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(54) **TARGET TRAINING SYSTEM**

ZIELTRAININGSSYSTEM

SYSTÈME D'ENTRAÎNEMENT SUR CIBLE

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Description

Technical Field of the Invention

[0001] This invention relates to a target training system, and in particular to an automated target training system.

Background to the Invention

[0002] Target training systems are commonly used to test and improve the accuracy of a marksman during target practice. It is useful for automated target training systems to be able to provide real-time feedback to the marksman or their coach. On land ranges this saves time for personnel who would otherwise physically have to check the target for impacts of projectiles (for example rounds or bullets); and reduces the number of personnel because one person can check feedback for several targets. On maritime ranges (i.e. a target floating on the surface of water) it is even more difficult, often prohibitively so, to physically check the target for impacts.

[0003] In both circumstances, moreover, real time feedback provides improved training by allowing the marksman to understand how their adherence to the marksmanship principles, the weather, target movement etc. influences their fall of shot.

[0004] US Patent 5,095,433 discloses an automated target training system which uses a plurality of vibration -sensors attached to a target. The outputs of the vibration sensors are voltage signals which are transmitted to a processor. A part of the processor acts as a comparator, the output of the comparator is biased at a low level until a voltage signal of sufficient strength is received from the sensors. If the processor determines that the target has been struck, an audible tone is outputted to the marksman, to inform them of an accurate shot. Furthermore, systems for detecting the impact point on a target are known from Patent Application Publications US 2012/0091660 A1 and US 2009/0102129 A1.

[0005] An approach that relies on measuring the strength of impact signals usually requires a threshold level to be set by calibration. However, the calibration may itself be dependent on variable factors such as the range to target and ammunition type. Thus, approaches relying on the thresholding of signal strength may not be robust, with the problem exacerbated by exposure to any high levels of vibration caused by background noise. Background noise is particularly a hindrance for targets attached to moving platforms and especially for targets in the maritime domain. In addition, significant background noise (particularly impulsive background noise) may make it harder to isolate vibrations generated in a target object by a projectile striking it from vibrations generated by the shock wave from a projectile passing close to the target.

[0006] It is therefore an aim of the invention to provide an improved target training system.

Summary of the Invention

[0007] According to various embodiments of the invention, there is provided a target training system according to any one of the appended claims.

[0008] The target having a plurality of target objects positioned adjacent to each other with a gap provided between them allows the target to be divided into discreet target objects. Therefore a projectile fired by a marksman can only hit one or some, but not all the target objects. This means that when a projectile is fired vibrations from background noise and vibrations from the noise of a shock wave of a projectile passing close by will be common to all sensors. However, vibrations picked up from the impact of a projectile will not be picked up by all target objects. Subsequently, the output signals from vibration sensors attached to each target object are compared by a processor. The processor determines when a relative threshold value higher than the lowest value of all the output signals compared by the processor is exceeded and identifies this as a hit. The result is that, even when the target is in the presence of background noise, the target training system can distinguish when a hit has been recorded.

[0009] A suitable relative threshold value may be set at two to three times higher than the value of the lowest value of output signal. However, other relative threshold values may also be used.

[0010] A relative threshold value can be set both for vibrations from a shockwave of a projectile passing close to all the target objects, and also for vibrations from an impact of a projectile. Therefore two relative threshold values higher than the lowest value output signal may be used. The first relative threshold value higher would indicate when a near miss had occurred because all target objects would be transmitting output signals to the processor higher than background noise. The second relative threshold value being set higher than the first relative threshold value would indicate an impact of one or more target objects.

[0011] A target is understood to mean a single zone for a marksman to shoot at. For example the target could be a plate with a printed picture of a person attached, or a picture of coloured concentric rings. Therefore a target object is understood as a discreet part of the target zone.

[0012] The output signals of the sensors attached to the target objects can be transmitted to a processor such as a computer by a cable or other hardwired connector attached to the sensor (such as fibre optic or electrical). If a fibre optic cable is used, it will be appreciated that electrical to optic converters may be required at either end of the cable to ensure that the measurement signal is in a format that can be processed by the processor.

[0013] Alternatively, the output signals may be transmitted to the processor by wireless technology for example a Radio Frequency (RF) signal using a RF transmitter connected to the sensor. The RF signal can then be received by a RF receiver, the signal being converted for use by the processor. Other forms of wireless technology known in the art may also be used. The advantage of wireless technology is that the output signals may be transmitted in situations where the use of a cable would be less practical such as when the target is some distance from the marksman or where the target is floating on water. The processor can output the results of each projectile fired onto a video display so that the marksman or coach can monitor performance.

[0014] In either case, the processor is configured to apply an appropriate threshold value or values so as to determine whether or not at least one of the target objects has been impacted by a projectile. The output of the processor may be a binary string representing, for example, a series of 'hit'/'no hit' values for each target object. The output of the processor may be transmitted from the processor by a wireless or wired connection (as appropriate) and may be communicated to the user in any suitable way, for example by means of a graphical user interface, an audible signal, an optical signal (for example flashing lights) or even as a tactile response (for example a vibration mode). Communication to the user by an optical signal attached to the target system (for example by means of flashing lights such as LEDs) is particularly preferred because of simplicity, low cost, no reliance on cables or wired connections and potential operation over water and/or long distance. Alternatively, a narrow band optical signal can be used, in conjunction with a camera and suitable filter at the firing point.

[0015] Advantageously, a target can be designed with the plurality of target objects, preferably more than two target objects, positioned symmetrically or approximately symmetrically around a vertical axis. This arrangement is particularly suited to maritime ranges because it enables the orientation of the target relative to the marksman to vary without affecting the utility of the target, for example if the target turns due to movement of ocean currents. It also prevents the target from acting as a sail and turning in the wind, as might happen where the target objects are all aligned along a linear axis.

[0016] A plurality of target objects may be attached to a base made from or comprising rubber, foam, wood or any other suitable material for absorbing vibration. The base may be configured to support the weight of the target objects during training, which may be especially advantageous in windy weather conditions. The target objects may be attached to a base made from or comprising a buoyant material such as rubber, foam or wood, so that the target is suitable for use on water or in maritime environments. The base may take the form of a support framework, for example a square frame made from metal or wood, or a hull structure. The frame may have vibration damping fixtures, for example rubber fixtures, for attaching the target objects. The vibration damping fixtures help to prevent vibrations caused by movement of the frame from being picked up by the vibration sensors attached to the target objects, and may also reduce the transmission of vibration between target objects via the frame. Vibration damping fixtures may take any suitable form (for example resilient components such a springs) and/or may comprise any suitable material, for example rubbers or foams. Wheels may be attached to the base to allow it to be towed, for example behind a vehicle.

[0017] The base may alternatively be attached to a moving platform such as those used in a gallery target training system or a remote controlled boat, to provide a shooter with a remote controlled mobile target.

Brief Description of the Drawings

[0018] Embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1a shows a schematic diagram of a plan view, of an array of target objects, suitable for use in a first embodiment of the invention.

Figure 1b shows a schematic diagram of a front view, of a target training system according to a first embodiment of the invention.

Figure 2a shows a schematic diagram of a plan view, of an array of target objects, suitable for use in a second embodiment of the invention.

Figure 2b shows a schematic diagram of a front view, of a target training system according to a second embodiment of the invention.

Figure 3 is a schematic layout of equipment used to measure and record outputs from vibration sensors according to a third embodiment of the invention.

Figure 4 shows the measured vibrational response of three accelerometers positioned on a target training system.

[0019] The drawings are purely illustrative and are not to scale. Same or similar reference signs denote same or similar features.

Detailed Description

[0020] The plan view of Fig. 1a shows a view from above an array of target objects 2, 3 with vibration sensors attached.

[0021] A first embodiment 1 of the invention will now be described with reference to the schematic diagram of Figure 1b. The front view of Fig. 1b indicates schematically what a marksman carrying out target training would see.

[0022] Two adjacent target objects 2, 3 made from rectangular wooden boards 5mm thick and sized 0.6 m x 1.6 m, positioned into the ground adjacent to each other. This can be done by digging two trenches in the earth deep enough to support the target objects 2, 3. Metal plastic or other suitable rigid material could also be used for the target objects. The size of target objects could be varied dependent on the distance between the marksman and the target objects. A gap 5 between the target objects 2, 3, isolates them from mutual transmission of vibration, if one of the target objects 2, 3 is struck by a projectile. The gap between the target objects should be sufficient that they do not come into contact when excited by a projectile striking a target object.

[0023] The target objects 2, 3 each have vibration sensors 6, 7 attached by screws, however any secure attachment method such as adhesive could be used. The vibration sensors 6, 7 are MEMS accelerometers, which are each connected to a processor 30 via cables 32, 33. Other type of commercially available vibration sensors could be used. Vibrations from background noise, noise from the shockwave of a projectile passing close to target objects 2, 3 or from a projectile impacting one of the target object 2, 3 will be measured by the vibration sensors 6, 7. The output signals of the target object 2, 3 will then be transmitted via cables 32, 33 to the processor 30, so that the signals can be analysed. The processor 30 analyses the signals, if at least one of the output signals has an amplitude higher than the lowest output signal, by a set relative threshold value, the processor determines that at least one of the target objects as hit by a projectile.

[0024] The plan view of Fig. 2a shows a view from above and array of target objects 12, 13, 14 with vibration sensors 16, 17, 18 attached.

[0025] A second embodiment 10 of the invention will now be described with reference to the schematic diagram of Figure 2b. The front view of Fig. 2b indicates schematically what a marksman carrying out target training would see.

[0026] Three target objects 12, 13, 14 made from thin rectangular metal sheets 2mm thick, sized 0.8m x 2.0m, are positioned substantially symmetrical about a vertical axis 150. In this embodiment the target objects 12, 13, 14 are arranged in a triangular geometry, however a higher order of geometry, for example a hexagon could be used. The target objects 12, 13, 14 are affixed to a large foam base 19 by sliding the bottom part (not shown) of the target objects 12, 13, 14 into three preformed slots. A gap 15 between the target objects 12, 13, 14 isolates them from mutual transmission of vibration, if one of the target objects 12, 13, 14 is struck by a projectile. The gap between the target objects should be sufficient that they do not come into contact when either excited by a projectile striking a target object or by movement of the large foam base 19.

[0027] The target objects 12, 13, 14 each have vibration sensors 16, 17, 18 attached by an adhesive. The vibration sensors 16, 17, 18 are MEMS accelerometers, which in turn are each connected to a RF transmitter 133 via a short cable (not shown). Vibrations from background noise, noise from the shockwave of a projectile passing close to target objects 12, 13, 14 or from a projectile impacting the one of the target objects 12, 13, 14 will be measured by the vibration sensors 16, 17, 18. The output signals will then be transmitted to RF receiver 139, and inputted to processor 130, so that the signals can be analysed.

[0028] The processor 130 can be a computer or another electrical device capable of analysing the signals. The processor 130 analyses the signals, if at least one of the output signals has an amplitude higher than the lowest output signal, by a set relative threshold value, the processor determines that at least one of the target objects was hit by a projectile. It is also possible for all the vibration data (output signals) to be transmitted to the processor 130 in real-time and the real-time detection algorithm run on the processor 130.

[0029] A third embodiment of the invention will now be described with reference to Figure 3. Figure 3 is a schematic layout of equipment used to measure and record output signals from vibration sensors. The equipment could be used in conjunction with different numbers and geometrical arrangements of target objects including the two embodiments already described. This embodiment is described with reference to a target using three target objects affixed to a base.

[0030] Equipment used to measure and record output signals, located on target base 200 is comprised of three vibration sensors 206, 207, 208, which measure the amount of vibration there is from the target objects (not shown) to which they are attached. Analogue vibration output signals from sensors 206, 207, 208 are fed into a Digital to Analogue Converter or DAC 220. However the DAC 220, is not required if sensors with a digital output signals are used. The digital signals are then inputted into a processor 230 so that the signals can be recorded. The digital signals are then transmitted via a RF transmitter 350 to the firer platform 300. The dashed arrow represents the data communication between the two locations.

[0031] The digital signals are then received at marksman platform 300 by the RF receiver 360. A second processor 330 is used to analyse the signals and is configured to determine that at least one of the target objects has been hit by a projectile when the signal taken by the vibration sensor (for example 206) of that target object is a relative threshold value higher than the lowest output signal taken by all the vibration sensors 206, 207, 208. The results are outputted onto a visual display 370 so that they can be seen by the marksman and/or coach. Alternatively the results can be outputted to a speaker, different tones indicating whether a hit or a miss has been achieved.

[0032] If range information is required, GPS units 240 and 340 could be used. GPS unit 240 inputs location data of the target base 200 into the processor 230 and GPS unit 340 inputs location data of the marksman platform 300 into processor 330. The location data from processor 230 is transmitted together with the output signals to the marksman platform 300. All the location data is then finally computed by processor 330 and the location information displayed onto the visual display 370. The integration of the measurement equipment, processors, GPS units with a display, enable hit and miss; and range to target information to be to outputted to the marksman and/or coach, even if the target is mobile. If a static land range was used then GPS information would not be required because the position of the firer in relation to the target objects would be fixed.

[0033] An additional measurement sensor 306 located at the target platform 300 is used to record when a projectile is fired. A vibration sensor, microphone or other measurement sensor could be used. The output signal is then converted into digital data by the DAC 320, before inputting into the processor 330. The additional data can be computed and displayed for the purpose of indicating accuracy as a percentage as each projectile is fired rather than an absolute number.

[0034] A target training system similar to the embodiment of Figures 2a and 2b was constructed and tested. The test system had slightly smaller target objects (each 0.6 m by 1.6 m in size) and reinforcing struts were added to the target objects to reduce flexing under environmental test conditions.

[0035] The vibration sensors were tri-axial 200 g limit ADXL375 accelerometers manufactured by Analog Devices, chosen for their low cost and ability to measure high accelerations. Each sensor was encased in epoxy and embedded in a wooden plate which was in turn bolted to the target plates. This enabled the sensors to be swapped in the event of damage. All vibration sensors were mounted on the inner side of the target object, so as to provide additional protection from the weather and any fragmentation.

[0036] A micro-computer was used for data acquisition and processing. Each accelerometer was connected to the micro-computer using a Serial Peripheral Interface (SPI) bus running at 2 MHz, with data measured from each channel with a sample rate of 3.2 kHz. Power was supplied by a USB power pack, enabling operation for around 12 hours.

[0037] The target training system was fixed to a 6 m static towed target boat and calibration of the sensors was undertaken prior to subjecting the target to weapons fire. Accelerometer responses were recorded as a function of time from each sensor, for each of the three axes of that sensor (x, y and z). Figure 4 shows the measured vibrational response during part of the weapons fire. Three impact events can be seen, each impact producing a large vibrational response in two target plates. The peak acceleration is well in excess of the noise floor and, moreover, the reverberation of the structure is demonstrated to be sufficiently damped such that the measured accelerations are almost back at the level of the noise floor within approximately 1/10 second. This decay rate gave a good match with the rate of fire of the weapons used in the trial, and shows that detection of individual events is feasible.

[0038] It can be seen that there is a small signal from the accelerometer on the non-impacted target object. This is due to the shock wave from the weapons round, and was rejected from the detection algorithm by applying a suitable relative threshold value, based on the response of the other accelerometers.

[0039] Overall, a 'hit' detection algorithm programmed on the micro-computer detected 37 rounds striking the target training system. By counting holes in the target plates after the test, it was estimated that 40 rounds hit the target plates. The difference between the actual and detected hit rate may be due to simultaneous impact from rounds that fragmented on striking the target boat.

Claims

1. A target training system comprising:

a target having a plurality of target objects (2, 3, 12, 13, 14), the target objects being positioned adjacent to each other with a gap (5, 15) provided between them, each target object having a vibration sensor (6, 7, 16, 17, 18, 206, 207, 208) producing an output signal attached thereto, and a processor (30, 130, 330), the processor being configured to determine that at least a first one of the target objects has been impacted by a projectile when the output signal associated with the at least first one of the target objects is a relative threshold value higher than the lowest value of all the output signals.

2. The target training system of claim 1, wherein the output signals from the vibration sensors are transmitted to the processor by wired means (32, 33).

3. The target training system of claim 1, wherein the output signals from the vibration sensors are transmitted to the processor by wireless means, said means preferably comprising an RF transmitter (133, 350) and receiver (139, 360).

4. The target training system of any one of claims 1 to 3, further comprising a graphical user interface or audio/visual indicator (370) to present target impact information to a user.

5. The target training system of any preceding claim, wherein the target objects (12, 13, 14) are positioned substantially symmetrically about a vertical axis (150).

6. The target training system of any preceding claim, wherein the system further comprises a base (19) to which the target objects (12, 13, 14) are mounted.

7. The target training system of claim 6, wherein the base further comprises wheels.

8. The target training system of claim 6, wherein the base is configured for floating on water.

Patentansprüche

1. Zieltrainingssystem, umfassend:

ein Ziel, das mehrere Zielobjekte (2, 3, 12, 13, 14) aufweist,
wobei die Zielobjekte einander benachbart positioniert sind, wobei ein Abstand (5, 15) zwischen ihnen vorgesehen ist, wobei jedes Zielobjekt einen Vibrationssensor (6, 7, 16, 17, 18, 206, 207, 208), der ein Ausgabesignal erzeugt, aufweist, der daran angebracht ist, und
einen Prozessor (30, 130, 330),
wobei der Prozessor ausgelegt ist, festzustellen, dass mindestens ein erstes der Zielobjekte von einem Projektil getroffen wurde, wenn das Ausgabesignal, das mit dem mindestens ersten der Zielobjekte in Verbindung steht, ein relativer Schwellenwert ist, der höher als der niedrigste Wert aller Ausgabesignale ist.

2. Zieltrainingssystem nach Anspruch 1, wobei die Ausgabesignale von den Vibrationssensoren durch drahtgebundene Mittel (32, 33) an den Prozessor übertragen werden.

3. Zieltrainingssystem nach Anspruch 1, wobei die Ausgabesignale von den Vibrationssensoren durch drahtlose Mittel an den Prozessor übertragen werden, wobei die Mittel vorzugsweise eine HF-Übertragungseinrichtung (133, 350) und - Empfangseinrichtung (139, 360) umfassen.

4. Zieltrainingssystem nach einem der Ansprüche 1 bis 3, ferner umfassend eine grafische Benutzeroberfläche oder Audio-/visuelle Anzeige (370), um einem Benutzer Zielaufprallinformationen darzustellen.

5. Zieltrainingssystem nach einem der vorangehenden Ansprüche, wobei die Zielobjekte (12, 13, 14) im Wesentlichen symmetrisch um eine vertikale Achse (150) positioniert sind.

6. Zieltrainingssystem nach einem der vorangehenden Ansprüche, wobei das System ferner eine Basis (19) umfasst, an der die Zielobjekte (12, 13, 14) befestigt sind.

7. Zieltrainingssystem nach Anspruch 6, wobei die Basis ferner Räder umfasst.

8. Zieltrainingssystem nach Anspruch 6, wobei die Basis zum Schwimmen auf Wasser ausgelegt ist.

Revendications

1. Système d'apprentissage de cible comprenant :

une cible ayant une pluralité d'objets de cible (2, 3, 12, 13, 14), les objets de cible étant positionnés adjacents les uns aux autres, un espace (5, 15) étant prévu entre eux, chaque objet de cible comportant un capteur de vibration (6, 7, 16, 17, 18, 206, 207, 208) produisant un signal de sortie associé à celui-ci, et
un processeur (30, 130, 330), le processeur étant configuré pour déterminer qu'au moins un premier des objets de cible a été frappé par un projectile lorsque le signal de sortie associé audit au moins un premier des objets de cible a une valeur de seuil relative supérieure à la valeur la plus faible de tous les signaux de sortie.

2. Système d'apprentissage de cible selon la revendication 1, dans lequel les signaux de sortie provenant des capteurs de vibration sont transmis au processeur par des moyens câblés (32, 33).

3. Système d'apprentissage de cible selon la revendication 1, dans lequel les signaux de sortie provenant des capteurs de vibration sont transmis au processeur par des moyens sans fil, lesdits moyens comprenant de préférence un émetteur RF (133, 350) et un récepteur RF (139, 360).

4. Système d'apprentissage de cible selon l'une quelconque des revendications 1 à 3, comprenant en outre une interface graphique utilisateur ou un indicateur audio/visuel (370) pour présenter des informations d'impact de cible à un utilisateur.

5. Système d'apprentissage de cible selon l'une quelconque des revendications précédentes, dans lequel les objets de cible (12, 13, 14) sont positionnés sensiblement symétriquement autour d'un axe vertical (150).

6. Système d'apprentissage de cible selon l'une quelconque des revendications précédentes, dans lequel le système comprend en outre une base (19) sur laquelle les objets de cible (12, 13, 14) sont montés.

7. Système d'apprentissage de cible selon la revendication 6, dans lequel la base comprend en outre des roues.

8. Système d'apprentissage de cible selon la revendication 6, dans lequel la base est configurée pour flotter sur l’eau.

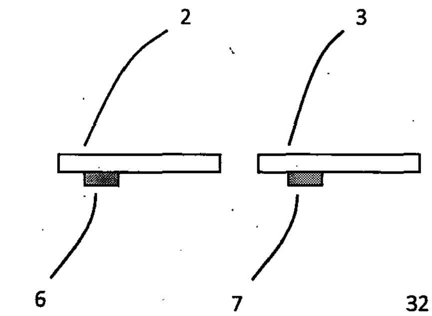


Figure 1a

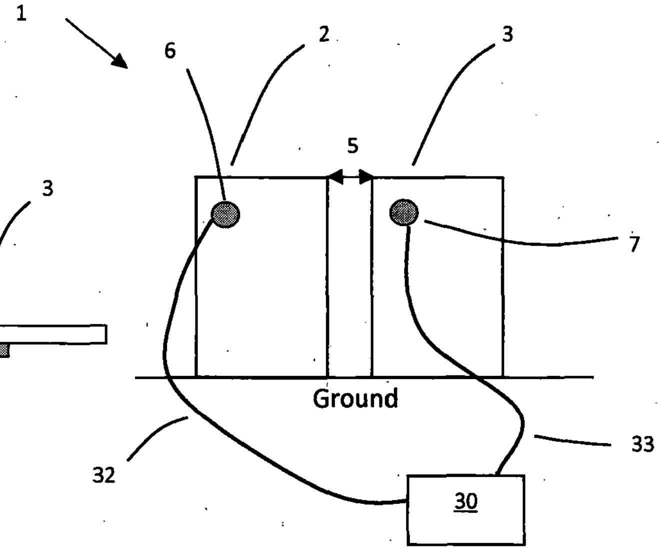


Figure 1b

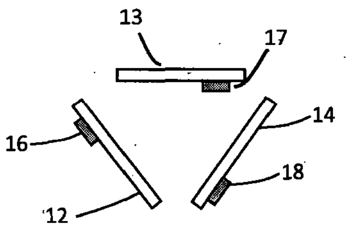


Figure 2a

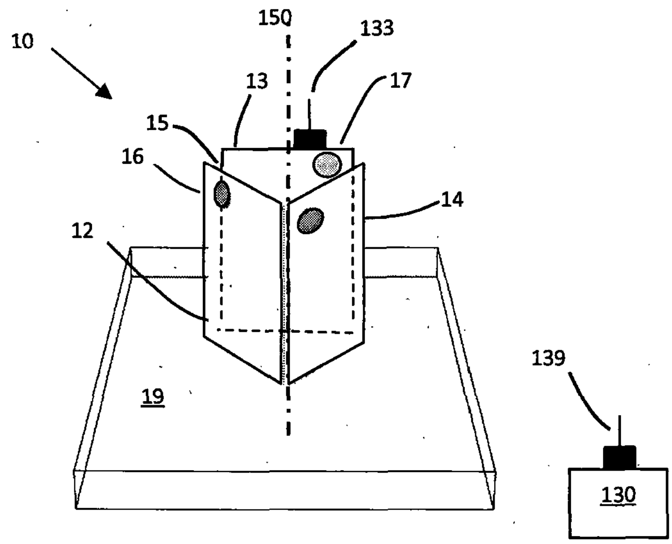


Figure 2b

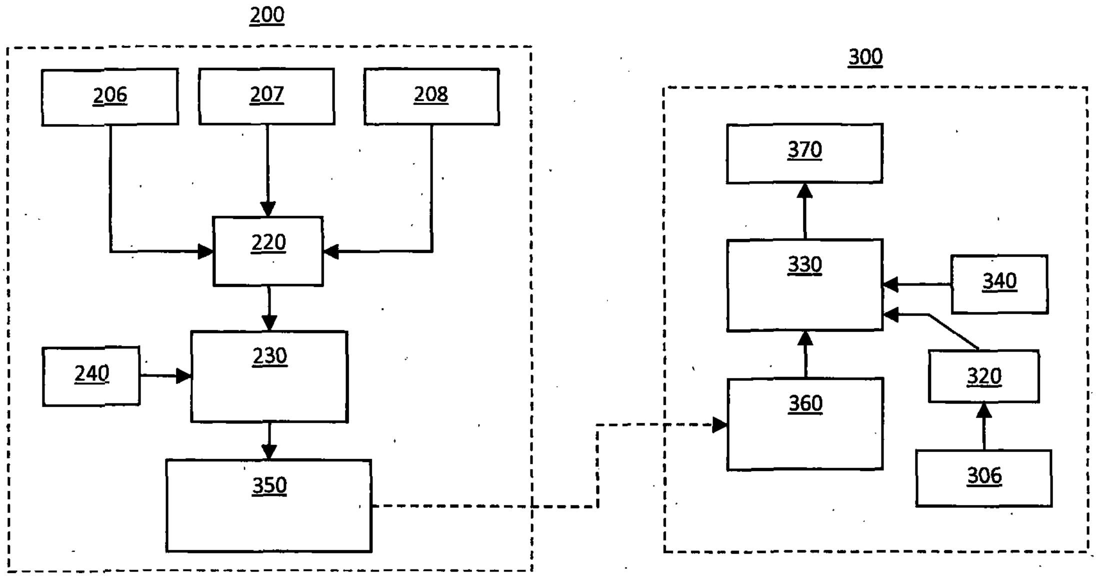
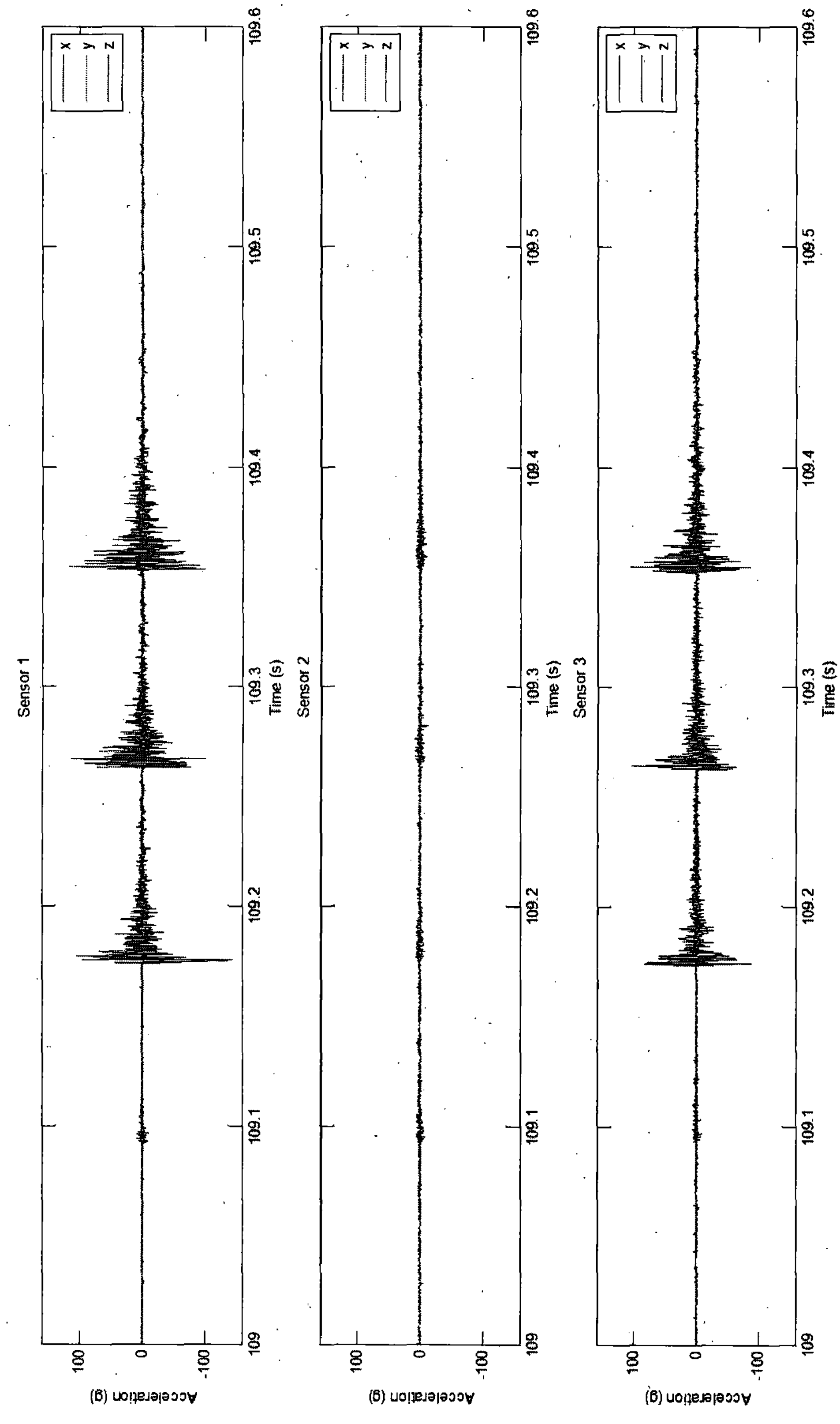


Figure 3

Figure 4


Sensor 1
Sensor 2
Sensor 3
x
y
z
Acceleration (g)
Time (s)
100
0
-100
109
109.1
109.2
109.3
109.4
109.5
109.6

REFERENCES CITED IN THE DESCRIPTION

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