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(54) **Electro-optical out-door battle-field simulator based on image processing.**

Auf Bildverarbeitung gegründeter elektrooptischer Aussenschlachtfeldsimulator

Simulateur électro-optique de champ de bataille extérieur basé sur un traitement d'images

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(73) Proprietor: **RAFAEL - ARMAMENT DEVELOPMENT AUTHORITY LTD.**
Haifa 31021 (IL)

(72) Inventor: **Berger Yosef**
D.N. Misgav 20149 (IL)

(74) Representative: **Colas, Jean-Pierre et al**
Cabinet JP Colas
37, avenue Franklin D. Roosevelt
75008 Paris (FR)

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Description

[0001] The present invention relates to a military training system for firing a weapon at a target and, more particularly, to a training system for firing an electro-optically guided anti-tank missile.

[0002] Military training exercises use simulation, wherever possible, rather than live ammunition or actual firing of weapons, both to save costs and to avoid unnecessary use of dangerous equipment.

[0003] More realistic simulation lends greater verisimilitude and helps train soldiers in conditions that more closely resemble battlefield conditions. Thus, in firing exercises, a soldier needs to aim a weapon, pull a trigger or otherwise activate firing, and see the results of a "hit".

[0004] A further requirement is that a training control center be able to monitor all training activities, if possible, in real time.

[0005] To heighten the sense of reality, there is a need for battlefield simulation systems that are integrated with armament systems and not intrusive add-ons.

[0006] Current weapons firing simulation systems employ a laser installed on the weapon that makes it possible to simulate firing, using a laser pulse instead of ammunition, and to identify the target hit.

[0007] In the case of anti-tank missile systems (ATMS), current simulations employ a pulsed laser, which is attached to and aligned with the missile launcher and which is fired instead of a missile. Detectors placed on the target are illuminated by the laser, may record a hit, and can relay that information both to the operator of the missile and to the training control center. This method is used in, for example, the Swedish BT46 system from Saab Training Systems.

[0008] The same system can also be attached to various types of guns and artillery and operated similarly.

[0009] US 4,793,811 discloses such a pulsed laser weapon firing simulation system, which is configured to measure the period of time from the appearance of the target to the actual firing by the operator, through the steps of identification and acquisition of the target.

[0010] These are suitable approaches for rigid, so-called "stiff-neck" weapons, whose aiming is restricted to the direction of a sensor fixed relative to the missile, but not for the new generation of ATMS which feature "flexible neck" seekers, whose sensors have an overall wider field of view obtained by varying the sensor orientation relative to the missile's canister axis. The problem here is that there is not necessarily any connection between the line of sight of the launcher and that of the seeker head.

[0011] Drawbacks of current simulation systems include :

- Rigid laser alignment:

  Being attached rigidly outside the missile or gun barrel, the laser mimics the launcher operation but not that of the separate target seeker, which is located in the seeker head of the missile and operates independently of the launcher before and after firing. A sensor in the seeker head is mounted on gimbals and can alter its pitch and yaw with respect to missile orientation and the target position, as required, in order to lock onto a desired target, something the launcher-mounted laser is unable to do.
  The situation may be likened to a light on a miner's helmet that may not necessarily be illuminating the spot where the miner is actually looking. Thus, a laser "hit" is not necessarily indicative of a missile hit; nor does a laser "miss" necessarily indicate a missile miss.

- The laser apparatus is a relatively heavy and cumbersome add-on. It requires calibration before use and is not easy to use.
- The laser apparatus is hazardous to human eyesight.
- The laser apparatus is limited by adverse weather conditions.

[0012] Thus there is a recognized need for, and it would be highly advantageous to have, a training system that is better integrated with and better simulates the missile's target-seeking operation, itself, and that is safer, less intrusive and cumbersome, and less adversely affected by weather conditions.

[0013] According to the present invention there is provided a simulator for simulating the firing of a weapon at one of a plurality of targets, each target having a respective shape, including: a housing substantially identical in size and shape to at least a discrete portion of the weapon; a sensor, operationally connected to the housing, for acquiring a plurality of images of at least one of the targets; an image processor for detecting and analyzing changes among the images and for initiating control signals based on the analysis; for each target, an infra-red lamp that is alternatively activated by one of the control signals to flash at a unique, respective frequency and deactivated by another of the control signals; and a mechanism for transmitting the control signals to the lamps.

[0014] Thereby, analysis by said image processor of light produced by a said infra-red lamp and detected by said sensor indicates at which target from amongst said plurality of targets said housing has been aimed, thus accurately simulating the aiming step of the firing of the weapon without any laser device.

[0015] According to a preferred embodiment of the present invention, the transmitting mechanism is wireless.

[0016] According to another preferred embodiment of the present invention, the transmitting mechanism is wired.

[0017] According to a preferred embodiment of the

present invention, the sensor includes a CCD television camera.

[0018] According to further features in preferred embodiments of the invention, the sensor forms part of the guidance system of an electro-optically guided missile.

[0019] According to further features of the present invention, there is provided a look-up table for the image processor including data about shapes of the targets and a capability of the image processor to utilize the data to calculate accuracy of aim at a target.

[0020] According to further features in preferred embodiments of the invention, there is provided, at each target, a pyrotechnic charge that is detonatable by a respective control signal and that is able to release variable quantifies of smoke in accordance with the calculated accuracy of aim.

[0021] According to the present invention, there is provided a method for identifying an acquired target comprising the steps of: (a) providing a weapon simulator including a housing substantially identical in size and shape to at least a discrete portion of the weapon; a sensor, operationally connected to the housing, for acquiring a plurality of images of a target; an image processor for detecting and analyzing changes among these images and for initiating control signals based on the analysis; for each target, an infra-red lamp that is alternatively activated by one of the control signals to flash at a unique, respective frequency and deactivated by another of the control signals; and a mechanism for transmitting the control signals to the lamps; (b) aiming the housing at one of the targets; (c) transmitting a signal to activate all the infra-red lamps; (d) acquiring the plurality of images, at known time intervals, of the target aimed at; (e) passing the images to the image processor, (f) calculating the flash frequency of the lamp on the target, aimed at by comparing successive images from the sensor; and (g) identifying the target aimed at by comparing the frequency with a look-up table of the unique frequencies.

[0022] According to further features of the present invention there is provided a method for determining accuracy of aim.

[0023] According to further features of the present invention there is provided a method for determining accuracy of aim comprising the further steps of providing a target-shape look-up table that includes data about the shapes of the respective targets and comparing the sensor images of an acquired target with the shape data.

[0024] According to a preferred embodiment of the present invention there is provided a method for a visual simulation of a hit.

[0025] According to a preferred embodiment of the present invention there is provided a method for a visual simulation of a hit comprising the steps of providing, at each target, a pyrotechnic charge and detonating the charge at an identified target.

[0026] According to preferred embodiment of the present invention there is provided a method for visually simulating the accuracy of a hit comprising the further step of differentially detonating the charge.

[0027] According to another embodiment of the present invention there is provided a method for simulation of firing of ballistic weapons.

[0028] According to another embodiment of the present invention there is provided a method for simulation of firing of ballistic weapons comprising the further step of providing calculation algorithms for the image processor that include calculation of parabolic trajectories incorporating known muzzle velocities, angle of elevation, and range of said target.

[0029] The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

- Figure 1 shows a configuration for battlefield training for electro-optically guided anti-tank missile systems;
- Figure 2 is a schematic representation of the guided missile's seeker head, showing the essential components of the present invention; and
- Figure 3 shows an implementation for non-electro-optically guided weapons.

[0030] The present invention is of an outdoors military training system for firing a weapon at a target, which provides for interaction between the training weapon and the target. Specifically, the present invention can be used for field training for electro-optically guided anti-tank missile systems. The present invention incorporates reporting mechanisms so that a training control center can be instantly aware of the results of training exercises. The present invention is a substitute for, or additional to, the currently used BT46 system, which is based on laser mechanisms.

[0031] The present invention may also be adapted to field training for other types of guns and artillery.

[0032] The present invention utilizes the in-built target seeking mechanism of ATMS, with the addition of a lightweight, inexpensive, and unobtrusive image processor.

[0033] According to the present invention, operation relies on identification of the frequency of a flashing infra-red lamp located on an acquired target. Identification is done by means of the image processor fed by the seeker sensor, such as a television camera in the missile's own target-seeker head, or by an add-on sensor.

[0034] The principles and operation of the present invention may be better understood with reference to the drawings and the accompanying description.

[0035] In general, the simulated weapon is a housing that represents, in shape and size, a discrete portion of a real weapon, and sufficient of the launcher to enable training in aiming and firing. It includes a missile guidance system but neither propulsion system nor explosive charge. Figure 1 shows a schematic view of the present invention in operation, for the case of an ATMS,

and Figure 2 a block diagram of the relevant parts of the missile's seeker head and the image processor.

[0036] The electro-optical guidance system of a missile simulator 10 includes a sensor 20, such as a CCD television camera or imager, in the seeker head 11 thereof. In practice, the missile simulator could be an actual missile, less the propulsion system and explosive charge thereof.

[0037] In normal use, sensor 20, which is sensitive to infra-red and visible light, captures an image 26 of a target 12. Sensor 20 is mounted on gimbals 21, which are an intrinsic part of the seeker, so that the pitch 27 and yaw 28 thereof may be varied to enable sensor 20 to see or to lock onto target 12.

[0038] In the present invention, each potential target 12 is equipped with a respective flashing infra-red lamp 13 mounted thereon, which is invisible to the operator's eye but detectable by sensor 20 (CCD television camera or IIR imager). The flashing frequency is unique to each particular target 12 whereupon each lamp 13 is located.

[0039] Successive images 26 from sensor 20 are passed, at predetermined time intervals, to an image processor 22 that detects changes among images 26. The time intervals are short enough to enable image processor 26 to calculate the flash frequency of lamp 13, and, by comparison with a pre-programmed look-up table 23, to identify at which target missile 10 is 'aiming'. By comparison with data, contained in a second look-up table 24, about the shape and size of the targets, image processor 22 also determines the accuracy of aiming. This information is relayed by a wireless signal 17 to target 12, in order to detonate a pyrotechnic charge 19 situated at target 12 to simulate a 'hit' by releasing smoke 14. A second wireless signal 16 is transmitted to a training control center, in order to enable trainers to monitor and control the training program and also to rate a trainee.

[0040] In more detail, the stages of operation are:

1. Weapon simulator 10 is aimed at target 12.
2. Seeker head 11 acquires target 12 and the operator locks onto target 12. At that moment wireless transmitter 15 transmits a signal 17A to all targets and activates an infra-red lamp 13 located on each target. Each lamp 13 flashes at a unique frequency specific to the associated target thereof.
3. Simultaneously, sensor 20 passes a sequence of images 26, at predetermined time intervals, of target 12, including flashing lamp 13, to image processor 22.
4. Image processor 22 calculates the frequency of lamp 13 on acquired target 12 by comparing successive images and, by comparing the frequency with an in-built look-up table of respective target frequencies 23, identifies which target has been acquired.
5. Having thus identified target 12, image processor 22 performs a further comparison of image 26 of target 12 with target-shape data 24 stored within image processor 22 to estimate aiming precision.
6. When the trainee operator is satisfied with his aim, he 'fires' the missile, which does not actually launch. Instead, a signal 17B is sent by transmitter 15 to detonate associated pyrotechnic charge 19 located at target 12, releasing smoke 14, to simulate a 'hit'. The charge is differentially detonatable: it is possible to vary the amount of smoke in accordance with the accuracy of aim to provide a visual representation of that accuracy.
7. Information about the launcher, the target 'hit', and the accuracy of aim is transmitted to simulation control center 16 to update the data held there.
8. Preferably, the entire target-acquisition process is recorded at the control center on videotape for later debriefing.
9. The system allows for simulation of the times of flight and probability of hitting a target, for the purpose of simulation of various types of munitions (such as missile, shell, bullet, *etc*).

[0041] It is seen that the invention, by utilizing the missile's in-built sensor, solves the problem of the difference between the missile line of sight, which may vary in flight, and that of an externally attached laser, as occurs in existing systems.

[0042] Furthermore, the invention, by utilizing a passive, already in-built sensor such as a CCD camera, has advantages of weight, safety (no laser beam), operational simplicity (calibration is not needed as it would be for a separate laser system aligned with the missile), debriefing (possibility of video record), low cost (less technically complicated), and better visibility in adverse weather conditions (CCD is more sensitive than the human eye and is less affected by atmospheric conditions than lasers).

[0043] Moreover, since the present invention is normally integrated into the simulated weapon and is therefore unobtrusive, there is the consequence that a conventional laser, may be added to the simulated weapon to facilitate integration into conventional battlefield simulators that use laser or other techniques such as in the earlier mentioned BT46 system. This adds versatility to the invention.

[0044] In another embodiment the present invention is partially realized by a simpler system, in which the image processing stage is employed without sending a signal 16 back to the control center and/or the target 12 by use of transmitter 15, which may therefore be absent.

[0045] In yet another embodiment of the present invention, wireless communication is replaced with wired transmission of signals and data. In this case, transmitter 15 is absent and is replaced by cables.

[0046] Yet another embodiment of the present invention is for non-electro-optically guided weapons systems, such as rifles and artillery. In such a ballistic implementation, wherein a gun or cannon is substituted for

the launcher, there is no missile, and a sighting mechanism substitutes for the guidance system. In such cases, 'discrete portion' of the weapon includes only the gun or cannon and the sighting mechanism and 'aiming' means pointing the housing so that, if it were a real weapon, a projectile fired therefrom would follow a trajectory to the target; thus the sensor needs to be adjustable for range and other considerations in the same way as sights on a real weapon. In this embodiment as illustrated in Figure 3, there is no signal from sensor 20 to an operator's screen and sensor 20 is not mounted on gimbals but is secured rigidly to a weapon barrel 31. An inexpensive, light-weight CCD television camera sensor is less obtrusive than a laser, as used in current systems. In this case, the aforementioned provision mentioned in stage of operation 9, for simulation of time of flight etc comes into play to cope with the case of ballistic projectiles, wherein the sensor points at the target while the gun barrel does not because the projectile describes a parabolic trajectory. All needed details for the simulation are calculated from positional data.

[0047] While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

Claims

1. A simulator (10) for simulating the firing of a weapon at one of a plurality of targets (12), each target (12) having a respective shape, comprising :

a) a housing substantially identical in size and shape to at least a discrete portion of the weapon;
b) a sensor (20), operationally connected to said housing, for acquiring a plurality of images (26) of at least one of the targets (12); and
c) an image processor (22) for detecting and analyzing changes among said images (26) and for initiating control signals (17) based on said analysis,
characterized in that the simulator further comprises :
d) for each target (12), an infra-red lamp (13) that is alternatively:

i) activated by one of said control signals (17) to flash at a unique, respective frequency and
ii) deactivated by another of said control signals; and

e) a mechanism (15) for transmitting said control signals (17) to said lamps (13), whereby analysis by said image processor (22) of light produced by a said infra-red lamp (13) and detected by said sensor (20) indicates at which target (12) from amongst said plurality of targets (12) said housing has been aimed, thus accurately simulating the aiming step of the firing of the weapon.

2. A simulator (10) according to claim 1, **characterized in that** said mechanism (15) is wireless.

3. A simulator (10) according to claim 1, **characterized in that** said mechanism (15) is wired.

4. A simulator (10) according to claim 1, **characterized in that** said sensor (20) includes a CCD television camera.

5. A simulator (10) according to claim 1, **characterized in that** said sensor (20) includes part of a guidance system of an electro-optically guided missile.

6. A simulator (10) according to claim 1, **characterized in that** said image processor (22) includes a look-up table (24) that includes data about shapes of respective said targets (12), said image processor (22) being operative to calculate an accuracy of an aim at the target (12) whereat the firing of the weapon is simulated.

7. A simulator (10) according to claim 1, **characterized in that** it further comprises:

f) at each target (12), a pyrotechnic charge (19) that is detonatable by a respective said control signal (17).

8. A simulator (10) according to claim 7, **characterized in that** said image processor (22) includes a look-up table (24) that includes data about shapes of respective said targets (12), said image processor (22) being operative to calculate an accuracy of an aim at the target (12) whereat the firing of the weapon is simulated.

9. A simulator (10) according to claim 8, **characterized in that** said pyrotechnic charge (19) is differentially detonatable in accordance with said accuracy of aim calculation.

10. A method of simulating the firing of a weapon at one of a plurality of targets (12), **characterized in that** it comprises the steps of:

a) providing :

(i) a weapon simulator (10) including a housing substantially identical in size and shape to at least a discrete portion of the weapon ;

(ii) a sensor (20), operationally connected to said housing, for acquiring a plurality of images (26) of the target (12) ; and
(iii) an image processor (22) for detecting and analyzing changes among said images (26) and for initiating control signals (17) based on said analysis;
(iv) for each target (12), an infra-red lamp (13) that is alternatively:

(A) activated by one of said control signals (17) to flash at a unique, respective frequency and
(B) deactivated by another of said control signals (17) ; and

(v) a mechanism (15) for transmitting said control signals (17) to said lamps (13) ;

b) aiming said housing at one of the targets (12);
c) activating all said infra-red lamps (13);
d) acquiring a plurality of images (26), at predetermined time intervals, of the target (12) whereat said housing is aimed ;
e) passing said images (26) to said image processor (22);
f) calculating a flash frequency of the lamp (13) on the target (12) whereat said housing is aimed, by comparing successive said images (26) and
g) identifying the target (12) whereat said housing is aimed, by comparing said calculated flash frequency with a look-up table (23) of said respective frequencies,

whereby said identifying at which target (12) from amongst said plurality of targets (12) said housing has been aimed is an accurate simulation of the aiming step of firing of the weapon.

11. The method of claim 10, **characterized in that** it further comprises the step of :

h) visually simulating a hit.

12. The method of claim 11, **characterized in that** said simulating is effected by steps including :

i) providing, at each target (12), a pyrotechnic charge (19) ; and
ii) detonating said charge (19) at the target (12) whereat said housing is aimed.

13. The method according to claim 12, **characterized in that** said charge (19) is detonated differentially.

14. The method according to claim 10, **characterized in that** it further comprises the step of :

h) determining an accuracy of said aim.

15. The method according to claim 14, **characterized in that** determining of said accuracy is effected by steps including :

i) providing a look-up table (24) that includes data about shapes of the targets (12) ; and
ii) comparing said images (26) of the target (12) with said shape date.

16. The method according to claim 14, **characterized in that** said determining of said accuracy is effected by steps including calculating a trajectory from said housing to the target (12) whereat said housing is aimed.

Patentansprüche

1. Simulator (10) zum Simulieren des Abschusses einer Waffe auf eines von mehreren Zielen (12), wobei jedes Ziel (12) eine jeweilige Form aufweist, umfassend:

a) ein Gehäuse, das in Größe und Form im Wesentlichen mit wenigstens einem diskreten Abschnitt der Waffe identisch ist;
b) einen mit dem Gehäuse wirkverbundenen Sensor (20) zum Erfassen mehrerer Bilder (26) wenigstens eines der Ziele (12);
c) eine Bildverarbeitungsvorrichtung (22) zum Erkennen und Analysieren von Veränderungen zwischen den Bildern (26) und zum Initiieren von Steuersignalen (17) anhand der Analyse;
dadurch gekennzeichnet, dass der Simulator des Weiteren folgendes umfasst:
d) für jedes Ziel (12) eine Infrarotlampe (13), die alternativ

i) durch eines der Steuersignale (17) aktiviert wird, dergestalt, dass sie mit einer eindeutig zuordnungsfähigen jeweiligen Frequenz blinkt, und
(ii) durch ein anderes der Steuersignale deaktiviert wird; und

e) einen Mechanismus (15) zum Übertragen der Steuersignale (17) zu den Lampen (13),

wobei die von der Bildverarbeitungsvorrichtung (22) vorgenommene Analyse des Lichts, das von einer der Infrarotlampen (13) abgegeben wurde und von dem Sensor (20) erfasst wird, anzeigt, auf welches der mehreren Ziele (12) das Gehäuse gezielt hat, wodurch präzise der Ziel-Schritt des Ab-

schusses der Waffe simuliert wird.

2. Simulator (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Mechanismus (15) ein drahtloser Mechanismus ist.

3. Simulator (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Mechanismus (15) ein drahtgebundener Mechanismus ist.

4. Simulator (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Sensor (20) eine CCD-Fernsehkamera enthält.

5. Simulator (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Sensor (20) einen teil eines Lenksystems einer elektro-optisch gelenkten Rakete enthält.

6. Simulator (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Bildverarbeitungsvorrichtung (22) eine Nachschlagetabelle (24) enthält, die Daten über Formen jeweiliger Ziele (12) enthält, wobei die Bildverarbeitungsvorrichtung (22) in der Lage ist, eine Zielgenauigkeit bezüglich des Ziels (12) zu berechnen, auf das der Abschuss der Waffe simuliert wird.

7. Simulator (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** er des Weiteren folgendes umfasst:

   f) an jedem Ziel (12) eine pyrotechnische Ladung (19), die mittels eines jeweiligen Steuersignals (17) gezündet werden kann.

8. Simulator (10) nach Anspruch 7, **dadurch gekennzeichnet, dass** die Bildverarbeitungsvorrichtung (22) eine Nachschlagetabelle (24) enthält, die Daten über Formen jeweiliger Ziele (12) enthält, wobei die Bildverarbeitungsvorrichtung (22) in der Lage ist, eine Zielgenauigkeit bezüglich des Ziels (12) zu berechnen, auf das der Abschuss der Waffe simuliert wird.

9. Simulator (10) nach Anspruch 8, **dadurch gekennzeichnet, dass** die pyrotechnische Ladung (19) entsprechend der Zielgenauigkeit quantitativ variabel gezündet werden.

10. Verfahren zum Simulieren des Abschusses einer Waffe auf eines von mehreren Zielen (12), **dadurch gekennzeichnet, dass** es folgende Schritte umfasst:

    a) Bereitstellen

       (i) eines Waffensimulators (10) mit einem Gehäuse, das in Größe und Form im Wesentlichen mit wenigstens einem diskreten Abschnitt der Waffe identisch ist;
       (ii) eines mit dem Gehäuse wirkverbundenen Sensors (20) zum Erfassen mehrerer Bilder (26) des Ziels (12);
       (iii) einer Bildverarbeitungsvorrichtung (22) zum Erkennen und Analysieren von Veränderungen zwischen diesen Bildern (26) und zum Initiieren von Steuersignalen (17) anhand der Analyse;
       (iv) einer Infrarotlampe (13) für jedes Ziel (12), die alternativ

          (A) durch eines der Steuersignale (17) aktiviert wird, dergestalt, dass sie mit einer eindeutig zuordnungsfähigen jeweiligen Frequenz blinkt, und
          (B) durch ein anderes der Steuersignale (17) deaktiviert wird; und

       (v) eines Mechanismus' (15) zum Übertragen der Steuersignale (17) zu den Lampen (13);

    b) Zielen mit dem Gehäuse auf eines der Ziele (12);
    c) Aktivieren aller Infrarotlampen (13);
    d) Erfassen mehrerer Bilder (26) des vom Gehäuse anvisierten Ziels (12) in bekannten Zeitabständen;
    e) Weiterleiten der Bilder (26) zu der Bildverarbeitungsvorrichtung (22);
    f) Berechnen einer Blinkfrequenz der Lampe (13) an dem vom Gehäuse anvisierten Ziel (12) durch Vergleichen aufeinanderfolgender Bilder (26); und
    g) Identifizieren des vom Gehäuse anvisierten Ziels (12) durch Vergleichen der errechneten Blinkfrequenz mit einer Nachschlagetabelle (23) der jeweiligen Frequenzen,

    wobei das Erkennen, auf welches der mehreren Ziele (12) das Gehäuse gerichtet ist, eine exakte Simulation des Ziel-Schrittes des Abschusses der Waffe darstellt.

11. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, dass** es des Weiteren folgenden Schritt umfasst:

    h) visuelles Simulieren eines Treffers.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** das Simulieren durch Schritte bewirkt wird, die folgendes enthalten:

    i) Bereitstellen einer pyrotechnischen Ladung (19) an jedem Ziel (12); und

ii) Zünden der Ladung (19) an dem Ziel (12), auf das mit dem Gehäuse gezielt wird.

13. Verfahren nach Anspruch 12, **dadurch gekennzeichnet, dass** die Ladung (19) quantitativ variabel gezündet werden kann.

14. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, dass** es des Weiteren folgenden Schritt umfasst:

h) Ermitteln einer Zielgenauigkeit.

15. Verfahren nach Anspruch 14, **dadurch gekennzeichnet, dass** das Ermitteln dieser Genauigkeit durch Schritte bewirkt wird, die folgendes enthalten:

i) Bereitstellen einer Nachschlagetabelle (24), die Daten über Formen der Ziele (12) enthält; und
ii) Vergleichen der Bilder (26) des Ziels (12) mit den Form-Daten.

16. Verfahren nach Anspruch 14, **dadurch gekennzeichnet, dass** das Ermitteln dieser Genauigkeit durch Schritte bewirkt wird, die das Berechnen der Flugbahn von dem Gehäuse zu dem vom Gehäuse anvisierten Ziel (12) enthalten.

Revendications

1. Simulateur (10) pour simuler le tir d'une arme vers l'une d'une pluralité de cibles (12), chaque cible (12) ayant une forme respective, comprenant :

a) un boîtier sensiblement identique en dimension et en forme à au moins une partie discrète de l'arme ;
b) un capteur (20), connecté de manière opérationnelle audit boîtier, pour acquérir une pluralité d'images (26) d'au moins l'une des cibles (12) ; et
c) un processeur d'image (22) pour détecter et analyser les changements parmi lesdites images (26) et pour initier des signaux de contrôle (17) sur la base de ladite analyse ;

caractérisé en ce que le simulateur comprend en outre :

d) pour chaque cible (12), une lampe infrarouge (13) qui est alternativement :

i) activée par l'un desdits signaux de contrôle (17) pour clignoter à une fréquence respective unique et
ii) désactivée par un autre desdits signaux de contrôle ; et

e) un mécanisme (15) pour transmettre lesdits signaux de contrôle (17) auxdites lampes (13),

moyennant quoi l'analyse par ledit processeur d'image (22) de la lumière produite par ladite lampe infrarouge (13) et détectée par ledit capteur (20) indique vers quelle cible (13) parmi ladite pluralité de cibles (12) ledit boîtier a été dirigé, simulant ainsi avec précision l'étape de visée du tir de l'arme.

2. Simulateur (10) selon la revendication 1, **caractérisé en ce que** ledit mécanisme (15) est sans fil.

3. Simulateur (10) selon la revendication 1, **caractérisé en ce que** ledit mécanisme (15) est filaire.

4. Simulateur (10) selon la revendication 1, **caractérisé en ce que** ledit capteur (20) comprend une caméra de télévision CCD.

5. Simulateur (10) selon la revendication 1, **caractérisé en ce que** ledit capteur (20) comprend une partie d'un système de guidage d'un missile guidé électro-optiquement.

6. Simulateur (10) selon la revendication 1, **caractérisé en ce que** ledit processeur d'image (22) comprend une table de recherche (24) qui comprend des données sur les formes desdites cibles respectives (12), ledit processeur d'image (22) étant opérationnel pour calculer une précision d'une visée vers la cible (12) vers laquelle le tir de l'arme est simulé.

7. Simulateur (10) selon la revendication 1, **caractérisé en ce qu'**il comprend en outre :

f) au niveau de chaque cible (12), une charge pyrotechnique (19) que ledit signal de contrôle (17) respectif peut faire détoner.

8. Simulateur (10) selon la revendication 7, **caractérisé en ce que** ledit processeur d'image (22) comprend une table de recherche (24) qui comprend des données sur les formes desdites cibles respectives (12), ledit processeur d'image (22) étant opérationnel pour calculer une précision d'une visée vers la cible (12) vers laquelle le tir de l'arme est simulé.

9. Simulateur (10) selon la revendication 8, **caractérisé en ce que** ladite charge pyrotechnique (19) peut être faite détoner de manière différentielle conformément à ladite précision du calcul de visée.

10. Procédé de simulation du tir d'une arme vers l'une d'une pluralité de cibles (12), **caractérisé en ce qu'**il comprend les étapes consistant à :

a) fournir :

(i) un simulateur d'arme (10) comprenant un boîtier sensiblement identique en dimension et en forme à au moins une partie discrète de l'arme ;
(ii) un capteur (20), connecté de manière opérationnelle audit boîtier, pour acquérir une pluralité d'images (26) de la cible (12) ; et
(iii) un processeur d'image (22) pour détecter et analyser les changements parmi lesdites images (26) et pour initier des signaux de contrôle (17) sur la base de ladite analyse ;
(iv) pour chaque cible (12), une lampe infrarouge (13) qui est alternativement :

(A) activée par l'un desdits signaux de contrôle (17) pour clignoter à une fréquence respective unique et
(B) désactivée par un autre desdits signaux de contrôle (17) ; et

(v) un mécanisme (15) pour transmettre lesdits signaux de contrôle (17) auxdites lampes (13) ;

b) diriger ledit boîtier vers l'une des cibles (12) ;
c) activer toutes lesdites lampes infrarouges (13) ;
d) acquérir une pluralité d'images (26), à des intervalles de temps prédéterminés, de la cible (12) vers laquelle ledit boîtier est dirigé ;
e) transmettre lesdites images (26) audit processeur d'image (22) ;
f) calculer une fréquence de clignotement de la lampe (13) sur la cible (12) vers laquelle ledit boîtier est dirigé, en comparant lesdites images (26) successives ; et
g) identifier la cible (12) vers laquelle ledit boîtier est dirigé, en comparant ladite fréquence de clignotement calculée à une table de recherche (23) desdites fréquences respectives,

moyennant quoi l'identification de la cible (12) parmi ladite pluralité de cibles (12) vers laquelle ledit boîtier a été dirigé est une simulation précise de l'étape de visée du tir de l'arme.

11. Procédé selon la revendication 10, **caractérisé en ce qu'**il comprend en outre l'étape consistant à :

h) simuler visuellement une frappe.

12. Procédé selon la revendication 11, **caractérisé en ce que** ladite simulation est effectuée par des étapes consistant à :

i) fournir, au niveau de chaque cible (12), une charge pyrotechnique (19) ; et
ii) faire détoner ladite charge (19) au niveau de la cible (12) vers laquelle ledit boîtier est dirigé.

13. Procédé selon la revendication 12, **caractérisé en ce que** ladite charge (19) est faite détonnée de manière différentielle.

14. Procédé selon la revendication 10, **caractérisé en ce qu'**il comprend en outre l'étape consistant à :

h) déterminer une précision de ladite visée.

15. Procédé selon la revendication 14, **caractérisé en ce que** la détermination de ladite précision est effectuée par des étapes consistant à :

i) fournir une table de recherche (24) qui comprend des données sur les formes des cibles (12) ; et
ii) comparer lesdites images (26) de la cible (12) avec lesdites données de forme.

16. Procédé selon la revendication 14, **caractérisé en ce que** ladite détermination de ladite précision est effectuée par des étapes consistant à calculer une trajectoire dudit boîtier vers la cible (12) vers laquelle ledit boîtier est dirigé.

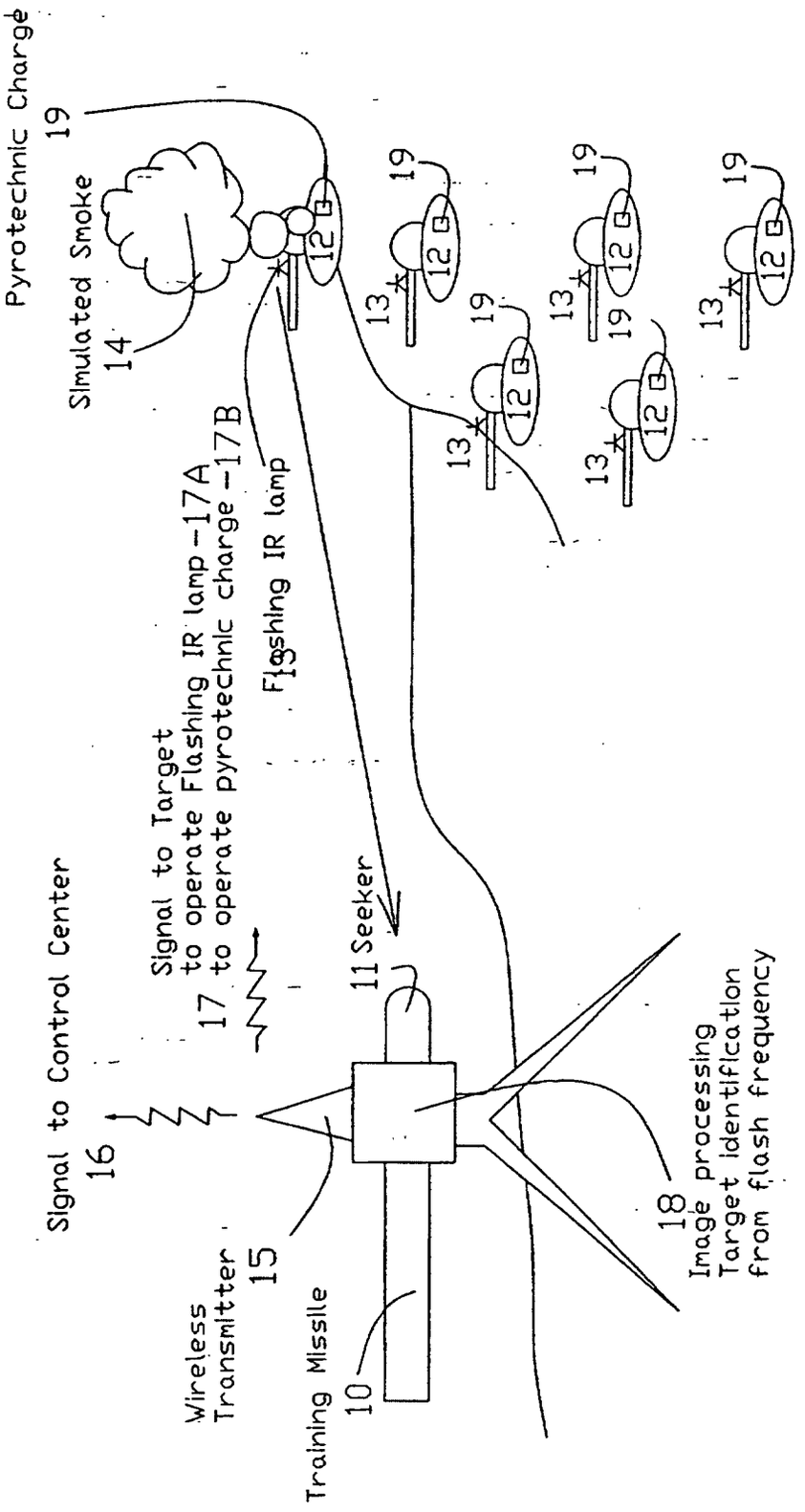


Fig. 1 - Battle field Simulator for ED ATMS

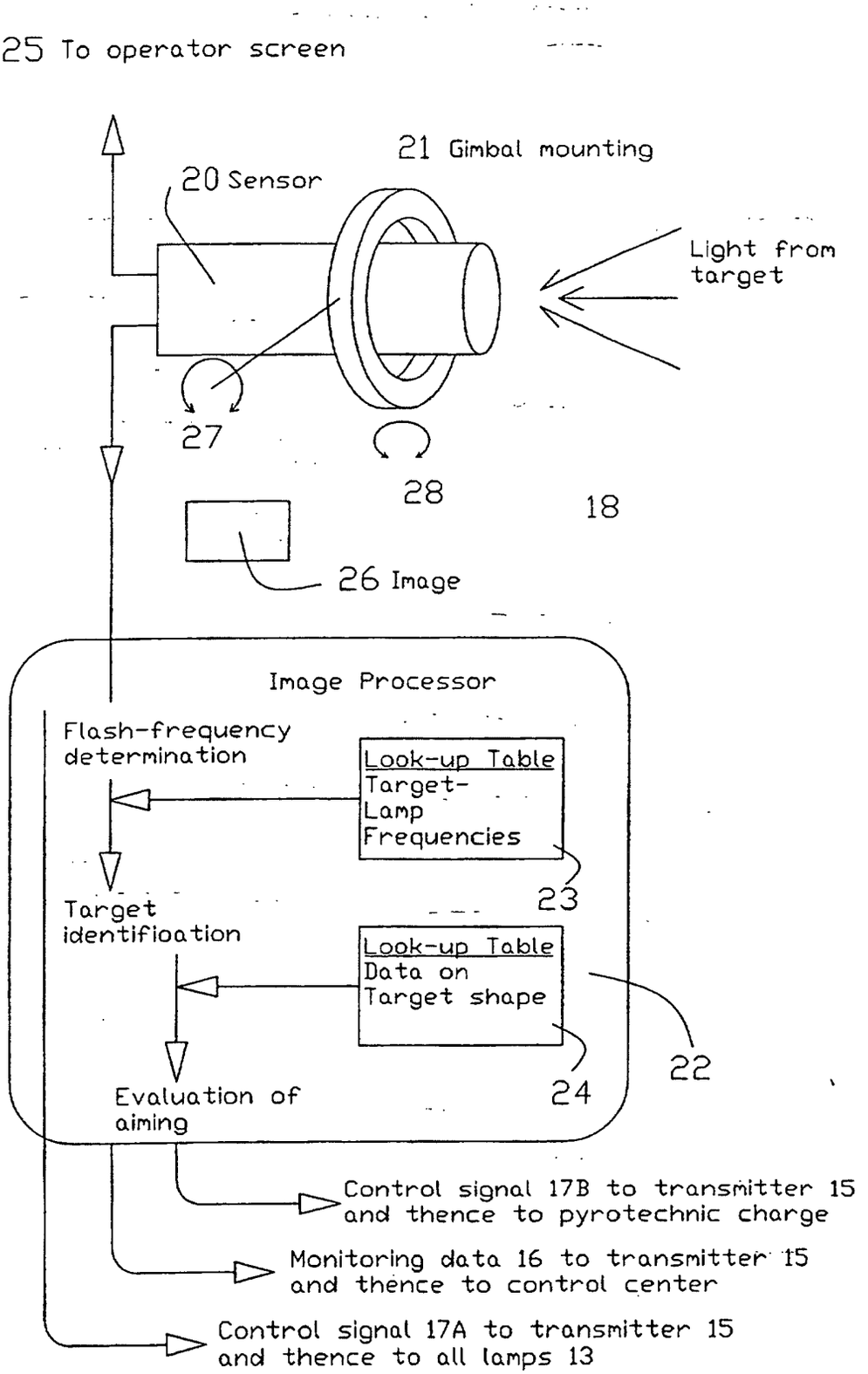


Fig. 2 - Schematic of Operation of Seeker Head and Image Processor

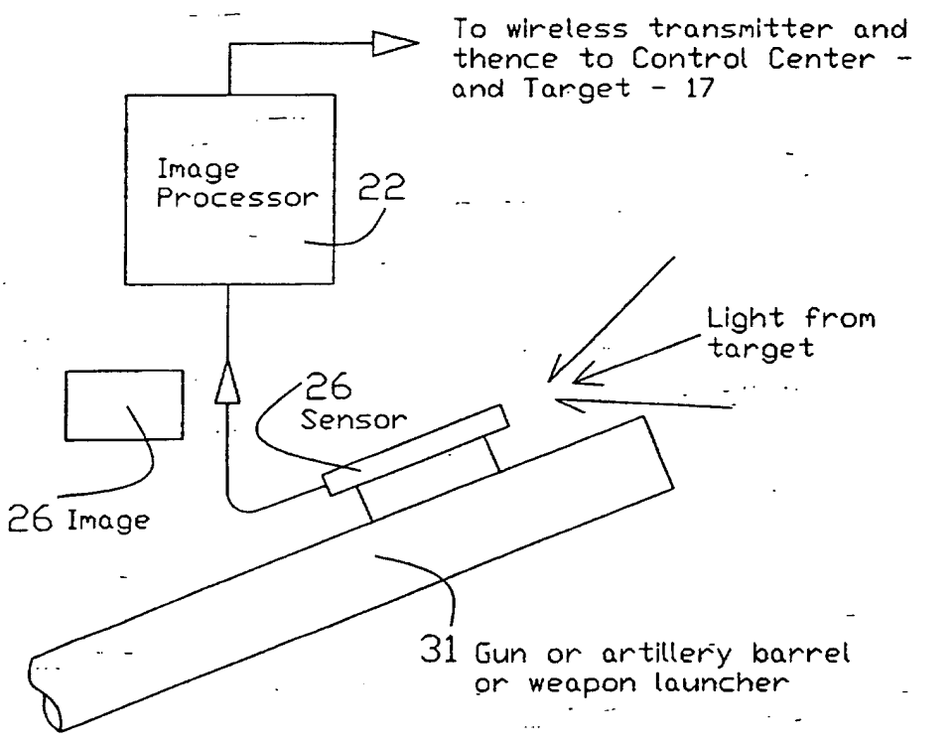


Fig. 3 - Implementation for non-EO guided weapons