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(54) Optical positioning system for a virtual shoulder gun-firing simulator

(57) The purpose of this Invention Patent Request is a positioning system for a virtual shoulder gun-firing simulator, the differentiating elements of which are a projection screen with an active element and a receiver located on the simulated arm.

This system is especially suitable for arm simulators that do not rest on the ground, thus permitting reduction of both the size and the complexity of the simulation equipment, as well as the time it takes to put it into operation, with the result it is completely portable and compatible with the present mobility of military units (Figure 1).

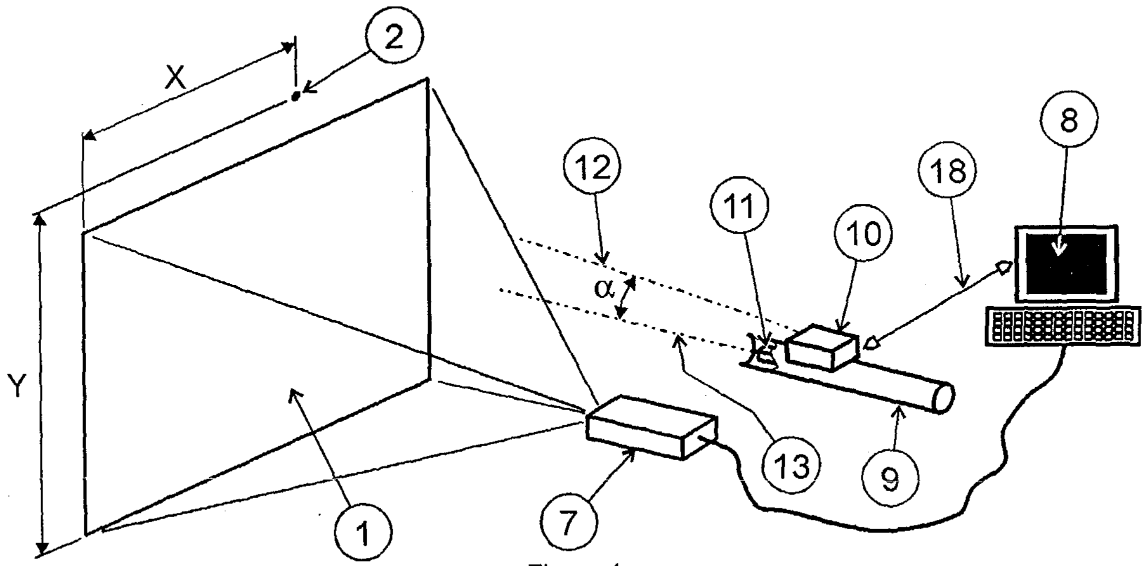

Figure 1

EP 1 524 486 A1

Description

Purpose

[0001] The purpose of this Invention Patent Request is an optical positioning system for a virtual shoulder gun-firing simulator.

History

[0002] At present there is a generalized tendency in all the armed forces throughout the world to reduce training costs of the marksmen of any type of arm.

[0003] In this respect, the use of equipment based on computer systems is imposed, which have virtual targets within a generated atmosphere (image and sound) together with a simulated arm that allows performance of normal preparation, aiming and firing processes of a real arm.

[0004] One of the questions that all the systems have to solve is to know in what direction the simulated arm is pointing. Various solutions have been developed for this purpose and are briefly described as history:

- Cathodic ray screen (CRT) and sensor in the simulated arm. This is based on the fact that a certain number of times per second (25, 50, 100) the image of the CRT screen is illuminated by rows of points -pixels - and turns off completely. The sensor informs the system of the moment when the pixel to which it is pointed lights up, therefore the system knows which pixel it is.

- Due to the operating principle, this technique is not applicable to TFT screens (flat screens, projectors, etc.) where the image does not light up by rows of pixels but all at once. Therefore, its use is widely extended in video games but is not applicable to the large size projected images.

- Reference to a fixed point on the ground. This is a very reliable system as it is based on sensors -encoders or potentiometers, for example- placed between the arm and its support. This technique, suitable for an arm simulator resting on the ground -for example, those that have a tripod- are completely unsuitable for light arms fired from the shoulder, where the existence of a support would take away all realism.

- Reference to a passive screen. Its use is limited to aiming at a point of color on a white screen. Its cost is very economic but is incompatible with the use of a realistic visual environment.

- Fixed cameras that identify the position of a simulated arm based on reference points. This system requires modifications in the external aspect of the simulated arm but, above all, requires the fixed location of a certain number of cameras in the room, which is incompatible with the portable concept.

- Gyroscopic system with external visual environment. This system is very efficient and realistic, but requires the initial identification of a reference point with regard to the presentation screen and frequent verification of this reference, thus returning to the initial problem. Furthermore, the complexity of the gyroscopic sensors as regards the necessary precision makes its cost very high. On the other hand, it may entail an excessive weight, incompatible with a light arm.

- Gyroscopic system with internal visual environment. This is also very efficient and realistic and requires the introduction of a system generating the image of the environment inside the arm aiming equipment itself, which makes it unsuitable for small, light arms or with simple aiming systems.

- Simulated arm with active transmitted and screen with receivers. This system, which is fairly reliable, uses an infrared laser-type transmitter on the arm. It requires a receiver matrix located on the screen that, in order to obtain suitable precision, makes this element a complicated and delicate component and, therefore, difficult to maintain apart from being very heavy, which greatly limits is portability.

Description of the invention

[0005] The solution to which this patent request refers is based on the use of a projection screen provided with, at least, one transmitting element that produces a point of light in the non-visible. coded spectrum or not, and which can be on the surface of the screen itself or outside it nearby, and a simulated arm provided with at least one sensitive receiving device on the non-visible spectrum.

[0006] Identification of the point (or points) of non-visible light by the receiving device (or devices) installed on the simulated arm permit easy performance of the operations needed for the most efficient simulation.

[0007] This solution resolves the inconveniences described above, as:

- It permits the use of images projected on a large size screen
- It does not need to be rested on the ground
- It permits the generation of any complex visual environment on a screen external to the arm
- It does not require the installation of fixed elements in the room
- It does not require excessively expensive or delicate components
- All its components are light and robust, compatible

with the simulation of light arms and with the basic portability concept

Brief Description of the Drawings

[0008] The following drawings are included at the end of this invention patent request:

Figure 1 - General configuration of the system
Figure 2 - Transmitting spotlight
Figure 3 - Receiver block diagram
Figure 4 - Image received by the sensor devices
Figure 5 - Assignment of coordinates by the control logic

[0009] The numbers between square brackets in the text are references to these figures.

Practical performance of the invention

[0010] The following is a description, although not limited, of one of the many possible performances of positioning system for a virtual shoulder gun-firing simulator to which this invention patent request refers.

[0011] This performance consists of a screen [1] provided with a transmitting spotlight [2] located on known X and Y coordinates.

[0012] This transmitting spotlight [2], in turn, is formed by a conventional lamp [3] with the required power, housed in a closed receptacle [4] that has only one small orifice [5] covered by an infrared filter [6]. This set generated an infrared point of light - not visible - of small dimensions.

[0013] The image - visible - is projected on the screen [1] coming from a conventional projector [7] and generated by a computer [8] that control the entire system.

[0014] A simulated arm [9] permits the user to carry out the same maneuvers and manipulation as with a real arm, specifically, aiming is made through its viewer [10].

[0015] The simulated arm [9] is provided with a receiver [11] designed and located in such a way that its presence is not noticed even by the marksman.

[0016] The existing ∝ angle between the axis [12] of the viewer [10] and the axis [13] of the receiver [11] depends on their design and, therefore, is known. This angle refers to positions in space, although for the sake of simplifying the illustration, Figure 1 represents one plane only.

[0017] The receiver [11] is formed by two sensor devices [14.1 and 14.2] of the CCD matrix type, able to decompose the image received in a large number of pixels. These sensor devices [14.1 and 14.2] are placed orthogonally to each other.

[0018] Each of the sensor devices [14.1 and 14.2] has an infrared filter [15.1 and 15.2] and an optic filter [16.1 and 16.2] that permit suitably focusing the light entering on the sensitive surface of the sensor. The resulting set is exclusively sensitive to the infrared light and the image collected by each sensor device [14.1 and 14.2] is similar to the one represented in Figure 4.

[0019] The information collected by each sensor device [14.1 and 14.2] is sent to the control logic [17], which determines in what file is the pixel or pixels excited by the light coming from the transmitting spotlight [2]. As the two sensor devices [14.1 and 14.2] are placed orthogonally to each other, they can assign values to the horizontal and vertical coordinates of the transmitting spotlight situation [2] within the image received (see Figure 5).

[0020] The control logic [17] sends said coordinates through the interface [18] to the computer equipment [8]. The interface [8] can be either via electric cable, optic fiber o radio.

[0021] Finally, the computer equipment [8], which includes the suitable program, controls the whole system and manages the information it contains.

Operation

[0022] In order to better explain the operation of the described performance and the possibilities it offers, its application has been chosen for an arm provided with, as an aiming element, a shooting direction that, based on the telemetry performed on the target and its followup during a brief period of time, as well as the input of other data (type of ammunition, temperature, etc.) calculates and shows the marksman the point where he has to aim to hit the target.

[0023] An arm of this type is described in Spanish Patent no. P9201304-X "Shooting direction system for tense shooting arm", registered by the same inventor as this patent.

[0024] The operation steps are as follows:

1) The transmitting spotlight [2] placed on the screen [1] or nearby issues a small point of light in the non-visible spectrum.

2) The projector [7] shows on the screen [1] the image of the environment on which the marksman can use the simulated arm [9]. This image is generated by the computer equipment [8] according to its programming and in accordance with the instructor's orders, and can reproduce any aspect of the combat (different landscapes, climates and targets, enemy fire ...), even sounds through the suitable equipment.

As the point of light of the transmitting spotlight [2] is transmitted in the non-visible spectrum, the marksman does not see any strange element on the image of the projected environment, neither by glancing or aiming the simulated arm [9] through its aiming direction [10].

The marksman aims the simulated arm [9] and, when it is pointing to the target, gives the order to the aiming direction to start the follow-up. At this moment the systems starts a reading cycle of the position:

a. The sensor devices [14.1 and 14.2] receive the image of the screen through their optic filters [16.1 and 16.2] with the non-visible point of light of the transmitting spotlight

Thanks to the infrared filters [15.1 and 15.2] with which they are provided, the image of the projected environment, which is visible light, is eliminated and does not affect the sensor devices [9.1 and 9.2]

b. Each sensor [14.1 and 14.2] decomposes the image in pixels and sends the corresponding information to the control logic [17]

c. The control logic [17] identifies in which file of each sensor the transmitting spotlight [2] is registered

The values coming from both sensors form the coordinates of the transmitting spotlight relative to the image received.

d. The control logic sends said information to the computer equipment [8] of the system through the interface [18]

e. The computer equipment [8], thanks to its programming, recognizes the X and Y coordinates of the transmitting spotlight [2] as regards the screen [1], the $\propto$ angle between the axes [12 and 13] of the aiming direction [10] and the receiver [11]

With these data and the relative coordinates received from the control logic [17] it calculates at what point of the screen [1] the aiming direction [10] is pointing

4) Based on the point of the screen [1] where the aiming direction [10] is pointed, the computer equipment [8] assigns a distance value to the target.

5) At the end of the target followup time another reading cycle of the position is performed.

6) Based on the distance between the points calculated in 3) and 5), the computer equipment [8] calculates the lateral movement of the target.

7) The assigned distance and lateral movement values of the target are transmitted to the aiming direction [10].

8) The aiming direction [5] then calculates the future point to be aimed at and shows it to the marksman.

9) The marksman corrects the aim and pulls the trigger. At this moment another reading cycle of the position is made.

10) Based on the point of the screen [1] at which the aiming direction [10] is pointed at the moment the trigger is pulled, the computer equipment [8] calculates the impact point of the shot and shows on the screen [1] through the projector [7] a representation of the point of impact, including, for example, the destruction of the target.

[0025] At the same time it informs the instructor of the points obtained and files it for the final report.

Alternatives

[0026] Two alternatives can be inferred immediately from the description included in this patent request, both with advantages and disadvantages:

- Use of more than one light transmitting spotlight in the non-visible spectrum The use of at least two transmitting spotlights, the coordinates of which are known, permits determination of angle of the simulated arm. This information can be taken into account by the system control equipment, providing better realism for the simulation - very necessary for certain types of arms (long distance, low initial speed, ...)

  The use of more than one transmitting spotlight means a more complex and heavier equipment with greater computing requirements.
- Use of one sensitive sensor device only in the non-visible spectrum The use of one receiver device implies a savings as regards volume on the simulated arm, which may be critical for arms with small-sized aiming equipment.

  Its disadvantage is that instead of counting files in two CCD sensor devices it counts files and pixels, even though there is only one sensor device. This change requires a much higher computing speed with the result that both the programming as well as the necessary equipment (software and hardware) is more complicated, thus separating the equipment from the basic concepts of simplicity and portability desired.
- Codified transmittal of the light transmitting spotlight in the non-visible spectrum The use of a codified transmittal in the transmitting spotlight permits the system to identify said transmitting spotlight, differentiating it from other non-visible radiation sources that may be in the vicinity

Its use entails a greater computing load.

Claims

1. Positioning system for a virtual shoulder gun-firing simulator consisting in a screen, a simulated arm and a computer system, **characterized by** the fact it has a light transmitter in the non-visible spectrum formed by a lamp that issues in a non-visible frequency or a conventional lamp provided with an infrared filter and placed on the projection screen or its vicinity in a known position.

2. Positioning system for a virtual shoulder gun-firing simulator, according to claim 1, consisting in a screen, a simulated arm and a computer system, **characterized by** the fact it has two light transmitters in the non-visible spectrum, each one formed by a lamp that issues in a non-visible frequency or a conventional lamp provided in an infrared filter and placed on the projection screen or its vicinity in known positions to permit determining the angle of the simulated arm.

3. Positioning system for a virtual shoulder gun-firing simulator, according to claim 1 or 2, **characterized by** the fact it has two CCD type sensor devices, sensitive to the light in the same non-visible spectrum, each one formed by a specific receiver or by a conventional receiver provided with an infrared filter and orthogonally placed on a simulated arm.

4. Positioning system for a virtual shoulder gun-firing simulator, according to claim 3, **characterized by** the fact it has a control logic able to determine in which file of each sensor are the pixels excited by the non-visible light coming from the transmitter.

5. Positioning system for a virtual shoulder gun-firing simulator, according to claim 1 or 2, **characterized by** the fact it has a CCD type sensor device, sensitive to the light in the same non-visible spectrum, formed by a specific receiver or by a conventional receiver provided with an infrared filter and placed on a simulated arm.

6. Positioning system for a virtual shoulder gun-firing simulator, according to claim 5, **characterized by** the face it has a logic control able to determine in which file and column of the sensor are the pixels excited by the non-visible light coming from the transmitter.

7. Positioning system for a virtual shoulder gun-firing simulator, according to any of the above claims, **characterized by** the fact that transmittal of the transmitter(s) is codified, thus permitting the system to differentiate it from other non-visible light sources.

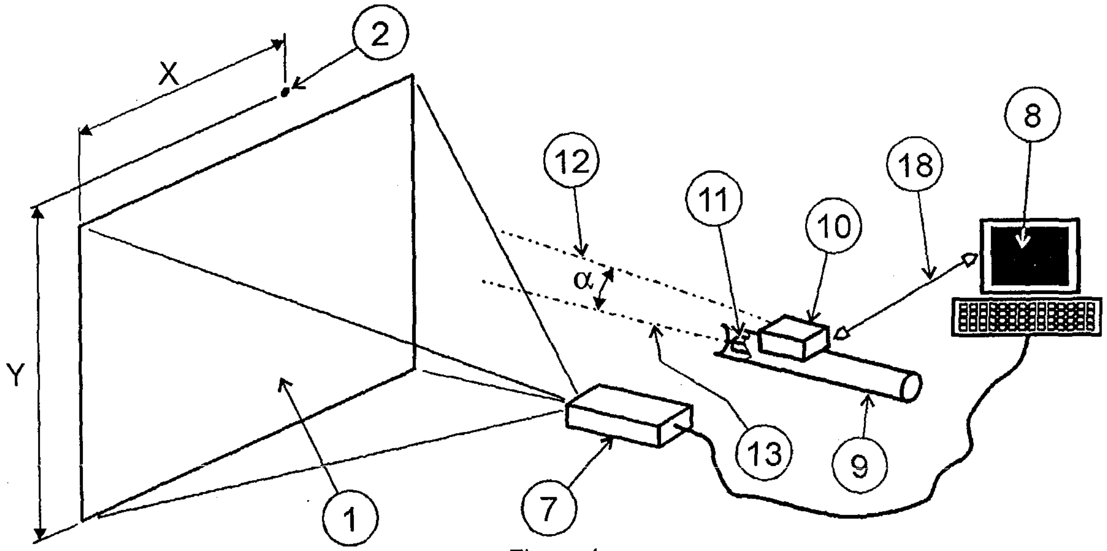

Figure 1

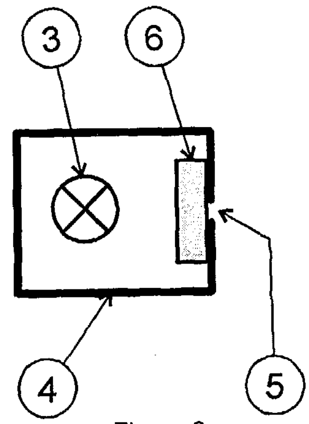

Figure 2

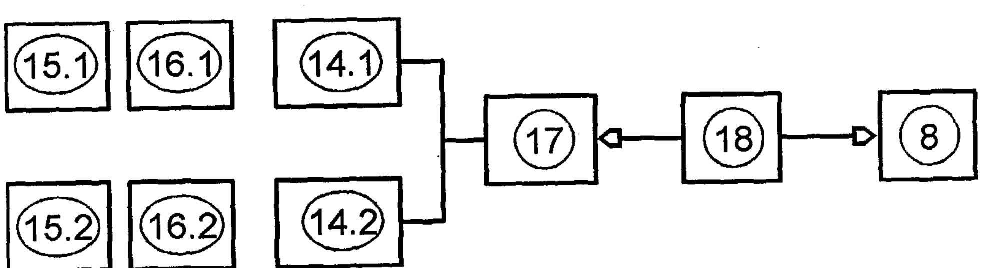

Figure 3

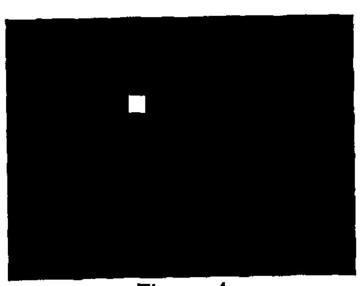
Figure 4

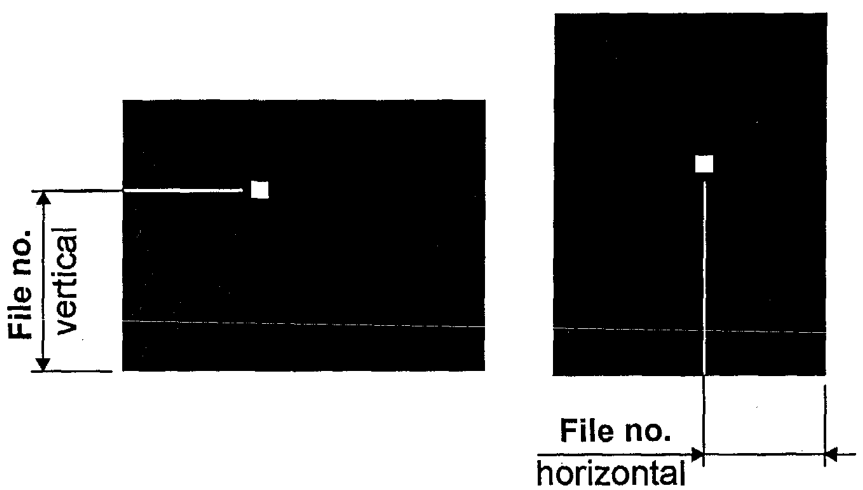

Figure 5

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EUROPEAN SEARCH REPORT

Application Number
EP 04 38 0204

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)
F41G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	17 January 2005	Blondel, F

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 38 0204

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