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(54) **Spotter scope**

(57) Systems and methods for automatically generating an aim point correction for sniper operations. The present invention reduces spotter/sniper workload and improves trace spotting analysis. An example system includes a scope, a video capture component, an output device, and a processor in signal communication with the video capture component and the output device. The video capture component captures video of a bullet from when the bullet left a weapon to at least when the bullet crossed a previously determined target range. The processor determines from the captured video where the bullet was located relative to an intended target when the bullet was at the target range, generates a new aim point if the bullet was determined to have missed an intended hit point, and outputs the generated new aim point to the output device.

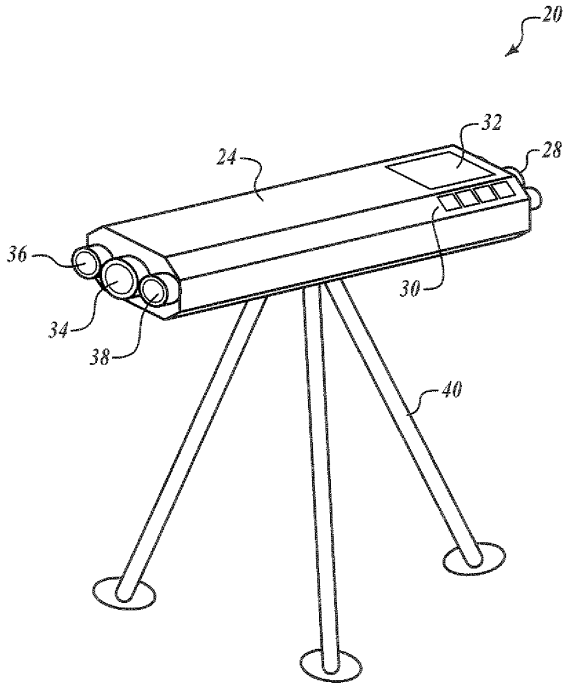

FIG.1

EP 1 860 395 A1

Description

[0001] U.S. military sniper teams generally consist of a shooter and an observer (or spotter). The observer uses a non-electronic glass optics-based spotting scope to observe a target, determine distance, and estimate wind speed and direction before a shot is fired. The spotter conveys this information to the shooter for point of aim adjustments prior to shooting. Distance is estimated manually.

[0002] After the shooter fires, the spotter tries to observe the actual path of the bullet (trace) to the intended target (point of impact) through the spotting scope. The spotter then attempts to determine if the target was hit based on the observed trace trajectory. If the target was not hit, the spotter determines where the bullet crossed the plane of the target and suggests an aiming correction to the shooter. Observing target can only be performed during daylight and the trace is extremely difficult to observe even under ideal daylight conditions. Trace observations are also subject to very large errors. Also, if no spotter is present, then observation of the trace trajectory is not possible.

[0003] Therefore, there exists a need for an improved spotter scope.

[0004] The present invention provides systems and methods for automatically generating an aim point correction for sniper operations. The present invention reduces spotter/sniper workload and improves trace spotting analysis.

[0005] An example system includes a scope, a video capture component, an output device, and a processor in signal communication with the video capture component and the output device. The video capture component captures video of a bullet from when the bullet left a weapon to at least when the bullet crossed a previously determined target range. The processor determines from the captured video where the bullet was located relative to an intended target when the bullet was at the target range, generates a new aim point if the bullet was determined to have missed an intended hit point, and outputs the generated new aim point to the output device.

[0006] In one aspect of the invention, the intended hit point is the intended target.

[0007] In another aspect of the invention, the video capture component includes a digital video camera and/or an infrared video camera.

IN THE DRAWINGS

[0008] Preferred and alternative embodiments of the present invention are described in detail below with reference to the following drawings:

[0009] FIGURE 1 illustrates a perspective view of an example spotter scope formed in accordance with an embodiment of the present invention;

[0010] FIGURE 2 illustrates a block diagram of components of the scope shown in FIGURE 1;

[0011] FIGURE 3 is a flow diagram of an example process performed by the scope of FIGURES 1 and 2;

[0012] FIGURE 4 is an example image viewable by a user of the scope; and

[0013] FIGURE 5 is a perspective view of a sniper's gun-mounted scope.

[0014] FIGURE 1 shows an example spotter scope 20 formed in accordance with an embodiment of the present invention. The scope 20 may be hand-held or mounted to a support device, such as a tripod 40. The scope 20 includes a housing 24 with a scope lens 34, a video lens 36, and an infrared lens 38 located at a first end of the housing 24. At a second end of the housing 24 are eye pieces 28 that correspond to the lenses 34-38, user interface controls 30, and a display device 32.

[0015] As shown in FIGURE 2, the scope 20 includes a processor 60 that is in data communication with user interface controls 30, the display device 32, and an output device 42. An example of the output device 42 is a digital micro mirror device (DMD) that is controlled by a Digital Signal Processing (DSP) chip for presenting images in the field of view through the scope lens 34 and via an associated eye piece.

[0016] In one embodiment, the processor 60 includes video capture components 80, video processing components 82, and a targeting component 88. The video capture components 80 includes a digital video camera associated with the video lens 36 and an infrared video capture component associated with the infrared lens 38. The video capture components 80 capture video images of a trajectory of a bullet expelled by a nearby weapon. The captured video is sent to the video processing components 82 for analysis. In a daytime situation, the video captured by the digital video camera is processed to determine trajectory of the bullet and at night the video captured by the infrared camera is used to determine bullet trajectory. Daytime video capture with the digital video camera can be augmented by the infrared camera where conditions warrant. Once the trajectory has been determined from one or both of the generated video images, the processing component 82 determines where the bullet was most likely to have crossed the plane of the intended target. If the processing component 82 determines that the trajectory of the bullet shows that the bullet did not hit the intended target, then the targeting component 88 determines an aiming correction location. The processing component 82 and the targeting component 88 includes a display component for generating an image of the location of where the bullet crossed the target plane (processing component 82) and an image for a new aiming point (targeting component 88). The images are sent to the display device 32 and/or the output device 44 for presentation within the field of view of the scope, other video capture devices may be used.

[0017] The processor 60 may output the captured video to the display device 32. Also, the display device 32 may present scope status information, activateable user controls (e.g., touch screen control buttons), previously

stored information, or information received (wirelessly or via wire) from another system.

[0018] FIGURE 3 is a flow diagram of an example process 120 performed by the components of the scope 20. First, at a block 126, one of the video capture components 80 records video at some point prior to firing of the weapon that is in close proximity to the scope 20. The video capture components 80 may be activated manually by the user interacting with the user interface controls 30 or the display device 32, by activation of a remote control that is in wired or wireless signal communication with the processor 60. In one embodiment, the remote control device may be a voice capturing device and the processor 60 includes a voice processing component (not shown) that interprets voice signals sent to it via the remote control. Activation or deactivation of the capturing of video images can be performed automatically, for example, by sensing activation of the weapon and by deactivating after a predefined period of time from when the weapon was activated. Next, at a block 128 image analysis of the captured video is automatically performed in order to determine trajectory of the bullet. At a block 132, the processor 60 automatically determines the point where the bullet crossed the intended target based on the determined trajectory, the frame rate of the captured video, a predicted range of the intended target, and a determination of when the bullet left the weapon or when the trigger was pulled. The determination of when the bullet left the weapon or trigger activation may be based on a sensed event, such as sound or shock as sensed by a sensing device (not shown).

[0019] At block 134, processor 60 outputs a dot, such as a red dot, to represent the determined point where the bullet crossed the intended target. The outputted dot is presented on the output device 42. If, at the decision block 136, it was determined that the bullet did hit the target, then the process is done, *See* block 138. However, if the bullet did not hit the target as determined at the decision block 136, the processor 60, at a block 140, determines an aiming correction point based on the point determined at the block 32 and the previous aiming point. At a block 42, a corrected pipper location or aim point location is generated and displayed and outputted by the output device 142 or the display device 32. The determination by the processor 60 of whether the bullet hit the target is based on comparing the point determined at the block 132 to a stored image that is sized according to the determined predicted range of the target.

[0020] FIGURE 4 illustrates an image 160 that a viewer sees through the scope 20. A center pipper 166 in this example is located at the center of the intended target. After the weapon has been fired and the analysis has been performed at blocks 128 and 132, the point 168 is displayed to one viewing the image 160 in order to show where the point is that was determined at the block 132. After the correction determination is made at the block 140, a new pipper 170 is generated and outputted according to the block 142. The point 168 and pipper 170 are presented within the scope by a DMD and DSP chip.

[0021] The corrected pipper location, such as the pipper 170 of FIGURE 4, is conveyed to the sniper. The sniper viewing the target through gun-mounted scope 180 adjusts their targeting in order to match the new aim location, .See aim point 188. If it is determined that the new aim location is outside of the MILDOT settings of a typical scope, then the sniper will activate a dial 190 in order to adjust the targeting aim point according to the new aim point.

[0022] In one embodiment, the range of the target is predicted manually by the spotter or shooter or automatically by the processor 60. The spotter or shooter determines range by known techniques and enters the determined range into the processor 60 using the user interface controls 30 or the display device 32. The processor 60 automatically determines range by using image analysis of a center portion of an image recorded by one of the video capture components 80 after the user has placed the crosshair on the intended target and instructed the processor 60 to calculate range. The processor 60 performs image matching that matches a prestored target object (upper body human form) to a similar object in the captured image. After a match has been determined, range is determined by determining a width and/or a height dimensions of the matched object in the captured image and comparing that to predefined width and height dimensions for a typical or predefined target.

Claims

1. A method for automatically generating an aim point correction, the method comprising:

   capturing video of a bullet from when the bullet left a weapon to at least when the bullet crossed a previously determined target range;
   automatically determining from the captured video where the bullet was located relative to an intended target when the bullet was at the target range;
   automatically generating a new aim point if the bullet was determined to have missed an intended hit point; and
   outputting the generated new aim point.

2. The method of Claim 1, wherein the intended hit point is the intended target and wherein capturing includes capturing daytime video images.

3. The method of Claim 1, wherein capturing includes capturing infrared video images.

4. The method of Claim 1, further comprising automatically determining range of the target.

5. The method of Claim 1, wherein outputting includes

displaying the generated new aim point in a field of view of a scope.

6. A system for automatically generating an aim point correction, the system comprising:

a scope;
a video capture component configured to capture video of a bullet from
when the bullet left a weapon to at least when the bullet crossed a previously determined target range;
an output device;
a processor in signal communication with the video capture component and the output device, the processor comprising:

a first component configured to determine from the captured video where the bullet was located relative to an intended target when the bullet was at the target range;
a second component configured to generate a new aim point if the bullet was determined to have missed an intended hit point; and
a third component configured to output the generated new aim point to the output device.

7. The system of Claim 6, wherein the intended hit point is the intended target and wherein the video capture component includes a digital video camera.

8. The system of Claim 6, wherein the video capture component includes an infrared video camera.

9. The system of Claim 6, wherein the processor comprises a fourth component configured to determine range of the target.

10. The system of Claim 6, wherein the output device includes a component for outputting the generated new aim point in a field of view of the scope.

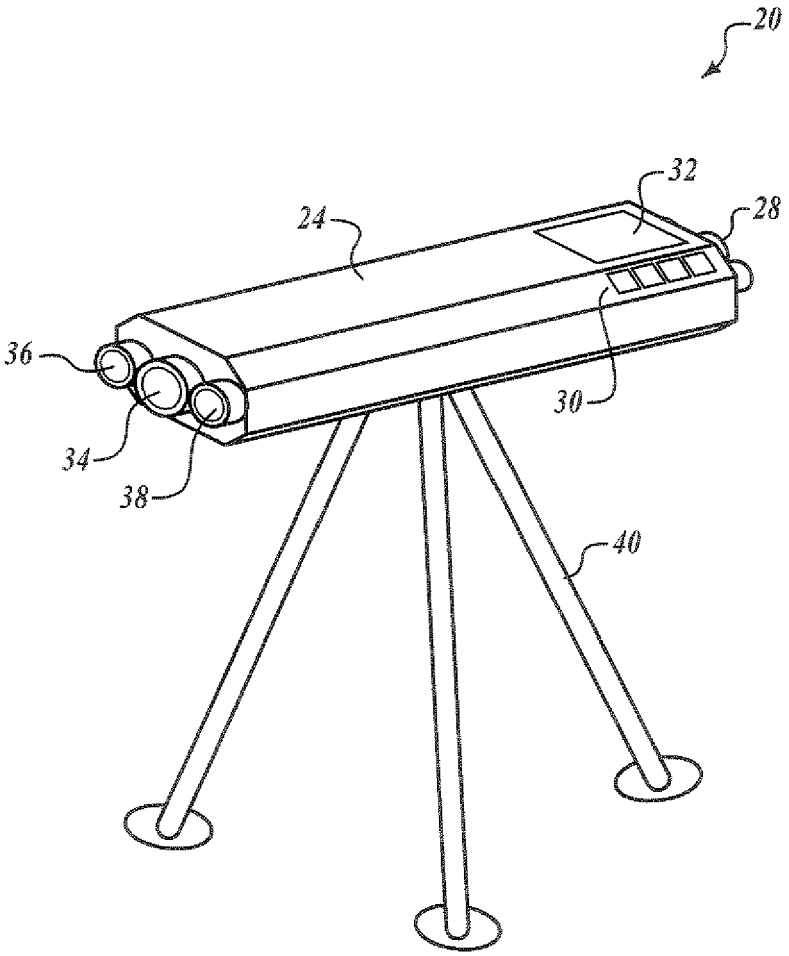

FIG.1

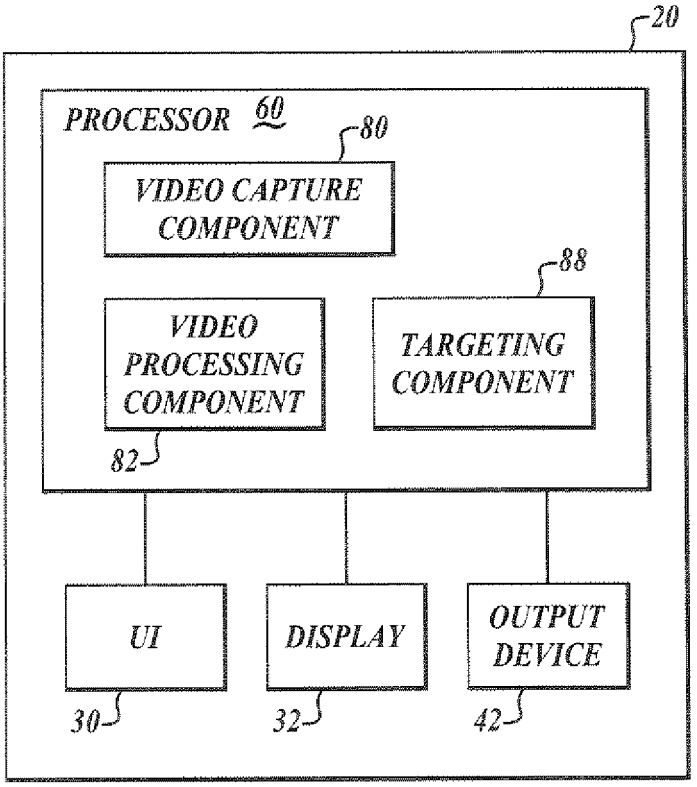
20
PROCESSOR 60
80
VIDEO CAPTURE COMPONENT
88
VIDEO PROCESSING COMPONENT
82
TARGETING COMPONENT
UI
30
DISPLAY
32
OUTPUT DEVICE
42

FIG.2

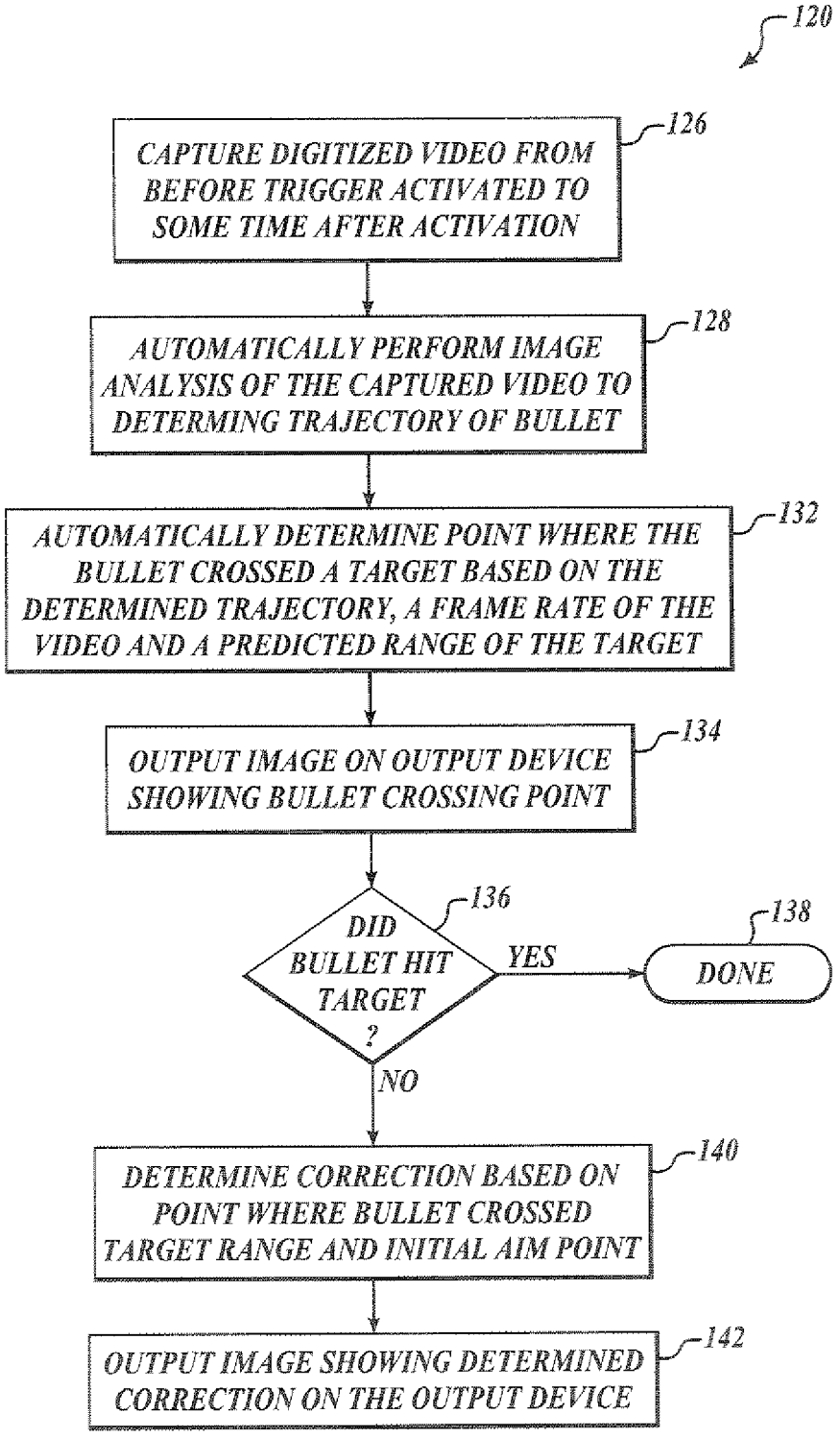
120
CAPTURE DIGITIZED VIDEO FROM BEFORE TRIGGER ACTIVATED TO SOME TIME AFTER ACTIVATION
126
AUTOMATICALLY PERFORM IMAGE ANALYSIS OF THE CAPTURED VIDEO TO DETERMING TRAJECTORY OF BULLET
128
AUTOMATICALLY DETERMINE POINT WHERE THE BULLET CROSSED A TARGET BASED ON THE DETERMINED TRAJECTORY, A FRAME RATE OF THE VIDEO AND A PREDICTED RANGE OF THE TARGET
132
OUTPUT IMAGE ON OUTPUT DEVICE SHOWING BULLET CROSSING POINT
134
DID BULLET HIT TARGET ?
136
YES
DONE
138
NO
DETERMINE CORRECTION BASED ON POINT WHERE BULLET CROSSED TARGET RANGE AND INITIAL AIM POINT
140
OUTPUT IMAGE SHOWING DETERMINED CORRECTION ON THE OUTPUT DEVICE
142

FIG.3

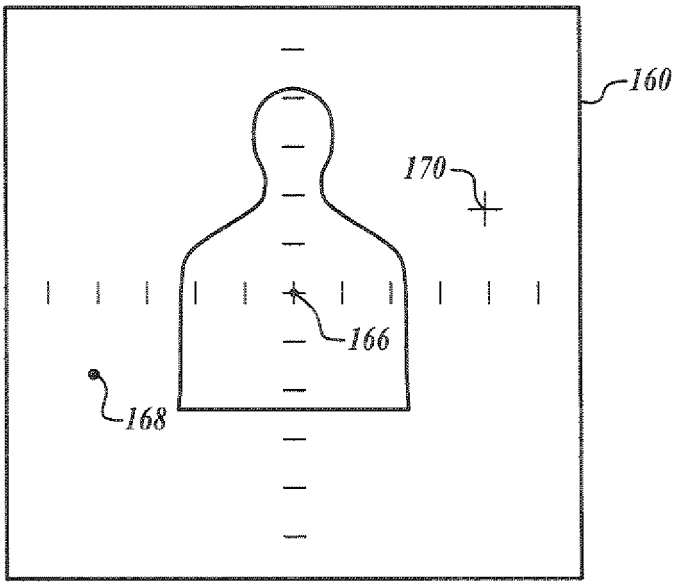

FIG.4

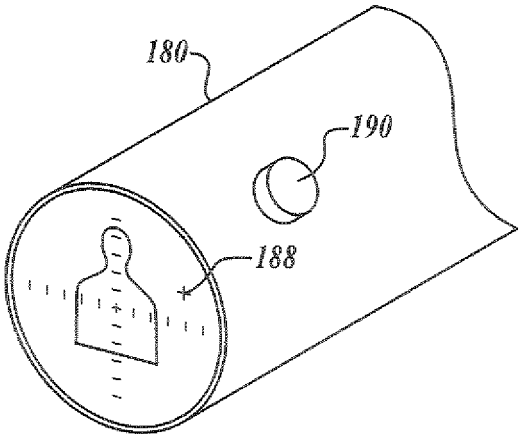

FIG.5

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EUROPEAN SEARCH REPORT

Application Number
EP 07 10 7673

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 October 2007	Henderson, Richard

CATEGORY OF CITED DOCUMENTS

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