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METHOD AND DEVICE FOR SIMULATING DETONATING PROJECTILES**Field of the Invention**

5 The present invention refers to a method for simulating the effect of exploding projectiles fired by weapons. Furthermore, the invention refers to a device for carrying out a method for simulating the effect of exploding projectiles fired by weapons.

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Background of the Invention

Known types of detonating projectiles are those fired by ballistic weapons (mortars, artillery). For simulation
15 purposes, the trajectory and the location of the detonation are calculated on the basis of the gun orientation and other parameters. Due to the relatively long time of flight of several seconds, this calculation can be performed by a central computer.

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Recently, however, infantry weapons have been introduced which also operate according to this principle. These weapons are essentially similar to rifles. The soldier takes aim at the edge of a building, for example, thereby allowing
25 the targeting device to determine the corresponding distance and store it. Then the soldier aims past the edge and fires. The shot travels the previously determined distance and detonates at the end thereof, or at some distance before or behind it. Essentially, it is thereby possible to hit a
30 target behind the aimed edge, or, in simple terms, to shoot to a certain extent "around the corner".

Since in particular the time of flight is for this kind of weapon rather in the range of milliseconds, it is not
35 possible to simulate the effect of this weapon by a central

computer without admitting an unrealistic delay between the firing and its effect.

Summary of the Invention

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It is therefore an object of the present invention to provide a method and a device for simulating the effect of detonating projectiles which allows realistically short delays between firing and detonation at the target location.

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According to a first aspect of the invention this object is attained by a method wherein a weapon signal emitted by the weapon when fired is detected by a sensor located near the target area and the sensor prompts at least one associated transmitter to emit an impact signal which is adapted to cover also that portion of the impact area of the simulated explosion which cannot be covered by the weapon signal of the weapon.

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According to a second aspect of the invention there is provided a device which comprises a sensor and a transmitter, which sensor being effectively linked to the transmitter in such a manner that a weapon signal which is detected by the sensor and which indicates the simulated firing of a projectile having an explosive effect in the target area prompts the emission of an impact signal in the impact area of the simulated projectile by the transmitter.

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According to a third aspect of the invention there is provided a device according to the second aspect, wherein the sensor is directionally sensitive and preferably comprises a plurality of sensor elements each of which covers a sector of the total angular range covered by the sensor in order to determine the angle of incidence of the

weapon signal emitted by the weapon at least stepwise and wherein the transmitter is adapted to emit the impact signal with a directionally variable range and particularly comprises a plurality of transmitter elements each of which
5 is adapted to supply approximately a sector with a controllable range, so that the transmitter is adapted for being triggered by the sensor according to the angle of incidence of the weapon signal of the weapon in such a manner that the area supplied with an effective impact
10 signal by the transmitter represents an improved approximation to the impact area of a projectile exploding in reality.

The principal aspect of the method according to the
15 invention is that firing information emitted by the simulated weapon is locally detected and emitted in the impact area of the simulated detonation, i.e. particularly also in the area which is invisible from the position of the shooter. Preferably, a transceiver unit is provided on the
20 obstacle for this purpose. The receiver of this unit records information emitted by the weapon that the shot has been fired and activates the transmitter unit which emits information on the simulated detonation in the impact area. Participants in the exercise who are present in the impact
25 area and equipped with corresponding receivers are thus informed of the fact that they have been hit and are eliminated or considered as injured.

According to a preferred embodiment, the direction from
30 which the weapon is pointed at the obstacle is furthermore determined in order to be able to demarcate the impact area of the detonation more precisely. In this case it is further preferred that the transmitter also offers the possibility

of selectively supplying the impact signal to certain portions of the possible impact area only.

Brief Description of the Drawings

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The invention will be explained in more detail with reference to an exemplary embodiment illustrated in the figures.

10 FIG. 1 schematically shows a simulation situation;

FIG. 2 shows an enlarged top view of a transceiver unit;
and

15 FIG. 3 shows a front view of a transceiver unit.

Description of the Preferred Embodiment

According to the invention a transceiver unit 5 is affixed
20 to the edge 1 of a schematically illustrated building 3. It is noted that the size of transceiver unit 5 is shown in FIG. 1 in an exaggerated manner compared to simulated impact area 7 of the detonation.

25 The purpose of the simulation is to simulate the effect of a projectile approaching on trajectory 9 and detonating at location 10. It is assumed in an idealizing manner that the impact of the explosion at location 10 covers area 7, wherein trajectory 9 is flat. The simulation requires that
30 the corresponding weapon is provided with a device allowing the emission of firing information into the area visible from the weapon. Generally, this would be a simulation device using a laser source. Known embodiments of such devices are already capable of compensating elevation and
35 lead by projecting the laser beam into the target area with

a lateral and/or vertical deviation. For explosive projectiles and other applications, it is known that the laser device sweeps a larger part of the target area, i.e. that the laser beam is guided over a determined surface in a zigzag movement, for example, thereby activating detectors provided in equipment and on training participants in the impact area.

In the case of the weapon for which the simulation is intended, at first, edge 1 is targeted. The laser beam of the weapon hits transceiver unit 5. If necessary, the receiver of the unit is thereby set to an alarm condition. The receiver is directionally sensitive in order to be able to determine the direction of trajectory 9 at least approximately. Furthermore, the transceiver unit comprises a reflector device 20 which reflects the laser beam back onto itself. This allows the targeting device to detect that its beam has hit a transceiver unit 5. Subsequently, as the weapon is pointed at target location 10, the targeting device may deviate the laser beam with respect to the orientation of the weapon or expand it in such a manner that it still hits transceiver unit 5.

When the weapon is fired, a corresponding piece of information is transmitted by the laser beam to the receiver of the transceiver unit. This will activate the transmitter section 27 of transceiver unit 5, which in turn will emit the impact signal in impact area 7. In the example shown in FIG. 1 it is assumed that impact area 7 represents essentially an ellipse whose longer axis is perpendicular to trajectory 9. Equipment and/or simulation participants present in impact area 7 and carrying detectors responding to the signal of the transmitter of transceiver unit 5 are thus immediately after the firing informed of the fact that

they are exposed to the impact of this weapon by the activation of their sensors.

In other words, transceiver unit 5 transforms the hit signal
5 emitted by the simulation device of the weapon into an impact signal that covers impact area 7, i.e. also locations which cannot be attained by the hit signal of the weapon itself for physical reasons.

10 FIGs. 2 and 3 show transceiver unit 5 on a greatly enlarged scale. It comprises essentially three sections. Reflector section 20 is arranged at the top and serves for reflecting the laser signal emitted by the weapon back onto itself, thereby allowing the weapon to locate transceiver unit 5.

15 Sensor 22 is arranged in the center. It is composed of a number of sensor elements 24, each of which surveys a sector. For example, the arrangement of FIG. 2 allows the determination of the horizontal (virtual) trajectory 9 with
20 a resolution of 45 degrees. Sensor elements 24 may be usual photo-sensitive elements which are separated from each other by separating walls 26 in order to ensure the sector-shaped directional characteristic.

25 Transmitter 27 is arranged at the bottom of transceiver unit 5. It comprises a number of transmitter elements 29, each of which approximately covers a respective sector of the area surrounding the transceiver unit. Furthermore, the non-represented control system of transceiver unit 5 also
30 controls the transmitting power of transmitter elements 29 in order to control the range of the impact signal emitted by the transmitter elements and thereby to reproduce the shape of impact area 7.

The control both of the simulation device of the weapon and of transceiver unit 5 can be realized by conventional means. For example, each sensor may be connected to a threshold amplifier which responds when a signal is received and
5 ensures that each transmitter element is supplied with a certain amount of energy whereby the range of the impact signal in the corresponding direction is adjusted. The resulting shape of the reproduced impact area 7 corresponds to the orientation of the respective sensor element 24 and
10 thus to that of trajectory 9.

Control devices for this purpose are known to those skilled in the art and therefore need not be explained in more detail.

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An alternative possibility of controlling transceiver unit 5 consists in providing the respective building 3 with a sufficiently powerful simulation computer which detects the weapons, particularly of the simulated type, that are
20 monitored by the transceiver units and possibly fired only near the house and activates the corresponding transmitter units 20. With this arrangement, it is additionally possible to provide further transmitter units which are not integrated in the transceiver units, and/or to inform
25 participants or equipment of their location in the impact area, e.g. by radio. Since this local computing unit may basically also be informed of the position and the number of all nearby participants, equipment, and weapons, it may simulate the application of the weapons, complementarily
30 with the local transceiver units 5, even if they are not used for their actual purpose, e.g. for direct fire which may not be recognized by transceiver units 5 in certain circumstances. However, as the case may be, a certain delay and thus a less realistic simulation of the impact may be
35 the result.

On the basis of the preceding description of a preferred embodiment, it will be understood by those skilled in the art that various modifications can be made without departing
5 from the scope of the invention as defined by the claims. For example if the requirements are less stringent, it is possible to omit the directional sensitivity of transmitter 27 as well as of sensor 22. If the range control and particularly also the directional characteristic of
10 transmitter 27 are omitted, an essentially circular impact area surrounding the transceiver unit will be the simulated. Even if the lack of any directional characteristic of the sensor unit might possibly be acceptable, the transceiver unit would then be incapable of discerning whether the
15 special weapon is used as intended or whether it is e.g. aimed at the obstacle directly. A correct application of the weapon would then be assumed in every case.

Instead of light (laser), other means of data transmission
20 could be considered, such as e.g. ultrasonic or radio signals, particularly of a high frequency, e.g. 2.4 GHz. However, in general, the latter are less suitable on account of their sensitivity to certain atmospheric conditions which would not substantially influence the course of the
25 simulation otherwise.

Further possible modifications are:

- Displaceable separating walls 26 between transmitter
30 elements which are positioned according to the trajectory in such a manner as to allow a better reproduction of the impact area by the transmitter elements;
- The sections of a transceiver unit (reflector, sensor,
35 transmitter) are in the form of separate parts, so as to

allow particularly the transmitter to be positioned for optimum signal emission and/or to be addressed by a plurality of sensor/reflector units;

- 5 - A 360° detection range of the transceiver unit in order to be mounted on a vehicle or another obstacle and to be able to simulate fire onto the obstacle from any direction and an impact behind the obstacle;
- 10 - An additional effect unit for producing realistic effects such as smoke, explosion noise, light flashes.

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Claims

1. A method for simulating the effect of exploding
projectiles fired by weapons, characterized in that a weapon
5 signal emitted by the weapon when fired is detected by a
sensor (22) located near the target area and said sensor
prompts at least one associated transmitter (27) to emit an
impact signal, said impact signal is adapted to cover also
that portion of the impact area (7) of the simulated
10 explosion which cannot be covered by the weapon signal of
said weapon.

2. The method of claim 1, wherein the trajectory (9) of
the simulated projectile is determined on the basis of the
15 angle of incidence of the weapon signal on said sensor (22)
and accordingly, the signal emitted by said transmitter is
modified directionally such that an improved approximation
of the area covered by said impact signal to the impact area
of a real projectile is accomplished.

20 3. A device for carrying out the method of claim 1 or 2,
characterized in that said device comprises a sensor (22)
and a transmitter (27), said sensor (22) being effectively
linked to said transmitter (27) in such a manner that a
25 weapon signal which is detected by said sensor and which
indicates the simulated firing of a projectile having an
explosive effect in the target area prompts the emission of
an impact signal in the impact area (7) of the simulated
projectile by said transmitter (27).

30 4. The device of claim 3, wherein said sensor (22) is
directionally sensitive and preferably comprises a plurality
of sensor elements (24) each of which covers a sector of the



total angular range covered by said sensor (22) in order to determine the angle of incidence of the weapon signal emitted by the weapon at least stepwise, and wherein said transmitter (27) is adapted to emit the impact signal with a directionally variable range and particularly comprises a plurality of transmitter elements (29) each of which is adapted to supply approximately a sector with a controllable range, so that said transmitter (27) is adapted for being triggered by said sensor (22) according to the angle of incidence of the weapon signal of said weapon in such a manner that the area supplied with an effective impact signal by said transmitter represents an improved approximation to the impact area (7) of a projectile exploding in reality.

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5. The device of claim 3 or 4, wherein said device comprises a reflector device (20) which reflects at least an effective portion of the weapon signal emitted by said weapon back onto the weapon, thus allowing the position of said reflector device to be determined by the simulation device of said weapon which emits the weapon signal and said weapon signal to be transmitted to said sensor (22) when said weapon is fired.

25 6. The device of any one of claims 3 to 5, wherein said sensor (22) is a sensor responding to laser light.

7. The device of any one of claims 3 to 6, wherein said transmitter (27) comprises at least one laser light source, preferably at least one laser diode, in order to be capable of emitting an impact signal in the form of laser light.

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8. The device of any one of claims 4 to 7, wherein said transmitter elements (29) are separated from each other by screens, in particular separating walls, said screens (26) providing an essentially sectorial restriction of the impact
5 signal emitted by said transmitter elements (29).

9. The device of claim 8, wherein said screens are adjustable in function of the angle of incidence of the weapon signal of said weapon on the sensor in order to allow
10 an improved adaptation of the area covered by the impact signal of said transmitter elements (29) to the impact area of a projectile exploding in reality.

10. The device of any one of claims 3 to 9, wherein said
15 sensor (22) is sensitive to high-frequency radio signals and/or to ultrasonic signals, and/or wherein said transmitter (27) is adapted to emit an impact signal in the form of a high-frequency radio and/or ultrasonic signal.

20 11. An installation for simulating combat action, comprising at least one obstacle to visibility, particularly a building, said obstacle being provided at its periphery, particularly at least at one corner, with a device according to any one of claims 3 to 10, thus allowing the simulation
25 of the effect of a weapon firing projectiles which explode at the target location.