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DISPLAY CONTROL FOR SCORE AND IMPACT POSITION IN TARGET DEVICE

BACKGROUND OF THE INVENTION

5 1. Field of the Invention:

The present invention relates to a target device for use in either a competition or a game, such as gun shooting, Japanese archery, archery, etc., for competing for a higher score based on the accuracy with which a
10 bullet, an arrow, or the like hits a target plate, or exercises for practicing such a competition or a game.

2. Description of the Related Art:

Target shooting sports including gun shooting, Japanese archery, archery, etc., have heretofore gained
15 popularity among many people. At present, not only Japanese archery and archery, but also gun shooting are played in competitions. According to a typical gun shooting competition, a player shoots a bullet from an air rifle or a laser beam from a laser gun toward a tar-
20 get, and competes for a higher score based on the accuracy with which the bullet or the laser beam hits the target.

Fig. 1 of the accompanying drawings shows partly in block form a conventional gun shooting competition system
25 for shooting a target with a laser beam emitted from a laser gun. As shown in Fig. 1, the conventional gun



shooting competition system has target device 1, laser gun 7 operated by a shooter, i.e., a player, target plates 4, 4', display unit 5, and switching unit 3. Target plates 4, 4' are used when target device 1 is spaced from laser gun 7 by distances of 10 m and 25 m, respectively. Target plates 4, 4' are selectively mounted removably on target device 1. In Fig. 1, target plate 4 is shown as being mounted on target device 1. If the distance from laser gun 7 to laser gun 7 is changed to 25 m, then target plate 4 mounted on target device 1 is replaced with target plate 4'. Switching unit 3 comprises a switching hub of 10BASE-T LAN (Local Area Network) 6. Display unit 5 is electrically connected through switching unit 3 to target device 1. Display unit 5 is positioned near the shooter.

Each player operates laser gun 7 to shoot light beam 2, i.e., a laser beam, toward target plate 4, and competes with other players based on a score that is added depending on the position where light beam 2 hits target plate 4. Light beam 2 shot from laser gun 7 is typically emitted from a semiconductor laser oscillation device mounted in laser gun 7. As with a real bullet shot from a real gun, light beam 2 is shot from the muzzle of laser gun 7 and travels straight.

Target device 1 detects the position where light beam 2 hits target plate 4, i.e., an impact position, and

transmits information representing the detected impact position to display unit 5. Display unit 5 also displays the identification number of the player, the light beam number, the score corresponding to the light beam number, the total score gained thus far, and the impact position, either simultaneously or at spaced time intervals.

The electronic gun shooting competition system uses a personal computer as display unit 5 which has a score calculating means for automatically carrying out a shooting competition score calculating process. Since the scores of the players can be calculated accurately at a high speed, the electronic gun shooting competition system can manage shooting competitions smoothly.

Fig. 2 of the accompanying drawings shows the surface of target plate 4. As shown in Fig. 2, target plate 4 has on its surface ten annular areas, including a central circular area just around center O, divided by ten concentric circles around center O. These areas are also referred to as score areas. Target plate 4 also has an outside area around the annular areas. The player gets no score when light beam 2 hits the outside area. A score for the outermost annular area, i.e., the annular area marked with "1", is 1. Scores for the other annular areas are progressively incremented by 1 toward center O, and the score for the central circular area is 10. A score which the player obtains when shooting target plate

4 is determined based on the distance from center O of target plate 4 to the impact position on target plate 4.

Target device 1 has a position-detecting optical device (not shown) for detecting the impact position.

5 The position-detecting optical device comprises a condenser lens and a position-detecting semiconductor device. The position-detecting semiconductor device comprises a CCD (Charge Coupled Device) or a PSD (Position Sensitive Device) which is known in the art. The PSD is
10 preferable to the CCD for its cost and detecting speed.

When the light beam 2 shot from laser gun 7 hits target plate 4, the PSD of target device 1 detects the impact position (x, y) of light beam 2 on target plate 4. The impact position (x, y) is equal to a coordinate position (x, y) in an orthogonal coordinate system on target
15 plate 4.

On target device 1, the origin of the orthogonal coordinate system is aligned with center O of target plate 4. Target device 1 calculates the distance from
20 the origin to the coordinate position (x, y), and calculates a score for light beam 2 by determining which score area the coordinate position (x, y) belongs to.

The PSD has a two-dimensional current generating membrane. If a laser beam is focused by the condenser
25 lens and applied as a beam spot to the two-dimensional current generating membrane at a coordinate position (x,

y), then the two-dimensional current generating membrane generates therein currents which are two-dimensionally linearly commensurate with the coordinate position (x, y). Specifically, the two-dimensional current generating
5 membrane generates two currents I_{x1} , I_{x2} flowing in two opposite directions along the x-axis and two currents I_{y1} , I_{y2} flowing in two opposite directions along the y-axis. The coordinates x, y of the coordinate position (x, y) are calculated from the currents I_{x1} , I_{x2} , I_{y1} ,
10 I_{y2} according to the following equations:

$$x = k(I_{x2} - I_{x1}) / (I_{x2} + I_{x1}) \quad (1)$$

$$y = k(I_{y2} - I_{y1}) / (I_{y2} + I_{y1}) \quad (2)$$

The beam spot position where both $(I_{x2} - I_{x1})$, $(I_{y2} - I_{y1})$ are zero is defined as the electrical and mechanical coordinate origin (0, 0) of the PSD. Target plate 4
15 needs to be positioned two-dimensionally with respect to the PSD within an allowable accuracy range.

In the conventional electronic gun shooting competition system, display device 5 for displaying scores and
20 impact positions is required to be positioned near the player's shooting spot. Therefore, the conventional electronic gun shooting competition system is not suitable for use in shooting exercises in limited spaces. The conventional electronic gun shooting competition sys-
25 tem is also disadvantageous in that its cost is high. Therefore, there has been a demand in the art for an

electronic gun shooting competition system which does not need a display unit such as display unit 5.

Gun shooting exercises or competitions which use real bullets allow the player to visually recognize an impact position on the target as a bullet mark is left on the target. However, a gun shooting system using a light beam such as a laser beam does not leave any bullet marks on the target. It has been customary for such a gun shooting system to incorporate a separate device for indicating impact positions on the target. According to another proposal, an indicator for indicating an impact position of a light beam is placed on the target. One problem with the proposed system is that it is unable to detect an impact position of the light beam which has hit the indicator.

SUMMARY OF THE INVENTION

It is an object of an embodiment of the present invention to provide a target device which allows a shooter that is located far from the target to easily recognize a shooting result without the need for a display device which would be located near the shooter's position for displaying an image of the target.

According to an aspect of the present invention, a target device has a light-emitting element group disposed near a target plate, and changes energizing patterns of

the light-emitting element group depending on a calculated score and/or a detected impact position.

The target device displays scores and impact positions with simple energizing patterns of the light-emitting element group. Since simple energizing patterns can visually be perceived from a distant location, the shooter positioned far from the target device is able to easily recognize the score and the impact position without the need for a display device for displaying an image of the target in the vicinity of the shooting spot where the shooter is positioned.

According to an embodiment of the present invention, the light-emitting element group comprises a plurality of light-emitting elements disposed at substantially equally spaced intervals around the target plate. Preferably, the light-emitting elements are positioned such that angles formed between straight lines extending from a center of the target plate to the light-emitting elements, respectively, are predetermined angles. Because the light-emitting elements are positioned at substantially equally spaced intervals, the impact position can be displayed on the target plate without unwanted localized display irregularities.

According to another embodiment of the present invention, one of the light-emitting elements which is closest to the impact position on the target plate is en-

ergized. Alternatively, one of the light-emitting elements is energized such that an angle formed between a straight line extending from a center of the target plate to the one of the light-emitting elements and a straight
5 line extending from the center of the target plate to the impact position on the target plate is minimum. With this arrangement, a direction in which the impact position deviates from the center of the target plate can be displayed.

10 According to still another embodiment of the present invention, a first light-emitting element, of the light-emitting elements, is determined such that an angle formed between a straight line extending from a center of the target plate to the first light-emitting element and
15 a straight line extending from the center of the target plate to the impact position on the target plate is a smallest first angle, and a second light-emitting element, of the light-emitting elements, is selected such that an angle formed between a straight line extending
20 from the center of the target plate to the second light-emitting element and the straight line extending from the center of the target plate to the impact position on the target plate is a next smallest second angle. The first light-emitting element is energized, and the second
25 light-emitting element is energized if the difference between the second angle and the first angle is at most a

predetermined angle. With this arrangement, the resolution with which to indicate the direction of the impact position with respect to the center of target plate can be twice the resolution of a target device having the
5 same number of light-emitting elements.

According to still another embodiment of the present invention, light-emitting elements to be energized are changed depending on the score calculated by a score calculating means. Alternatively, combinations of light-emitting elements to be energized are changed depending
10 on the score calculated by the score calculating means. If some scores are expressed by changing combinations of light-emitting elements, then the number of light-emitting elements for expressing a full score may be
15 small.

According to yet another embodiment of the present invention, the light-emitting element group comprises a first light-emitting element group energizable in energizing patterns which vary depending on the score calculated by the score calculating means, and a second light-emitting element group energizable in energizing patterns which vary depending on the detected impact position.
20 The first light-emitting element group and the second light-emitting element group should preferably be energizable to emit light in different colors, respectively.
25 Inasmuch as the first light-emitting element group and

the second light-emitting element group emit light in different colors, the shooter located far from the target device can easily distinguish the score and the impact position from each other.

5 According to yet another embodiment of the present invention, the light-emitting element group is energized to display the score and the impact position in a time-division manner. Alternatively, the light-emitting element group is energized to display the score and the im-
10 pact position alternately in an intermittent fashion. Furthermore, each of the light-emitting elements comprises a bicolor light-emitting diode for emitting light in two colors, and should preferably be energized to emit light to display the score and the impact position in
15 different colors for better visibility. Because one light-emitting element group is capable of displaying both scores and impact positions, the number of light-emitting elements used may be reduced, and the target device is relatively low in cost and small in size.

20 According to yet still another embodiment of the present invention, at least one of the light-emitting elements is operable as a ready lamp for indicating that a shooter can shoot at the target plate. Preferably, at least one of the light-emitting elements which is oper-
25 able as the ready lamp is positioned below the target plate. Since at least one of the light-emitting elements

doubles as a ready lamp, no additional ready lamp needs to be newly provided. Therefore, the number of light-emitting elements may be small. Since at least one of the light-emitting elements which is operable as the
5 ready lamp is positioned below the target plate, when the shooter holds a laser gun and aims at the target plate, the light-emitting element as the ready lamp is concealed from the vision of the shooter by the gunbarrel, and hence the ready lamp does not obstruct the shooting ac-
10 tion of the shooter.

According to yet still another embodiment of the present invention, at least one of the light-emitting elements is operable as a busy lamp for indicating that a shooter cannot shoot at the target plate. Preferably, at
15 least one of the light-emitting elements which is operable as the busy lamp is positioned above the target plate. Since at least one of the light-emitting elements doubles as a busy lamp, no additional busy lamp needs to be newly provided. Therefore, the number of light-
20 emitting elements may be small. Since at least one of the light-emitting elements which is operable as the busy lamp is positioned above the target plate, when the shooter holds the laser gun and aims at the target plate, the light-emitting element as the busy lamp is present in
25 the vision of the shooter, allowing the shooter to easily

recognize that the shooter cannot shoot at the target plate.

According to another embodiment of the present invention, the target device further comprises a switch
5 for setting a type of the target plate which is mounted in place, and an equation for calculating the score from the impact position is changed depending on the type of the target plate which is set by the switch. By
operating the switch, it is possible to accurately
10 calculate and display a score depending on the type of the target plate which is mounted in place.

According to a yet further embodiment of the present invention, the target device further comprises a detecting means for automatically detecting a type of the
15 target plate which is mounted in place, and an equation for calculating the score from the impact position is changed depending on the type of the target plate which is automatically detected by the detecting means. Since the equation for calculating scores is automatically
20 changed depending on the type of the target plate used, the user finds it less burdensome to change the target plate than with the target device with the switch, and scores are prevented from being calculated according to a wrong equation.

25 According to a still further embodiment of the present invention, the detecting means detects the type of

the target plate which is mounted in place by reading either the resistance of a resistor embedded in the target plate which is mounted in place, information stored in an IC chip embedded in the target plate which is mounted in place, magnetic information embedded in the target plate
5 which is mounted in place, or a pattern of slits disposed in the target plate which is mounted in place.

According to a still further embodiment of the present invention, the light-emitting element group is energizable in energizing patterns which are visually recognizable as a character and/or a numeral representing the score and/or the impact position.
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According to yet another embodiment of the present invention, the target device further comprises a sound output means for providing sound information depending on a shot on the target plate.
15

The sound output means provides predetermined sound information when a shot is detected on the target plate by the impact position detecting means. The shooter is thus given a feel similar to an actual gun shooting activity.
20

According to yet another embodiment of the present invention, the sound output means provides sound information depending on the score calculated by the score calculating means. The shooter can thus obtain an auditory recognition of the score of the shot.
25

The above and other objects, features, and advantages of the present invention will become apparent from the following description with reference to the accompanying drawings which illustrate examples of the present
5 invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view, partly in block form, of a conventional gun shooting competition system which employs a
10 laser gun for shooting a laser beam;

Fig. 2 is a view of a target plate used in the conventional gun shooting competition system;

Fig. 3A is a front elevational view of a target device according to a first embodiment of the present in-
15 vention;

Fig. 3B is a block diagram of a circuit arrangement of the target device according to the first embodiment;

Fig. 4A is a front elevational view of a target device according to a second embodiment of the present in-
20 vention;

Fig. 4B is a block diagram of a circuit arrangement of the target device according to the second embodiment;

Fig. 5A is a front elevational view of a target device according to a third embodiment of the present in-
25 vention;

Fig. 5B is a block diagram of a circuit arrangement of the target device according to the third embodiment;

Fig. 6A is a front elevational view of a target device according to a fourth embodiment of the present invention;

Fig. 6B is a block diagram of a circuit arrangement of the target device according to the fourth embodiment;

Fig. 7A is a front elevational view of a target device according to a fifth embodiment of the present invention;

Fig. 7B is a block diagram of a circuit arrangement of the target device according to the fifth embodiment;

Fig. 8A is a front elevational view of a target device according to a sixth embodiment of the present invention;

Fig. 8B is a block diagram of a circuit arrangement of the target device according to the sixth embodiment;

Fig. 9A is a perspective view of a target device according to a seventh embodiment of the present invention;

Fig. 9B is a block diagram of a circuit arrangement of the target device according to the seventh embodiment;

Fig. 10 is a block diagram of a circuit arrangement of a target device according to an eighth embodiment of the present invention;

Fig. 11A is a front elevational view of a target device according to a ninth embodiment of the present invention;

Fig. 11B is a block diagram of a circuit arrangement of the target device according to the ninth embodiment;

Fig. 12A is a perspective view of a target device according to a tenth embodiment of the present invention; and

Fig. 12B is a block diagram of a circuit arrangement of the target device according to the tenth embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

1st Embodiment:

Fig. 3A shows in front elevation a target device according to a first embodiment of the present invention, and Fig. 3B shows in block form a circuit arrangement of the target device according to the first embodiment. The target device has a front surface on which target plate 4 is mounted, the front surface facing a shooting spot where a shooter is positioned.

The front surface of the target device shown in Fig. 3A is of a square shape having a vertical dimension of 10 cm and a horizontal dimension of 10 cm. Target plate 4 which is also of a square shape is mounted on a

central area of the front surface of the target device.
Target plate 4 comprises a solid panel and has a plural-
ity of circular score areas as shown in Fig. 2 around its
center. Target plate 4 is fastened to a casing of the
5 target device by four screws 5 at its corners.

The target device has LED group 9 comprising eight
light-emitting elements, i.e., light-emitting diodes
(LEDs) 9₁ through 9₈, disposed around target plate 4.
LEDs 9₁ through 9₈ are spaced at substantially equal in-
10 tervals around target plate 4. Specifically, LEDs 9₁
through 9₈ are positioned such that each of straight
lines (indicated by the dot-and-dash lines in FIG. 3A)
extending from the center of target plate 4 to respective
LEDs 9₁ through 9₈ is angularly spaced 45° from other ad-
15 jacent straight lines.

The target device also has impact position detector
11, score calculator 12A, and light-emitting element en-
ergizing unit 13A. The target device displays a score
with LED group 9. Impact position detector 11 detects
20 impact position (x, y) on target plate 4 according to the
equations (1), (2) described above. Score calculator 12A
calculates the distance from center O of target plate 4
to impact position (x, y) based on detected impact posi-
tion (x, y), and compares the calculated distance with
25 the ranges (radii) of the score areas to calculate a
score for detected impact position (x, y). It is neces-

sary that center O of target plate 4 and the detecting origin of impact position detector 11 be in complete alignment with each other.

Light-emitting element energizing unit 13A determines an energizing pattern of LEDs 9_1 through 9_8 of LED group 9 depending on the score which has been calculated by score calculator 12A. For example, if the score calculated by score calculator 12A is "1", then light-emitting element energizing unit 13A energizes only LED 9_1 . If score calculator 12A has calculated scores "2" through "8", then light-emitting element energizing unit 13A energizes only LEDs 9_2 through 9_8 , respectively. Thus, an LED or LEDs corresponding to a score calculated by score calculator 12A are energized. Consequently, when only LED 9_5 is energized as a result of a shot, the shooter can immediately recognize that the shot has won a score "5". If score calculator 12 has calculated a score "9", then light-emitting element energizing unit 13A energizes LED 9_2 and LED 9_7 . If score calculator 12 has calculated a score "10", then light-emitting element energizing unit 13A energizes all LED 9_1 through LED 9_8 . Stated otherwise, the target device changes combinations of LEDs to be energized depending on the score which has been calculated by score calculator 12A. Usually, at least 10 LEDs would be required to display scores "0" through "10". According to the present embodiment, how-

ever, since some scores are expressed by changing combinations of LEDs to be energized, the number of LEDs that are required may be reduced from 10 to 8.

In the present embodiment, the LEDs are energized progressively counterclockwise from the left lowermost one below target plate 4 in Fig. 3A as the score increases. However, the LEDs may be energized progressively clockwise. The number of LEDs that are used may further be reduced by using a binary representation of scores. According to the present invention, the LEDs may be energized in any energizing patterns insofar as they allow the shooter to read scores which it has won. While target plate 4 comprises a solid panel in the present embodiment, it may comprise a sheet of film or paper.

2nd Embodiment:

Fig. 4A shows in front elevation a target device according to a second embodiment of the present invention, and Fig. 4B shows in block form a circuit arrangement of the target device according to the second embodiment.

As shown in Fig. 4A, the target device according to the second embodiment has LED group 9 comprising eight LEDs 9₁ through 9₈ disposed around target plate 4. According to the second embodiment, eight LEDs 9₁ through 9₈ of LED group 9 are used to give an approximate indication of an impact position on target plate 4, rather than

to indicate a score. As shown in Fig. 4B, the target device also has impact position detector 11 and light-emitting element energizing unit 13B. Light-emitting element energizing unit 13B energizes LED group 9 depending on an impact position on target plate 4. It is now assumed that the impact position on target plate 4 is represented by point A in Fig. 4A. Position (x, y) of point A is calculated according to the equations (1), (2) described above. Line segment OA extends from center O of target plate 4 to point A. Point A is positioned between line segment OB extending from center O to LED 9₄ and line segment OC extending from center O to LED 9₅. Angle θ_1 formed between line segments OA, OB is smaller than angle θ_2 formed between line segments OA, OC.

Light-emitting element energizing unit 13B energizes LED 9₄ on line segment OB. Consequently, when the shooter hits target plate 4 at a certain impact position, light-emitting element energizing unit 13B energizes an LED, all LEDs 9₁ through 9₈ of LED group 9, such that the angle formed between a line segment extending from center O to that LED and a line segment extending from center O to the impact position is minimum. Stated otherwise, the score areas on target plate 4 are divided into eight angular zones having equal angles (45°) around center O by eight LEDs 9₁ through 9₈ disposed at equal angles around target plate 4, and light-emitting element energizing

unit 13B determines which one of the divided angular zones the impact position is located in, and energizes an LED belonging to the determined angular zone. The shooter can confirm from the shooting spot in which direction the impact position deviates from center O. Generally, in gun shooting competitions, most impact positions concentrate on score areas representing scores "7" through "10", i.e., score areas near center O. Therefore, the direction in which the impact position deviates from center O presents more important information than the distance by which the impact position deviates from center O for the shooter to correct its shooting action. The target device according to the second information displays that deviating direction to give the shooter an indication of the deviating direction of the impact position. The shooter confirms the displayed deviating direction, and corrects its shooting action based on the confirmed deviating direction.

Alternatively, an LED, of all LEDs 9_1 through 9_8 of LED group 9, which is linearly closest to point A of the impact position may be energized to present an approximate indication of the impact position to the shooter.

3rd Embodiment:

Fig. 5A shows in front elevation a target device according to a third embodiment of the present invention, and Fig. 5B shows in block form a circuit arrangement of

the target device according to the third embodiment. The target device according to the third embodiment has LED group 9 of eight LEDs 9_1 through 9_8 disposed around target plate 4 as with the second embodiment. As shown in FIG. 5B, the target device according to the third embodiment also has impact position detector 11 and light-emitting element energizing unit 13C.

It is now assumed that the impact position on target plate 4 is represented by point A in Fig. 5A. Point A is positioned between line segment OB extending from center O to LED 9_4 and line segment OC extending from center O to LED 9_5 . Angle θ_1 formed between line segments OA, OB is smaller than angle θ_2 formed between line segments OA, OC. According to the third embodiment, light-emitting element energizing unit 13C also energizes LED 9_4 on line segment OB as with the target device according to the second embodiment.

If the difference between angle θ_1 and angle θ_2 is at most a predetermined angle of 11.25° , then light-emitting element energizing unit 13C energizes not only LED 9_4 , but also LED 9_5 . When the shooter sees the energization of both LEDs 9_4 , 9_5 , the shooter becomes aware of the fact that the impact position deviates from center O in an intermediate direction between LEDs 9_4 , 9_5 . With the target device according to the third embodiment, therefore, light-emitting element energizing unit 13C deter-

mines an LED (first light-emitting element, i.e., LED 9_4 in FIG. 5A), of all LEDs 9_1 through 9_8 of LED group 9, such that the angle formed between a line segment extending from center O to that LED and line segment OA extending from center O to the impact position (point A) is
5 smallest (first angle, i.e., θ_1 in FIG. 5A), and an LED (second light-emitting element, i.e., LED 9_5 in FIG. 5A) such that the angle formed between a line segment extending from center O to that LED and line segment OA is next
10 smallest (second angle, i.e., θ_2 in FIG. 5A). Then, light-emitting element energizing unit 13C energizes the first light-emitting element (LED 9_4), and also energizes the second light-emitting element (LED 9_5) if the difference between the first angle and the second angle is at
15 most a predetermined angle.

If the predetermined angle is 11.25° , then the score areas on target plate 4 can be divided into 16 angular zones having equal angles (22.5°) around center O. With this arrangement, although the number of LEDs used
20 in the target device according to the third embodiment is the same as the number of LEDs used in the target device according to the second embodiment, the resolution with which to indicate the direction of the impact position with respect to the center of target plate 4 can be twice
25 the resolution of the target device according to the sec-

ond embodiment, i.e., can be represented by the 16 angular zones.

The target device according to the third embodiment can display impact positions with simple energizing patterns of LED group 9. Since such simple energizing patterns of LED group 9 can visually be perceived from a distant location, the shooter positioned far from the target is able to easily recognize the impact position without the need for a display device for displaying an image of the target in the vicinity of the shooting spot where the shooter is positioned.

4th Embodiment:

Fig. 6A shows in front elevation a target device according to a fourth embodiment of the present invention, and Fig. 6B shows in block form a circuit arrangement of the target device according to the fourth embodiment. The target device according to the fourth embodiment has LED group 8 (first light-emitting element group) of eight LEDs 8₁ through 8₈ and LED group 9 (second light-emitting element group) of eight LEDs 9₁ through 9₈ which are disposed around target plate 4.

As shown in FIG. 6B, the target device according to the fourth embodiment also has impact position detector 11, score calculator 12A, and light-emitting element energizing unit 13D.

LED group 8 serves to display a score calculated by score calculator 12A, and LED group 9 serves to display an impact position detected by impact position detector 11. Both LED groups 8, 9 are energized by light-emitting
5 element energizing unit 13d. As with the first and second embodiments, LEDs 8₁ through 8₈ and LEDs 9₁ through 9₈ are positioned such that each of straight lines (indicated by the dot-and-dash lines in FIG. 6A) extending from the center of target plate 4 to respective LEDs 8₁
10 through 8₈ and respective LEDs 9₁ through 9₈ is angularly spaced 45° from other adjacent straight lines. In the fourth embodiment, LED group 9 is disposed outwardly of LED group 8. However, LED groups 8, 9 are not limited to the layout shown in FIG. 6A, but LED group 8 may be dis-
15 posed outwardly of LED group 9.

With the target device according to the fourth embodiment, LED group 8 and LED group 9 emit light in different colors. For example, LEDs 8₁ through 8₈ of LED group 8 comprise red light-emitting diodes, and LEDs 9₁
20 through 9₈ of LED group 9 comprise green light-emitting diodes. These differently colored light emission from LED group 8 and LED group 9 is effective to prevent the shooter from mixing up score displays and impact position displays.

25 According to the fourth embodiment, LED group 8 for displaying scores are energized in the same energizing

patterns as with the first embodiment, and LED group 9 for displaying impact positions are energized in the same energizing patterns as with the second and third embodiments.

5 5th Embodiment:

Fig. 7A shows in front elevation a target device according to a fifth embodiment of the present invention, and Fig. 7B shows in block form a circuit arrangement of the target device according to the fifth embodiment. The
10 target device according to the fifth embodiment has LED group 19 of eight LEDs 19₁ through 19₈ which can be energized in energizing patterns that are changed depending on a score calculated by score calculator 12A and can also be energized in energizing patterns that are changed
15 depending on an impact position detected by impact position detector 11.

As shown in FIG. 7B, the target device according to the fifth embodiment also has impact position detector 11, score calculator 12A, and light-emitting element energizing unit 13E. Light-emitting element energizing
20 unit 13E energizes LED group 19 to display a score and an impact position in a time-division manner, or preferably alternately in an intermittent fashion.

Each of LEDs 19₁ through 19₈ of LED group 19 comprises a bicolor LED for emitting color selectively in
25 two colors. If each of LEDs 19₁ through 19₈ is a bicolor

LED for emitting color selectively in red and green, then light-emitting element energizing unit 13E controls LEDs 19₁ through 19₈ to emit light in red for displaying scores and to emit light in green for displaying impact positions. Since LED group 19 emits light in different colors for displaying scores and impact positions, the shooter can easily distinguish score displays and impact position displays from each other.

According to the fifth embodiment, LED group 19 are energized in the same energizing patterns as with the first embodiment for displaying scores, and LED group 19 are energized in the same energizing patterns as with the second and third embodiments for displaying impact positions.

Inasmuch as one LED group 19 is capable of displaying both scores and impact positions with bicolor LEDs, the number of LEDs used may be smaller than the number of LEDs used in the fourth embodiment. Therefore, the target device according to the fifth embodiment is relatively low in cost and small in size.

6th Embodiment:

Fig. 8A shows in front elevation a target device according to a sixth embodiment of the present invention, and Fig. 8B shows in block form a circuit arrangement of the target device according to the sixth embodiment. The target device according to the sixth embodiment has LED

group 9 of eight LEDs 9₁ through 9₈ as with the target device according to the first embodiment. According to the sixth embodiment, at least one of LEDs 9₁ through 9₈, e.g., LEDs 9₁ through 9₃, is used as a ready lamp for indicating that the shooter can shoot a light beam, and at least one of LEDs 9₁ through 9₈, e.g., LEDs 9₅ through 9₇, is used as a busy lamp for indicating that the shooter cannot shoot a light beam. LEDs 9₁ through 9₃, which double as the ready lamp, are positioned below target plate 4. Therefore, when the shooter holds the laser gun and aims at target plate 4, LEDs 9₁ through 9₃ are concealed from the vision of the shooter by the gunbarrel, and hence the ready lamp does not obstruct the shooting action of the shooter. LEDs 9₅ through 9₇, which double as the busy lamp, are positioned above target plate 4. Therefore, when the shooter holds the laser gun and aims at target plate 4, LEDs 9₅ through 9₇ are present in the vision of the shooter, allowing the shooter to easily recognize that the shooter cannot shoot a light beam.

As shown in FIG. 8B, the target device according to the sixth embodiment also has impact position detector 11, score calculator 12, and light-emitting element energizing unit 13F. Light-emitting element energizing unit 13F operates LED group 9 selectively as the ready lamp or the busy lamp in response to a signal from an external source.

According to the sixth embodiment, since LEDs 9₁ through 9₈ of LED group 9 double as the ready lamp and the busy lamp, no separate ready lamp and busy lamp need to be provided, and hence the number of LEDs used may be
5 reduced.

In the target devices according to the second through fifth embodiments, the LED group or groups may be operated as a ready lamp and a busy lamp.

7th Embodiment:

10 Fig. 9A shows in perspective a target device according to a seventh embodiment of the present invention, and Fig. 9B shown in block form a circuit arrangement of the target device according to the seventh embodiment. Target plates which are spaced at different distances
15 from laser gun (not shown in FIG. 9A), e.g., target plate 4 (spaced 10 m from laser gun) and target plate 4' (spaced 25 m from laser gun) shown in Fig. 1, have differently sized score areas. Even when an impact position remains the same on the different target plates, it is
20 necessary for a score calculator to use a score calculating equation depending on the score areas of the target plate that is actually mounted on the target device. As shown in FIG. 9A, the target device according to the seventh embodiment has target plate setting switch 10 which
25 can be operated by the user for setting the type of the

target plate that is actually mounted on the target device.

As shown in FIG. 9B, the target device according to the seventh embodiment also has target plate setting switch 10, impact position detector 11, score calculator 12B, and light-emitting element energizing unit 13A. Depending on the type of the target plate which has been set by the user using target plate setting switch 10, light-emitting element energizing unit 13A determines a score calculating equation for determining a score from an impact position on the target plate, and calculates a score according to the determined equation. Therefore, the target device can display an accurate score depending on the type of the target plate that is actually mounted on the target device.

Target plate setting switch 10 may be incorporated in the target devices according to the fourth through sixth embodiments.

8th Embodiment:

Fig. 10 shows in block form a circuit arrangement of a target device according to an eighth embodiment of the present invention. The target device according to the eighth embodiment has target plate detector 14 for automatically detecting the type of the target plate that is actually mounted on the target device, in addition to impact position detector 11, score calculator 12B, and

light-emitting element energizing unit 13A. Target plate detector 14 comprises pull-up resistor 14a and detector 14b. Resistor 15 which is embedded in the target plate is electrically connected to detector 14b. Detector 14b
5 has its one terminal connected to pull-up resistor 14a and its other terminal connected to ground. Resistor 15 has a resistance which varies depending on the type of the target plate used, e.g., target plate 4 or target plate 4'. When target plate 4 is mounted on the target
10 device, resistor 15 embedded in target plate 4 has its ends electrically connected to detector 14b, which reads the resistance of resistor 15, detects the type of mounted target plate 4, and provides outputs the detected type to score calculator 12B.

15 After being supplied with the detected type from detector 14b, score calculator 12B applies an impact position on target plate 4 as detected by impact position detector 11 to the score calculating equation depending on the detected type, calculates a score according to the
20 score calculating equation, and supplies the calculated score to light-emitting element energizing unit 13A. The score is displayed in the manner described above in the first embodiment.

According to the eighth embodiment, since the score
25 calculating equation used in score calculator 12B is automatically changed depending on the type of the target

plate used, the user finds it less burdensome to change the target plate than with the seventh embodiment, and any errors involved in setting the type of the target plate used are eliminated.

5 According to the eighth embodiment, the type of the target plate used is detected based on the resistance of resistor 15 embedded in the target plate. However, the type of the target plate used may be detected by reading information stored in an IC chip embedded in the
10 target plate, magnetic information embedded in the target plate, or a pattern of slits disposed in the target plate.

 Target plate detector 14 may be incorporated in the target devices according to the fourth through sixth em-
15 bodiments.

9th Embodiment:

 Fig. 11A shows in front elevation a target device according to a ninth embodiment of the present invention, and Fig. 11B shows in block form a circuit arrangement of
20 the target device according to the ninth embodiment. As shown in Fig. 11A, the target device according to the ninth embodiment has seven-segment score display panel 16 for displaying a score, disposed in an upper right region of the surface of the target device on which target plate
25 4 is mounted. Seven-segment score display panel 16 has two sets of seven LEDs arranged in the shape of "8", the

LEDs being selectively energizable to display numerals representing a score.

As shown in FIG. 11B, the target device according to the ninth embodiment also has impact position detector 11, score calculator 12A, and score display unit 13G.

When a light beam shot from laser gun hits target plate 4, impact position (x, y) on target plate 4 is detected by impact position detector 11 using equation (1) and (2) described above, and score calculator 12A calculates a score based on detected impact position (x, y). The calculated score, which is either one of "0" through "10", is displayed on seven-segment score display panel 16 by score display unit 13G.

The target device according to the ninth embodiment dispenses with a score display unit such as display unit 5 of the electronic gun shooting competition system shown in Fig. 1, and allows the user to practice shooting in a relatively small space.

The target device may have not only the score display panels for displaying scores, but also an impact position display panel for displaying impact positions with characters.

In shooting competitions, the distance between the shooting spot where the shooter is positioned and target plate 5 is required to be 5 m at minimum, and the target device needs to have a surface area having vertical and

horizontal dimensions of 10 cm for installing target plate 4 thereon. Consequently, the size of seven-segment score display panel 16 mounted on the target device is limited, making it difficult for the shooter in the shooting spot to visually recognize clearly the numerals displayed on seven-segment score display panel 16. For this reason, it is preferable to display scores and impact positions in simple energizing patterns as with the target devices according to the first through eighth embodiments, rather than displaying scores and impact positions in numerals and characters with the score display panel.

10th Embodiment:

Fig. 12A shows in perspective a target device according to a tenth embodiment of the present invention, and FIG. 12B shows in block form a circuit arrangement of the target device according to the tenth embodiment.

As shown in Fig. 12A, the target device supports square target plate 4 centrally on its front surface, target plate 4 having circular score areas as shown in Fig. 2 around its center. Target plate 4 is fastened to a casing of the target device by four screws 5 at its corners.

Target device has speaker 18 mounted on a side wall of a casing thereof for producing speech or an electronic sound representative of an impact position and a score

based on the impact position when a light beam shot from the laser gun (not shown in FIG. 12A) hits target plate 4. Speaker 18 may be mounted on any regions of target device where target plate 4 is not mounted, rather than a side wall of the casing thereof.

As shown in Fig. 12B, the target device according to the tenth embodiment also has impact position detector 11, score calculator 12A, and sound output controller 17. When impact position detector 11 detects an impact position on target plate 4 at the time a light beam shot from the laser gun hits target plate 4, sound output controller 17 controls speaker 18 to output an electronic sound indicating that the light beam shot from the laser gun hits target plate 4. In gun shooting activities that use actual bullets, the sound that is produced when a bullet is shot from the gun is much louder than the sound that is produced when the bullet actually hits the target. To give the shooter a feel analogous to an actual shooting action using a real bullet with the target device according to the tenth embodiment, it is preferable to output the electronic sound from speaker 18 at the time the light beam is emitted from the laser gun. However, irrespective of whether a real bullet is shot from the real gun or a light beam is emitted from the laser gun, since the period of time that elapses after the shooter pulls the trigger until the real bullet or the light beam hits the target plate is considerably short, the shooter

the target plate is considerably short, the shooter can have a feel similar to a gun shooting action using a real bullet if an electronic sound simulating a real bullet shot is output from speaker 18 at the time the light beam emitted from the laser gun hits target plate 4.

Impact position detector 11 detects an impact position of the light beam emitted from the laser gun as with the above embodiments. Score calculator 12A also calculates a score based on the impact position detected by impact position detector 11 as with the above embodiments. Information representing the score calculated by score calculator 12A is sent to sound output controller 17, which controls speaker 18 to output a sound representing the score based on the score calculated by score calculator 12A. For example, the calculated score may be output as speech information from speaker 18. If the score is equal to or higher than a predetermined score, then speech information or a melody indicating that the score is equal to or higher than the predetermined score may be from speaker 18. Upon hearing such a sound, the shooter can obtain an auditory recognition of the score of the shot.

In the tenth embodiment, sound information is output from speaker 4 based on impact positions on target plate 4 and scores depending on the impact positions. The visual display system for displaying impact positions

and scores with LEDs according to any of the above embodiments may be combined with the system according to the tenth embodiment for producing an auditory presentation of impact positions and scores.

5 While preferred embodiments of the present invention have been described in specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following
10 claims.

CLAIMS:

1. A target device comprising:

a target plate;

5 a light-emitting element group disposed near
said target plate;

impact position detecting means for detecting
an impact position on said target plate and/or score cal-
culating means for calculating a score based on the im-
10 pact position detected by said impact position detecting
means; and

light-emitting element group energizing means
for changing energizing patterns of said light-emitting
element group depending on the calculated score and/or
15 the detected impact position.

2. A target device according to claim 1, wherein
said light-emitting element group comprises a plurality
of light-emitting elements disposed at substantially
20 equally spaced intervals around said target plate.

3. A target device according to claim 2, wherein
said light-emitting elements are positioned such that an-
gles formed between straight lines extending from a cen-
25 ter of said target plate to said light-emitting elements,
respectively, are predetermined angles.

4. A target device according to claim 1, wherein
said light-emitting element group comprises a plurality
of light-emitting elements, said light-emitting element
5 group energizing means energizing one of said light-
emitting elements which is closest to the impact position
on said target plate.

5. A target device according to claim 1, wherein
10 said light-emitting element group comprises a plurality
of light-emitting elements, said light-emitting element
group energizing means comprising means for energizing
one of said light-emitting elements such that an angle
formed between a straight line extending from a center of
15 said target plate to said one of the light-emitting ele-
ments and a straight line extending from said center of
said target plate to said impact position on said target
plate is minimum.

20 6. A target device according to claim 1, wherein
said light-emitting element group comprises a plurality
of light-emitting elements, said light-emitting element
group energizing means comprising means for determining a
first light-emitting element, of said light-emitting ele-
25 ments, such that an angle formed between a straight line
extending from a center of said target plate to said

first light-emitting element and a straight line extending from the center of said target plate to said impact position on said target plate is a smallest first angle, and a second light-emitting element, of said light-emitting elements, such that an angle formed between a straight line extending from the center of said target plate to said second light-emitting element and the straight line extending from the center of said target plate to said impact position on said target plate is a next smallest second angle, energizing said first light-emitting element, and energizing said second light-emitting element if the difference between said second angle and said first angle is at most a predetermined angle.

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7. A target device according to claim 1, wherein said light-emitting element group comprises a plurality of light-emitting elements, said light-emitting element group energizing means comprising means for changing light-emitting elements to be energized depending on the score calculated by said score calculating means.

8. A target device according to claim 7, wherein said light-emitting element group comprises a plurality of light-emitting elements, said light-emitting element group energizing means comprising means for changing com-

binations of light-emitting elements to be energized depending on the score calculated by said score calculating means.

5 9. A target device according to claim 1, wherein said light-emitting element group comprises a first light-emitting element group energizable in energizing patterns which vary depending on the score calculated by said score calculating means, and a second light-emitting
10 element group energizable in energizing patterns which vary depending on the impact position detected by said impact position detecting means.

 10. A target device according to claim 9, wherein
15 said first light-emitting element group and said second light-emitting element group are energizable to emit light in different colors, respectively.

 11. A target device according to claim 1, wherein
20 said light-emitting element group energizing means comprises means for energizing said light-emitting element group to display the score and the impact position in a time-division manner.

25 12. A target device according to claim 11, wherein said light-emitting element group energizing means com-

prises means for energizing said light-emitting element group to display the score and the impact position alternately in an intermittent fashion.

5 13. A target device according to claim 1, wherein said light-emitting element group comprises a plurality of light-emitting elements, each of said light-emitting elements comprising a bicolor light-emitting diode for emitting light in two colors.

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 14. A target device according to claim 13, wherein said light-emitting element group energizing means comprises means for energizing said light-emitting elements display the score and the impact position in different
15 colors.

 15. A target device according to claim 1, wherein said light-emitting element group comprises a plurality of light-emitting elements, at least one of said light-
20 emitting elements being operable as a ready lamp for indicating that a shooter can shoot at the target plate.

 16. A target device according to claim 15, wherein said at least one of said light-emitting elements which
25 is operable as the ready lamp is positioned below said target plate.

17. A target device according to claim 1, wherein
said light-emitting element group comprises a plurality
of light-emitting elements, at least one of said light-
5 emitting elements being operable as a busy lamp for indi-
cating that a shooter cannot shoot at the target plate.

18. A target device according to claim 17, wherein
said at least one of said light-emitting elements which
10 is operable as the busy lamp is positioned above said
target plate.

19. A target device according to claim 1, further
comprising:
15 a switch for setting a type of the target
plate which is mounted in place.

20. A target device according to claim 19, wherein
said score calculating means comprises means for changing
20 an equation for calculating the score from said impact
position, depending on the type of the target plate which
is set by said switch.

21. A target device according to claim 1, further
25 comprising:

detecting means for automatically detecting a type of the target plate which is mounted in place.

22. A target device according to claim 21, wherein
5 said score calculating means comprises means for changing an equation for calculating the score from said impact position, depending on the type of the target plate which is automatically detected by said detecting means.

10 23. A target device according to claim 21, wherein said detecting means comprises means for detecting the type of the target plate which is mounted in place by reading the resistance of a resistor embedded in the target plate which is mounted in place.

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24. A target device according to claim 21, wherein said detecting means comprises means for detecting the type of the target plate which is mounted in place by reading information stored in an IC chip embedded in the
20 target plate which is mounted in place.

25. A target device according to claim 21, wherein said detecting means comprises means for detecting the type of the target plate which is mounted in place by
25 reading magnetic information embedded in the target plate which is mounted in place.

26. A target device according to claim 21,
wherein said detecting means comprises means for detect-
ing the type of the target plate which is mounted in
5 place by reading a pattern of slits disposed in the tar-
get plate which is mounted in place.

27. A target device according to claim 1, wherein
said light-emitting element group is energizable in ener-
10 gizing patterns which are visually recognizable as a
character and/or a numeral representing said score and/or
said impact position.

28. A target device according to claim 1, further
15 comprising:

sound output means for outputting sound infor-
mation depending on a shot on said target plate and/or
said score and/or said impact position.

20 29. A target device comprising:
a target plate;
impact position detecting means for detecting
an impact position on said target plate;
score calculating means for calculating a
25 score based on the impact position detected by said im-
pact position detecting means; and

sound output means for outputting sound information depending on a shot on said target plate and/or said score and/or said impact position.

5 30. A target device according to claim 29, further comprising:

 a switch for setting a type of the target plate which is mounted in place.

10 31. A target device according to claim 29, further comprising:

 detecting means for automatically detecting a type of the target plate which is mounted in place.