

the present invention. This game machine is provided with a game main unit **10**, an operation casing **20** integrally or detachably or individually provided in front of the game main unit **10**, and a head detector **30**. A play area where a game player stands to play a game is defined before the operation casing **20**.

[0024] The game main unit **10** is a console box substantially in the form of a rectangular parallelepiped, and a monitor **11** of a specified size for displaying game images is provided substantially in the middle of the front surface of the game main unit **10**, preferably at such a height position where the game player's head is located substantially in the middle of the screen in a usual posture of the game player playing the game. Besides a CRT, an LCD, a plasma display, a liquid crystal projector and the like can be adopted as the monitor **11**. Loudspeakers **12** for presenting sound effects are provided at the top, preferably at the left and right sides of the game main unit **10**, and a panel or the like on which the name of the game, etc. is inscribed is provided therebetween. A circuit board on which controllers necessary to control the gaming operation, etc. is provided inside the game main unit **10**. A rectangular frame member **13** extending forward like eaves is provided at the top of the game main unit **10**, and supporting arms **13a** are provided between suitable positions of left and right frame pieces of the frame member **13** and the side surfaces of the operation casing **20**. A specified number of, e.g. three light sources **14** for electric decoration so as to correspond to three primary colors are provided on the front frame piece of the frame member **13** in such a manner as to face toward the game main unit **10**.

[0025] The frame member **13** functions as a supporting structure for the head detector **30**, and is adapted to locate the head detector above the play area, i.e. above the game player's head. An ultrasonic transmitter **31** for transmitting sound waves and ultrasonic waves as propagation mediums is provided in the transverse center of the front frame piece of the frame member **13**, and ultrasonic receivers **32**, **33** for receiving the ultrasonic waves as propagation mediums are transversely symmetrically provided with respect to the ultrasonic transmitter **31**. Besides ultrasonic waves, rays, particularly infrared rays may be used as the propagation mediums. Any of the ultrasonic transmitter **31** and the ultrasonic receivers **32**, **33** is formed by a piezoelectric device or the like. The ultrasonic transmitter **31** transmits an ultrasonic pulse of a specified duration at such a width of directivity as to cover the play area and in a specified cycle of, e.g.  $\frac{1}{60}$  sec. or in such a time cycle capable of following a displacement of the game player's head at a necessary resolving power. The ultrasonic receivers **32**, **33** are identically constructed and have a width of directivity sufficient to receive the ultrasonic waves transmitted from the ultrasonic transmitter **31** and reflected by the game player's head located in the play area. In the head detector **30** are provided, as shown in FIG. 2, a sensor driver **34** for supplying a drive signal (cyclical excitation pulse signal) to the ultrasonic transmitter **31**, and a position calculator **35** connected with the sensor driver **34** and the two ultrasonic receivers **32**, **33** and adapted to calculate the position of the game player's head in the space as described later. It should be noted that the sensor driver **34** and the position calculator **35** may be provided in the main game unit **10**.

[0026] The height of the operation casing **20** is set lower than the monitor **11**. A loudspeaker **21** for presenting sound

effects is provided in the middle of the upper surface slightly sloped downward to the front, i.e. in a position closer to the game player than the loudspeakers **12**, and a gun unit **22** simulating a gun as a game controller is provided in a specified position near the loudspeaker **21** via a cord **23** as a transmission line for control signals, etc. The gun unit **22** is stored in a containing box **20a** as shown when not being used, while being held by the game player when being used, i.e. during the game to shoot the enemy characters displayed on the monitor screen as described later. A start switch **24**, a coin slot **25**, and the like are provided on the front surface of the operation casing **20**. A coin switch **25a** (see FIG. 2) for detecting the presence or absence of an inserted coin is provided in an intermediate position of a coin path connected with the coin slot **25**.

[0027] FIG. 2 is a block construction diagram of the 3D video game machine. A game control unit **100**, an image control unit **110** and a sound control unit **120** are mounted on the circuit board in the main game unit **10**.

[0028] This game is, for example, a fighting game and assumes a battle of shooting between one or more gun-holding enemy characters displayed on the monitor screen and the game player. The enemy character displayed on the monitor screen is so controlled by the game control unit **100** as to shoot at a viewing point of a simulated camera, whereas the game player shoots the enemy character on the monitor **11** using the gun unit **22** while avoiding an attack from this enemy character.

[0029] The game control unit **100** is provided with, for example, a microcomputer (hereinafter, "CPU") **101** for controlling the progress of the game, and connected with a ROM **102** as a storage medium storing a game program such as a shooting battle game which is the game of this embodiment, the head detector **30** and other necessary elements. Besides the ROM, a ROM cassette, an optical disk, a flexible disk or the like may be used as the storage medium.

[0030] The image control unit **110** performs calculation of coordinates of the respective characters (enemy characters, various buildings and other object characters located in a game space) in a simulated 3D space when viewed from the viewing point of the simulated camera, a light source calculation, a calculation to transform the calculated coordinates in the simulated 3D space to those in a two-dimensional space, a processing to position polygons constituting an image to be formed in a display area of a RAM **111** and a texture mapping to the respective polygons. A position information transmitted from the head detector **30** as described later is used as an information on the viewing point of the simulated camera which is used in the calculation of the coordinates of the characters. Accordingly, the viewing point of the simulated camera substantially coincides with the eyes of the game player, and a character corresponding to the game player is not displayed on the screen of the monitor **11**.

[0031] The sound control unit **120** reads a sound data set in the game program according to the scene of the game from a sound data storage **121** and causes the read data to be outputted as sounds from either one of the loudspeakers **12**, **21**. In addition to BGMs and various presentation sounds, shooting sounds, bullet-hitting sounds, sounds the stray bullets make while flying through the air, sounds the stray bullets make upon striking against obstacles displayed in