 on which a virtual-reality environment 33 containing computer assisted exercise can be viewed. The same virtual-reality environment 33 is viewed by the trainee in the miniature monitor 11a connected to the integrated computer 13. The connection is established via Wi-Fi network card 40 integrated in each weapon mockup 10 and a commercial-off-the-shelf router 41. The only two components directly plugged into a power source 42 are server computer 36 with the monitor 37 and the router 41.

CLAIMS

1. A training device for man-portable weapons, comprising a weapon mockup (10), a triggering device (12), an aiming device (11), characterized in that:
   - an integrated computer (13) is placed inside the weapon mockup (10),
   - the weapon mockup (10) is an exact replica of an actual weapon or a shell of an actual weapon,
   - the triggering device (12) is connected to the integrated computer (13) so that the triggering is communicated to the integrated computer (13),
   - a miniature monitor (11a) is integrated in the housing of the aiming device (11) and connected to the integrated computer (13),
   - a motion sensor (14) is positioned in or on the weapon mockup (10) and connected to the integrated computer (13).
2. A training device according to claim 1, characterized in that the components of the integrated computer (13), a battery housing (19) with a battery (15), the motion sensor (14) are integrated in a frame (20).
3. A training device according to claim 2, characterized in that the frame (20) is custom made so as to fit into the weapon mockup (10) and is made of metal and serves as a cooler.
4. A training device according to the previous claims, characterized in that the motion sensor (14) is composed of at least one, preferably three individual sensing elements detecting rotations around three axes, analog to digital sampling unit, and computation and output block (23).
5. A training device according to the previous claims, characterized in that the integrated computer (13) is composed of:
   - a main board (25),
   - a handle board (30),

- a charger board (27),
- an USBI board (28),
- a computer board (26),
- a video board (31),
- a computing board (29), and
- a connector board (32);

wheras the main board (25) which is connected to the motion sensor (14), the battery (15), the computer board (26), the charger board (27), the USBI board (28) and the handling board (30); the handling board (30) is connected also to a power button (18), sound peripherals, and sensors (43), one of which detects the triggering action of the trigger on the triggering device (12); the computer board (26) is also connected to the video board (31) and the computing board (29); the video board (31) is further connected to the connector board (32); the connector board (32) is connected to the miniature monitor (11a); whereas the main board (25) controls all components to ensure full functionality of the integrated computer (13); the charger board (27) enables charging of the battery (15) while the battery is connected to the main board (25); the USBI board (28) enables connectivity of the integrated computer (13) with periphery; the video board (31) is handling all display calculations for miniature monitor (11a); the computing board (29) calculates orientation and rotational position of the weapon mockup (10) in real-world and translates it into the virtual-reality world, including handling calculation procedures of the virtual-reality environment software; the connector board (32) is handling the actual display of the virtual reality in the miniature monitor (11a).

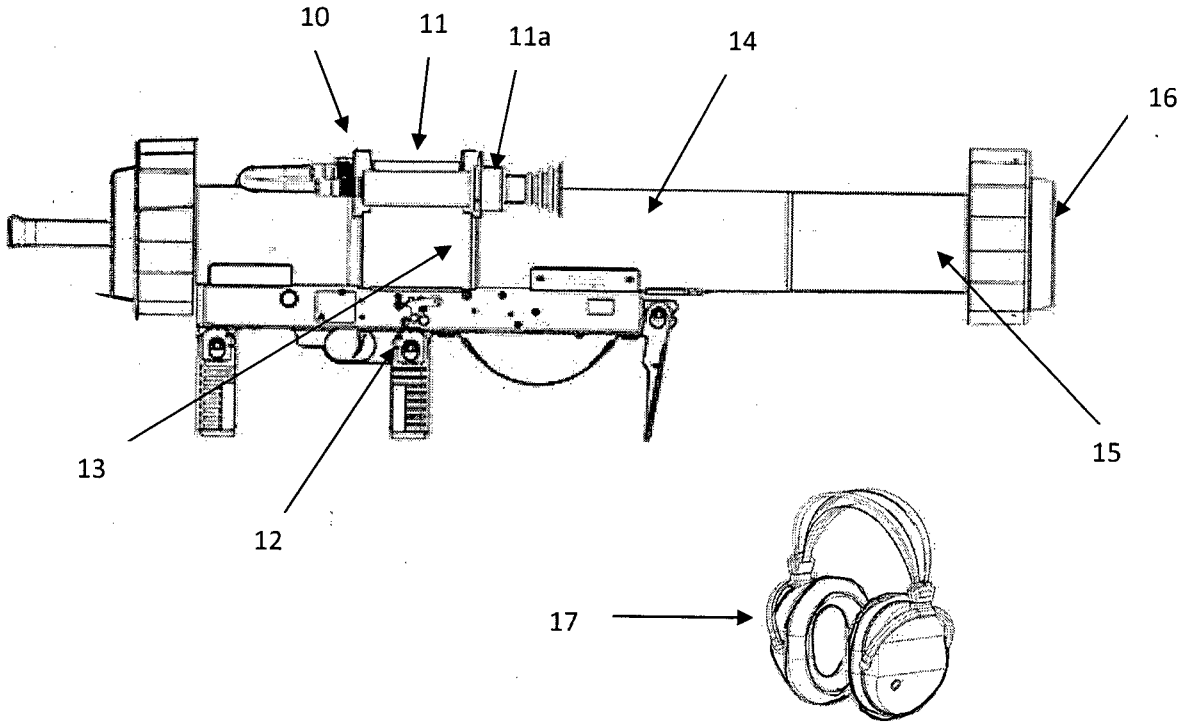
6. A training device according to the previous claims, characterized in that the man-portable weapon is a rocket propelled grenade launcher with an ultra-sound blast sensor (16) at the back side of the weapon mockup (10) to detect obstacles and / or persons in the rear.

7. A training device according to the previous claims, characterized in that a Wi-Fi network card (40) is connected to the integrated computer (13) via USBI board (28).

8. A training device according to claim 6 characterized in that the integrated computer (13) is connected to a server computer (36) via Wi-Fi network card (40) to enable the server computer (36) function as a main training control station and enabling manipulation in real time of various virtual-reality environment parameters, load and / or unload particular scenarios and to perform an After Action Review.

9. A training system for man-portable weapons, characterized in that at least two training devices according to claim 6 are connected via Wi-Fi network to a server computer (36) and multiplayer communication features are added to the virtual reality environment software, enabling multiple trainees each with its own training device to be trained at the same time in the same virtual-environments on the same or different physical locations.

FIGURE 1



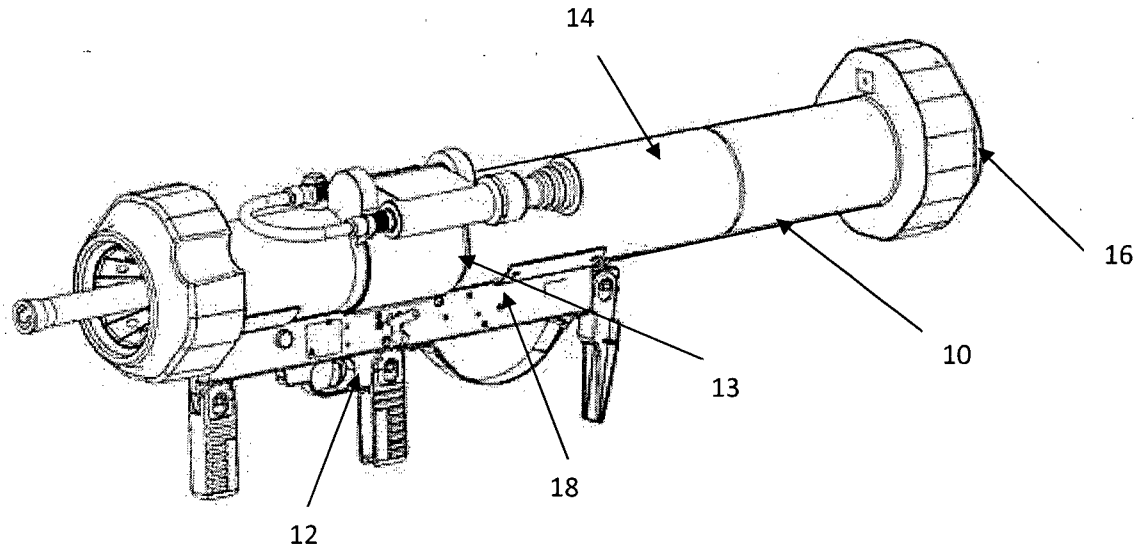


FIGURE 2

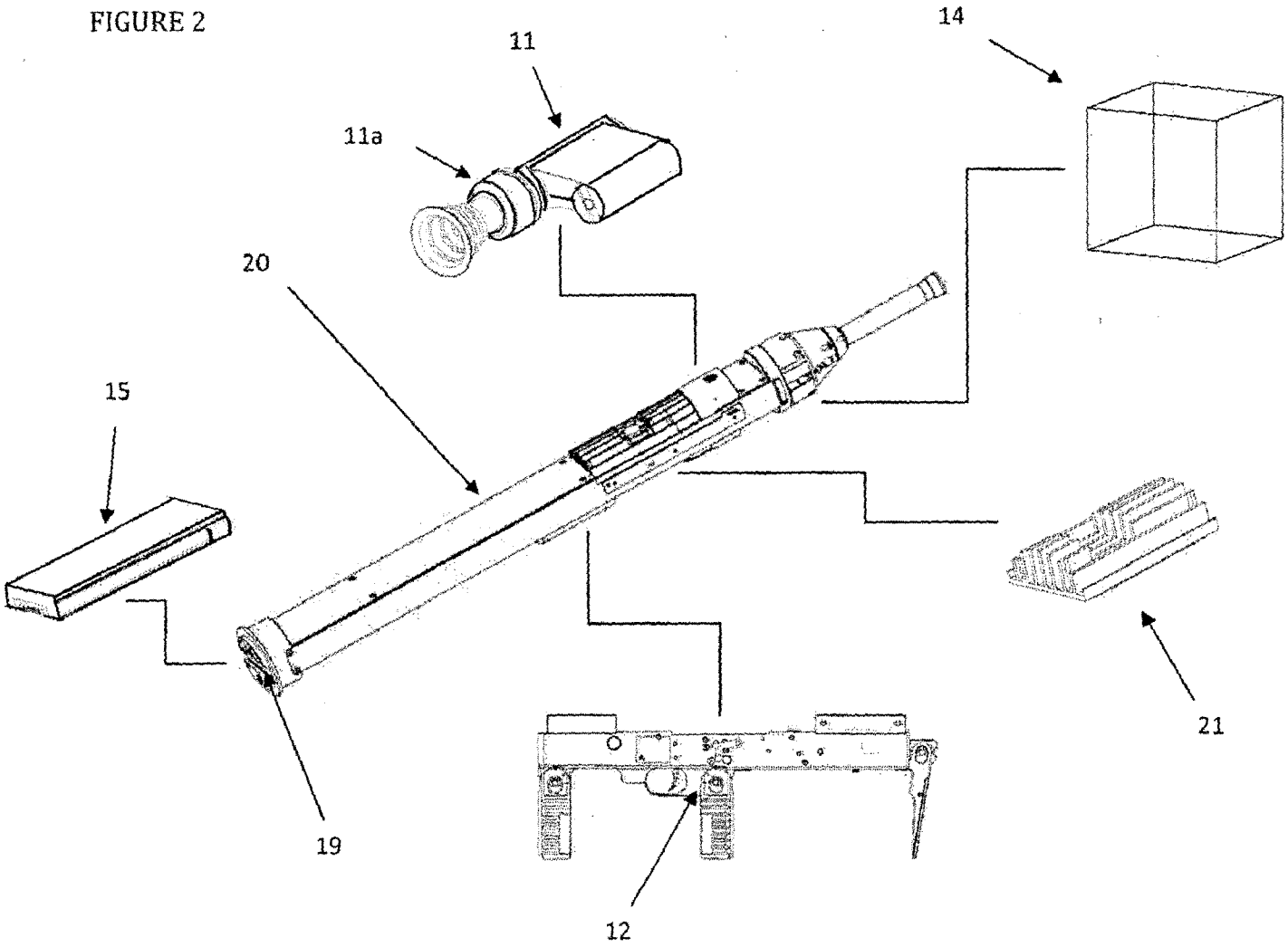


FIGURE 3

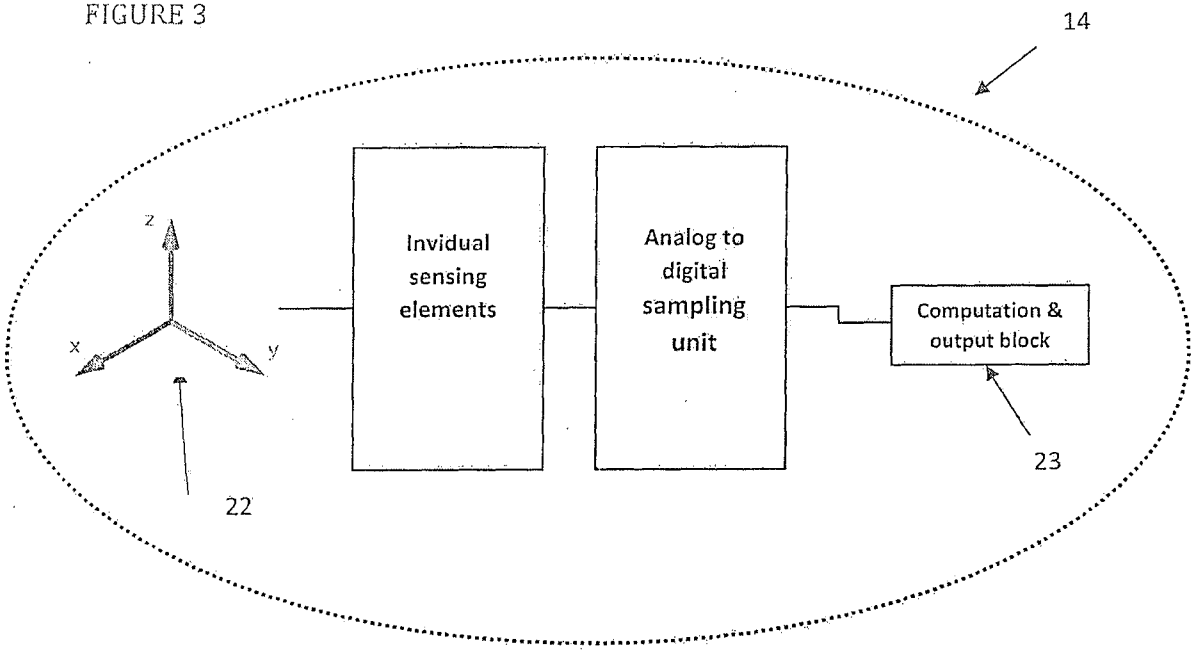


FIGURE 4

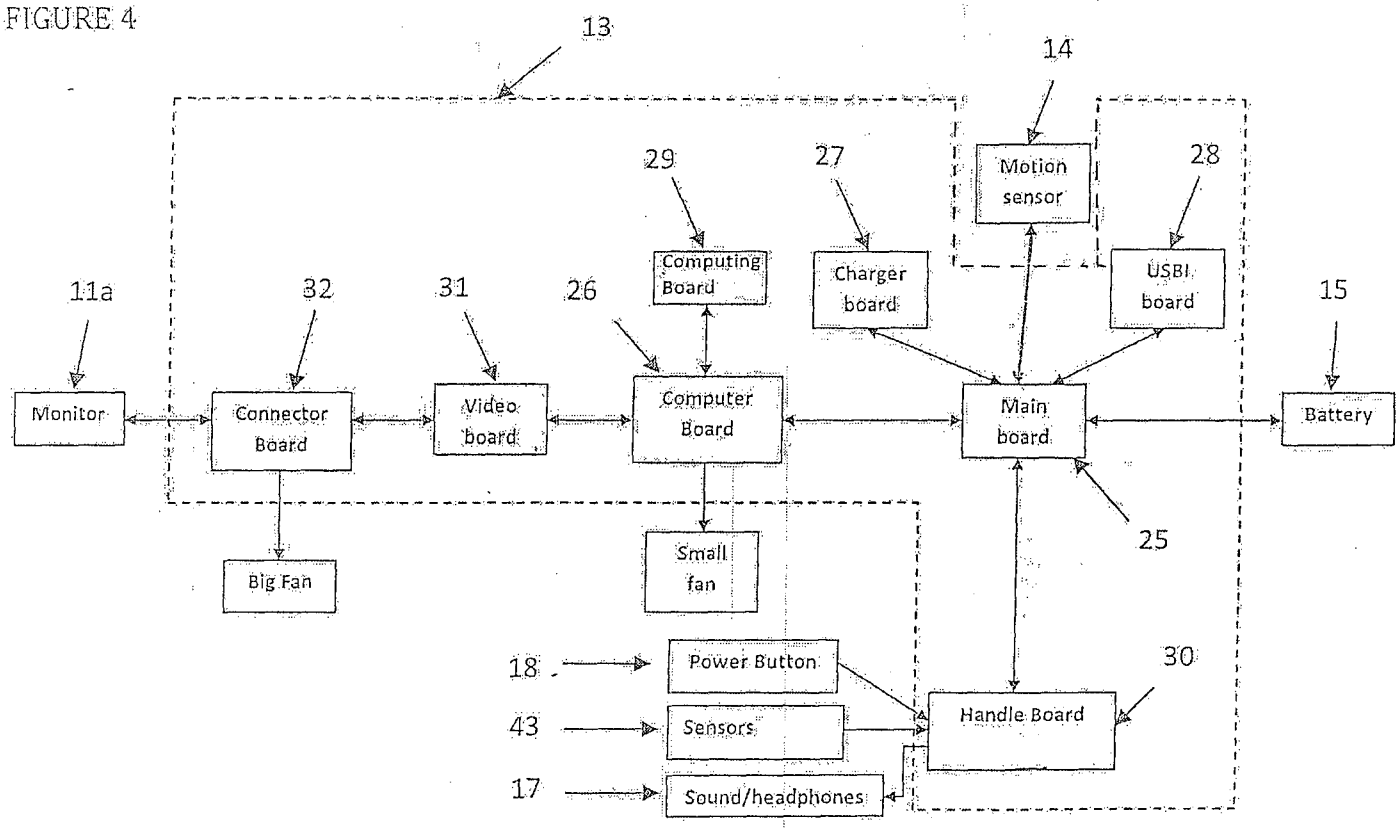


FIGURE 5

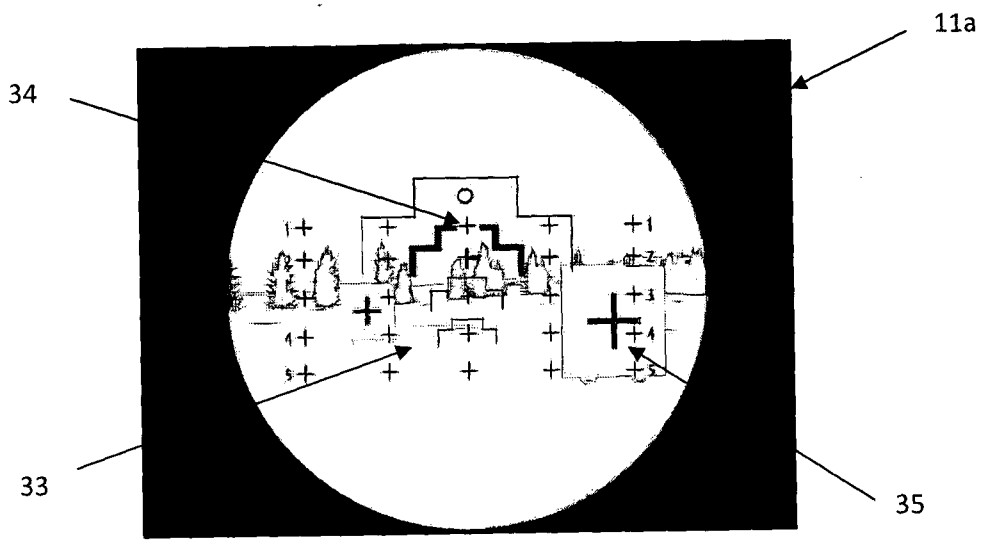
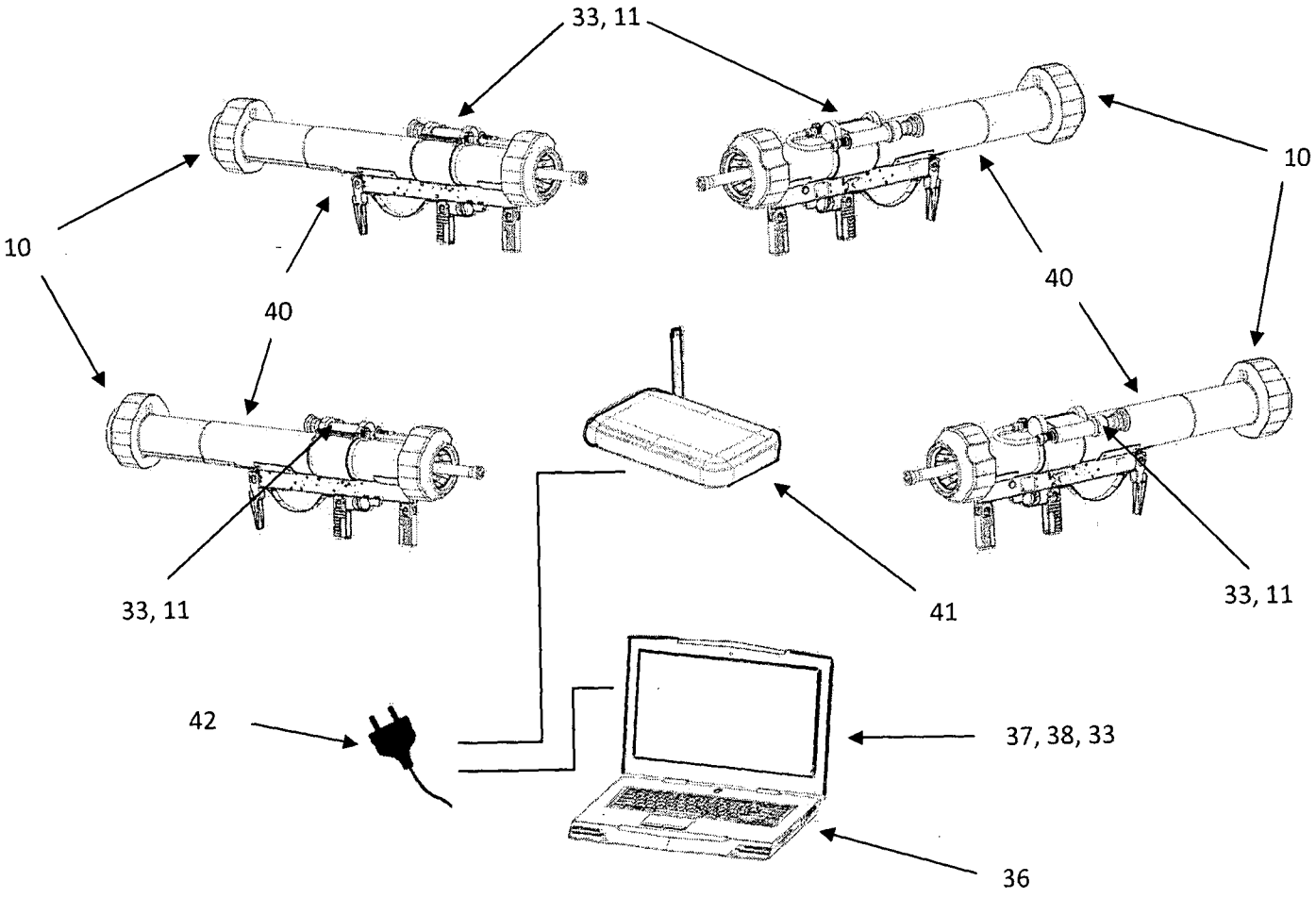


FIGURE 6



INTERNATIONAL SEARCH REPORT

International application No
PCT/SI2015/000022

A. CLASSIFICATION OF SUBJECT MATTER
INV. G09B9/00
ADD.

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)
G09B F41G F41A

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/073459 A2 (QUANTUM 3D [US]; MCAFEE THOMAS [US]; CIULLO WILLIAM RICHARD [US]) 13 July 2006 (2006-07-13)	1-3,5-9
Y	claim 1 paragraph [0027]; figures 1-5	4
Y	US 2013/288205 A1 (LUPHER JOHN HANCOCK [US] ET AL) 31 October 2013 (2013-10-31) paragraphs [0023] - [0031]; figures 1-2	4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 August 2015	08/09/2015

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

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006073459 A2	13-07-2006	US 2006204935 A1	14-09-2006
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US 2013288205 A1	31-10-2013	NONE	