

TRAINING ROBOT, CONTROL METHOD, AND CONTROL SYSTEM

TECHNICAL FIELD

[0001] The present disclosure relates to robot technology, and more particularly to a training robot, a control method and a control system.

BACKGROUND

[0002] Nowadays, there are some training robots of ball games in the market, such as badminton and table tennis training robots, etc. However, working methods of existing training robots are relatively single, and can only provide simple functions of servicing and giving feedback to user's hitting actions. However, traditional training mode is no longer able to meet different needs of users, and the training effect is not ideal.

SUMMARY

[0003] The present disclosure aims to provide a training robot, a control method and a control system to solve the problems in the prior art, achieve various serving and hitting modes, and provide users with a better training experience through cooperation of the serving mechanism and hitting mechanism.

[0004] The embodiment of the present disclosure provides a training robot, including: a base; a serving mechanism provided above the base, and including a ball cage, a clamping device, and a throwing device, the clamping device being configured to get a ball from the ball cage and place the ball on the throwing device, and the throwing device being configured to throw the ball out; a hitting mechanism provided above the base, and including a racket, a connecting arm, and a racket support rod, the racket being connected to the racket support rod through the connecting arm; a controller assembly configured to control the serving mechanism

and the hitting mechanism.

[0005] In some embodiments, the serving mechanism further includes a cage bracket and a cage support seat, the ball cage is detachably fixed to the cage support seat through the cage bracket, and the cage support seat is located on an upper surface of the base.

[0006] In some embodiments, the ball cage includes a plurality of ball cartridges, which are installed on a cage bracket and being rotatable relative to the cage bracket to align a ball outlet of one ball cartridge with the clamping device.

[0007] In some embodiments, the serving mechanism further includes a cage support seat and a first sensor provided on the cage support seat, the cage brackets are installed on the cage support seat, and the first sensor is configured to detect whether there is a ball in the ball cartridge aligned with the clamping device; the controller assembly is configured to obtain detection data of the first sensor and control the ball cage to rotate when there is no ball in the ball cartridge aligned with the clamping device.

[0008] In some embodiments, the throwing device includes a carrying platform and a platform support rod, and the controller assembly is configured to control the platform support rod to throw the ball in the carrying platform upwards, and control the racket of the hitting mechanism to hit the thrown ball.

[0009] In some embodiments, the serving mechanism further includes a cage support seat, the clamping device includes two clamping arms and a movable seat, and the clamping arms are rotatably fixed to the cage support seat through the movable seat.

[0010] In some embodiments, the serving mechanism is located in front of the hitting mechanism, the clamping device is located in front of the ball cage, the throwing device is arranged in front of the clamping device, a lower end of the ball cage tilts forward relative to an upper end of the ball cage, and a ball outlet on the lower end of the ball cage is aligned with the clamping device.

[0011] In some embodiments, the connecting arm is a flexible arm, the racket is connected to the flexible arm through a racket connecting portion, and the racket is detachably connected to the racket connecting portion; the flexible arm is fixed to the racket support seat sequentially through a flexible arm connecting portion and the racket support rod, and the racket support seat is located on an upper surface of the base.

[0012] In some embodiments, at least two first drive ropes extending in a length direction of the flexible arm are provided in the flexible arm, and the flexible arm connecting portion is provided with pulleys in one-to-one correspondence to the first drive ropes; the first drive ropes are wound around the pulleys, and one end of the first drive rope is connected to an upper portion of the flexible arm, the other end of the first drive rope passes through the racket support rod and is connected to the racket support seat, the racket support seat is provided with a rope drive motor, and the controller assembly is configured to control the rope drive motor to move the first drive ropes, thereby adjusting a posture of the flexible arm; the flexible arm is provided with a universal joint device, the universal joint device includes at least one connecting rod and two universal joint bases, the two universal joint bases are arranged at two ends of the flexible arm, respectively, two ends of the connecting rod are rotatably connected with the two universal joint bases, respectively, the first drive ropes are connected with the two universal joint bases, and when driving the first drive ropes to move, a relative position relationship between the two universal joint bases is adjusted to make the flexible arm tilt to one side of and/or rotate relative to the flexible arm connecting portion; the universal joint device further includes a second drive rope, two universal bearings and a transmission shaft, two ends of the transmission shaft are connected to the two universal joint bases through the universal bearings, respectively, and one end of the transmission shaft is connected with the racket connecting portion, the second drive rope is configured to drive the transmission shaft to rotate, so that the racket connecting portion drives the racket to rotate relative to the flexible arm.

[0013] In some embodiments, a camera is further provided above the base, and the camera is configured to communicate with the controller assembly to transmit collected images to the controller assembly; and/or, a second sensor is further provided on a side of or above the base, and the second sensor is configured to detect a position of a ball and communicate with the controller assembly to transmit detection data to the controller assembly.

[0014] In some embodiments, a bottom of the base is provided with a moving mechanism, and the controller assembly is further configured to control movement of the moving mechanism to move the training robot to a designated position.

[0015] The present disclosure further provides a control method of the training robot, wherein the method includes the following steps:

[0016] determining whether a current mode is a hitting mode or a serving mode;

[0017] if the current mode is the hitting mode, obtaining user's motion data and trajectory of a ball, analyzing to obtain a hitting strategy of the hitting mechanism, and controlling the hitting mechanism to hit the ball based on the hitting strategy, the hitting strategy including racket hitting posture, racket hitting speed, and landing point range of the ball;

[0018] if the current mode is the serving mode, controlling the clamping device of the serving mechanism to get a ball from the ball cage and place the ball on the throwing device, controlling the throwing device to throw the ball upwards, and controlling the hitting mechanism to hit the thrown ball.

[0019] In some embodiments, the step of controlling the clamping device of the serving mechanism to get a ball from the ball cage and place the ball on the throwing device, controlling the throwing device to throw the ball upwards, and controlling the hitting mechanism to hit the thrown ball includes the following steps:

[0020] obtaining user's motion data;

[0021] obtaining a training level of the user and determining a serving strategy based on

the user's motion data and the training level, the serving strategy including serving frequency, serving position range, landing point range, and serving speed;

[0022] controlling the clamping device of the serving mechanism according to the serving frequency to take out the ball from the ball cage and place the ball on the throwing device, and controlling the throwing device to throw the ball upwards;

[0023] controlling the hitting mechanism to hit the thrown ball based on the serving position range and the serving speed.

[0024] The present disclosure further provides a control method applied to the control method of the training robot, wherein the system includes:

[0025] a central controller, wherein when the current mode is the hitting mode, the central controller is configured to obtain the user's motion data and the trajectory of the ball, analyze to obtain the hitting strategy of the hitting mechanism, and send a hitting command including the hitting strategy to the hitting mechanism, when the current mode is the serving mode, the central controller is configured to send a serving command to the serving mechanism in the serving mode, and send a hitting command to the hitting mechanism;

[0026] a hitting controller configured to control the hitting mechanism to hit the ball based on an obtained hitting command;

[0027] a serving controller configured to control the clamping device of the serving mechanism to get the ball from the ball cage and place the ball on the throwing device based on an obtained serving command, and control the throwing device to throw the ball upwards.

[0028] The training robot, the control method, and the control system provided by the present disclosure have the following advantages:

[0029] The present disclosure provides a training robot, wherein the hitting mechanism can hit the balls in different postures and at different speeds, thereby achieving more kinds of hitting modes. The serving mechanism can serve the ball rapidly and continuously at variable

speeds through cooperation of the ball cage, the clamping device, and the throwing device. When the serving mechanism and hitting mechanism are cooperated in the serving mechanism, the ball is thrown up by the throwing device, then can be hit by the hitting mechanism in different postures and at different speeds, achieving more kinds of serving modes. Therefore, the present disclosure can meet user's different training needs, and provide the users with a better training experience.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

[0031] FIG. 1 is a structural schematic view of a training robot according to an embodiment of the present disclosure;

[0032] FIG. 2 is a structural schematic view of a serving mechanism according to the embodiment of the present disclosure;

[0033] FIG. 3 is a structural schematic view of the training robot while hitting a ball according to the embodiment of the present disclosure;

[0034] FIG. 4 is a structural schematic view of a hitting mechanism according to the embodiment of the present disclosure;

[0035] FIG. 5 is a schematic view of an internal structure of the hitting mechanism according to the embodiment of the present disclosure;

[0036] FIG. 6 is a structural schematic view of the hitting mechanism while hitting a ball according to the embodiment of the present disclosure;

[0037] FIG. 7 is a schematic view of replacing a racket according to the embodiment of the present disclosure;

[0038] FIG. 8 is a schematic view of the training robot being applied in a training ground according to the embodiment of the present disclosure;

[0039] FIG. 9 is a flowchart of a control method of a training robot according to an embodiment of the present disclosure.

[0040] Reference signs:

1	base	42	racket connecting portion
2	controller assembly	43	flexible arm
21	central controller	44	first drive rope
22	hitting controller	451	pulley
23	serving	452	rope drive motor
3	serving mechanism	46	universal joint device
31	ball cage	461	connecting rod
32	cage bracket	462	transmission shaft
33	clamping device	463	universal joint base
331	clamping arm	464	second drive rope
332	movable seat	465	universal bearing
34	throwing device	466	gear mechanism
341	carrying platform	47	flexible arm connecting portion
342	platform support rod	48	racket support rod
35	first sensor	49	racket support seat
36	cage support seat	51	camera
4	hitting mechanism	52	second sensor
41	racket	53	signal light
411	racket surface	6	roller
412	racket rod	91、92	shuttlecock
413	snap		

DETAILED DESCRIPTION

[0041] In the following, embodiments of the present disclosure will be described in detail with reference to the figures. The concept of the present disclosure can be implemented in a plurality of forms, and should not be understood to be limited to the embodiments described hereafter. In the contrary, these embodiments are provided to make the present disclosure more

comprehensive and understandable, and so the conception of the embodiments can be conveyed to those skilled in the art fully. Same reference signs in the figures refer to same or similar elements, so repeated descriptions of them will be omitted.

[0042] As shown in FIGS. 1 to 8, an embodiment of the present disclosure provides a training robot including: a base 1; a serving mechanism 3 provided above the base 1, the serving mechanism 3 including a ball cage 31, a clamping device 33, and a throwing device 34, the clamping device 33 being configured to get a ball from the ball cage 31 and place the ball on the throwing device 34, and the throwing device 34 being configured to throw the ball out; a hitting mechanism 4 provided above the base 1, the hitting mechanism 4 including a racket 41, a connecting arm 43, and a racket support rod 48, and the racket 41 being connected to the racket support rod 48 through the connecting arm 43; a controller assembly 2 configured to control the serving mechanism 3 and the hitting mechanism 4. In the embodiment, the connecting arm 43 is a flexible arm. In other alternative embodiments, the connecting arm 43 can also be a rigid and non-bendable connecting arm, all of which fall within the protection scope of the present disclosure.

[0043] In the embodiment, the hitting mechanism 4 is provided with a flexible arm 43. Under the control of the controller assembly 2, the flexible arm 43 of the hitting mechanism 4 can drive the racket 41 to hit the ball in different postures and at different speeds, thereby achieving more kinds of hitting modes. FIGS. 1 and 3 show the structure of the flexible arm 43 of the hitting mechanism 4 in two different postures, respectively. FIG. 1 shows an initial state of the flexible arm 43, and FIG. 3 shows a state of the flexible arm 43 when a shuttlecock 92 reaches a working height of the hitting mechanism 4 and the racket 41 is controlled to hit the ball.

[0044] The serving mechanism 3 can serve the ball rapidly and continuously at variable speeds through cooperation of the ball cage 31, the clamping device 33, and the throwing

device 34. Specifically, during a serving mode controlled by the controller assembly 2, firstly, the clamping device 33 gets a ball from the ball cage 31 and places the ball on the throwing device 34, the throwing device 34 throws the ball upwards, and then the controller assembly 2 controls the racket 41 of the hitting mechanism 4 to hit the thrown ball. The flexible arm 43 of the hitting mechanism 4 can also hit the thrown ball in different postures and at different speeds in the serving mode. Therefore, the present disclosure can achieve more kinds of serving modes through cooperation of the serving mechanism 3 and the hitting mechanism 4, thereby meeting different training needs of users.

[0045] In FIGS. 1 to 8, a badminton training robot is shown as an example. It can be understood that the present disclosure is not limited to the badminton training robot. In other alternative embodiments, the training robot can also be applied to other kinds of ball games, such as table tennis, tennis, volleyball, etc., all of which fall within the protection scope of the present disclosure.

[0046] As shown in FIG. 1, in the embodiment, the controller assembly 2 includes a central controller 21 located in the base 1, a hitting controller 22 located below the hitting mechanism 4, and a serving controller 23 located below the serving mechanism 3. The hitting controller 22 and the serving controller 23 are connected to the central controller 21. The central controller 21 is configured to send hitting commands and serving commands to the hitting controller 22 and the serving controller 23, respectively. The hitting controller 22 is configured to control the hitting mechanism to perform hitting actions based on the hitting commands, and the serving controller 23 is configured to control the serving mechanism to place the ball on the throwing device 34 and throw the ball upwards based on the serving commands.

[0047] As shown in FIG. 2, the serving mechanism 3 further includes a cage bracket 32 and a cage support seat 36. The ball cage 31 is detachably fixed to the cage support seat 36 through the cage bracket 32, and the cage support seat 36 is located on an upper surface of the

base 1. The serving controller 23 can be located inside the cage support seat 35 to control the components of the serving mechanism 3. The way of the ball cage 31 being detachably fixed to the cage support seat 36 through the cage bracket 32 can be the ball cage 32 being detachably connected to the cage bracket 32 or the cage bracket 32 being detachably connected to the cage support seat 36. In other alternative embodiments, the ball cage 31 can also be non-detachably fixed to the cage support seat 36 through the cage bracket 32. In the embodiment, the ball cage 31 includes a plurality of ball cartridges, which are installed on the cage bracket 32 and can rotate relative to the cage bracket 32 to align a ball outlet of one ball cartridge with the clamping device 33. In FIG. 2, a structure containing a shuttlecock 91 in a ball cartridge is shown as an example. In practical applications, one or more shuttlecocks 91 can be placed in each ball cartridge. Moreover, as the ball cartridge is in a strip shape, each ball cartridge is capable of accommodating a plurality of shuttlecocks 91. In the serving mode, when the shuttlecocks 91 in the ball cartridge currently aligned with the clamping device 33 are all removed, the serving controller 23 controls the cage bracket 32 to rotate the ball cage 31, thereby aligning another ball cartridge with the clamping device 33, and further ensuring the balls can be served rapidly and continuously.

[0048] As shown in FIG. 2, the serving mechanism 3 further includes a first sensor 35 provided on the cage support seat 36. The first sensor 35 is configured to detect whether there is a ball in the ball cartridge aligned with the clamping device 33. The first sensor 35 can use sensors such as radar or camera to detect whether the ball cartridge is empty. The controller assembly 2 is configured to obtain the detection data of the first sensor 35, and generate a cage rotation command when determining that there is no ball in the ball cartridge aligned with the clamping device 33. The cage rotation command is used for controlling the ball cage 31 to rotate at a certain angle, so that another ball cartridge with balls rotates to a position aligned with the clamping device 33. Therefore, through the automatic detection of the first sensor 35,

the controller assembly 2 can automatically rotate the ball cartridge with balls to be aligned with the clamping device 33, without a need of manual operation. The robot can be used more conveniently, and a more continuous and uninterrupted serving process can be achieved. The actions of obtaining the detection data of the first sensor 35 and generating the cage rotation command can be performed by the serving controller 23 or the central controller 21.

[0049] In the embodiment, the rotation of the ball cage 31 can be achieved through the cage bracket 32. The cage bracket 32 includes a central shaft and a cage installation portion, and a cage rotation motor is configured to execute the cage rotation command. The cage installation portion can rotate around the central shaft driven by the cage rotation motor, and the ball cartridges are installed on the cage installation portion. The cage rotation motor can be controlled by the controller assembly 2.

[0050] As shown in FIGS. 1 and 2, the serving mechanism 3 is arranged in front of the hitting mechanism 4, the clamping device 33 is arranged in front of the ball cage 31, the throwing device 34 is arranged in front of the clamping device 33, a lower end of the ball cage 31 tilts forward relative to an upper end of the ball cage 31, and a ball outlet on the lower end of the ball cage 31 is aligned with the clamping device 33. The shuttlecock 91 is accommodated in the ball cartridge of the ball cage 31 with the head thereof facing downwards, so the clamping device 33 can take out the ball conveniently. The position and structural cooperation of the serving mechanism 3 and the hitting mechanism 4 shown in FIG. 1 can realize a more compact structure of the training robot, and facilitate the serving mechanism 3 and the hitting mechanism 4 to cooperate to complete the serving action.

[0051] As shown in FIG. 2, in the embodiment, the throwing device 34 includes a carrying platform 341 and a platform support rod 342 arranged on two sides of the carrying platform 341. The controller assembly 2 is configured to control the platform support rod 342 to throw the ball in the carrying platform 341 outward and upwards at a certain angle, and

control the racket 41 of the hitting mechanism 4 to hit the thrown ball to complete the serving action. For throwing the ball, one end of the platform support rod 342 is rotatably connected to the racket support seat 49, and the other end is connected to the carrying platform 341. A platform rotation motor drives one end of the platform support rod 342 to rotate when obtaining a throwing command from the controller assembly 2, driving the carrying platform 341 to move, to throw the ball in the carrying platform 341 upwards. The carrying platform 341 is preferably an elastic platform, which can throw the ball out more conveniently, but the present disclosure is not limited to this. The throwing command can be generated by the central controller 21 or the serving controller 23.

[0052] As shown in FIG. 2, the clamping device 33 includes two clamping arms 331 and a movable seat 332. The clamping arms 331 are rotatably fixed to the cage support seat 36 through the movable seat 332. For example, one end of the clamping arm 331 is a clamping end for clamping the shuttlecock 91, and the other end of the clamping arm 331 is connected to the cage support seat 36 through a rotating shaft. The controller assembly 2 controls a clamping arm rotation drive motor to rotate the rotating shaft, causing the clamping arms 331 to rotate relative to the cage support seat 36. A clamping drive motor between the two clamping arms 331 can drive the clamping arms to clamp or release the shuttlecocks, by adjusting a distance between the clamping ends of the two clamping arms 331. When the shuttlecock 91 needs to be clamped, the distance between the clamping ends of the two clamping arms 331 can be reduced to prevent the shuttlecock 91 from accidentally falling. When the shuttlecock 91 needs to be released, the distance between the clamping ends of the two clamping arms 331 can be increased to release the shuttlecock 91.

[0053] As shown in FIG. 1, in the embodiment, a camera 51 is further provided above the base 1. The camera 51 communicates with the controller assembly 2 to transmit collected images to the controller assembly 2. The controller assembly 2 can firstly obtain user's motion

data and a trajectory of a ball through the camera 51 before generating the hitting command, determine a corresponding hitting strategy, and then control the hitting mechanism to hit the ball. The controller assembly can firstly obtain the user's motion data through the camera 51 before generating a serving command, determine serving position range and serving speeds, and then control the serving mechanism and the hitting mechanism to serve the ball. In another alternative embodiment, the camera 51 can also be set at other positions of the training robot, such as on a side surface of the training robot. In another alternative embodiment, the training robot may not be provided with any camera, but an external camera is provided in a training ground. The controller assembly 2 can use a communication module to communicate with the external camera to obtain images captured by the external camera. The communication module can be a wireless communication module (such as WIFI module, Bluetooth module, 4G module, etc.) or a wired communication module.

[0054] As shown in FIG. 1, in the embodiment, a second sensor 52 is further provided on a side of or above the base 1. The second sensor 52 is configured to detect a position of a coming ball hit by a user. The second sensor 52 communicates with the controller assembly 2 to transmit detection data to the controller assembly 2. The controller assembly 2 is configured to determine when to perform a hitting action based on the position of the coming ball. The second sensor 52 can be a sensor such as a radar, camera, etc.

[0055] As shown in FIG. 1, in the embodiment, a signal light 53 is provided on the base 1, which can be used to indicate the training robot's working status or power status. For example, a red light indicates low battery power, and a green light indicates sufficient battery power. The signal light 53 can also be provided at other positions of the training robot, such as on a side of the base 1, the hitting mechanism, or the serving mechanism. The training robot can be provided with a rechargeable battery in the base 1 to supply power to various mechanisms and components of the training robot. In other alternative embodiments, the training robot can also

use an external power supply instead of a built-in power supply, which also falls within the protection scope of the present disclosure.

[0056] As shown in FIG. 1, in the embodiment, a bottom of the base 1 is further provided with a moving mechanism, and the controller assembly 2 is further configured to control the movement of the moving mechanism to move the training robot to a designated position. In the embodiment, the moving mechanism includes rollers 6, but the present disclosure is not limited to this. In other embodiments, the moving mechanism can also use other types of mechanisms, such as tracks, all of which fall within the protection scope of the present disclosure. The controller assembly 2 can acquire the user's motion data from the images captured by the camera 51 or an external camera, thereby controlling the movement of the moving mechanism and making the training robot move to a position convenient for practicing with the user.

[0057] FIGS. 4-7 are schematic views of the hitting mechanism of the training robot according to the embodiment. In the embodiment, the racket 41 is connected to the flexible arm 43 through the racket connecting portion 42, and the racket 41 can be detachably connected to the racket connecting portion 42, facilitating the replacement of the racket 41 and achieving the reuse of the hitting mechanism. As shown in FIG. 7, the racket 41 includes a racket surface 411 and a racket rod 412, and a snap 413 is provided below the racket rod 412. The snap 413 is inserted into the racket connecting portion 42 and is connected to the racket connecting portion 42. In other alternative embodiments, the racket 41 can also be connected with the racket connecting portion 42 through other structures, for example, the racket 41 can also be externally hung on top of the flexible arm 43, which falls into the protection scope of the invention.

[0058] As shown in FIG. 4, the flexible arm 43 is fixed to the racket support seat 49 sequentially through a flexible arm connecting portion 47 and the racket support rod 48, and the racket support seat 49 is located on the upper surface of the base 1.

[0059] FIGS. 5 and 6 show the internal structure of the hitting mechanism in two different states, respectively. At least two first drive ropes 44 extending in a length direction of the flexible arm 43 are provided in the flexible arm 43. The first drive ropes 44 are connected to an upper part of the flexible arm 43 and a flexible arm connecting portion 47. The controller assembly 2 adjusts the posture of the flexible arm 43 by adjusting a length of a portion of the first drive rope 44 between two ends of the flexible arm 43. The first drive ropes 44 can be arranged on two sides of the flexible arm 43 to achieve a two-dimensional left and right swing of the flexible arm 43. The number of the first drive rope 44 can also be more than two, located at different positions in the flexible arm 43, and capable of pulling the flexible arm 43 to achieve more inclined angles of the flexible arm 43.

[0060] As shown in FIG. 5, the flexible arm connecting portion 47 is provided with pulleys 451 in one-to-one correspondence to the first drive ropes 44. The first drive ropes 44 are wound around the corresponding pulleys 451, and one end of each first drive rope 44 is connected above the flexible arm 43. The other end of the first drive rope 44 passes through the racket support rod 48 and is connected to the racket support seat 49. The racket support seat 49 is provided with a rope drive motor 452, the controller assembly 2 controls the rope drive motor 452 to move the first drive rope 44, thereby adjusting the length of the portion of the first drive rope 44 between the two ends of the flexible arm 43. The rope drive motor 452 can further be connected to the first drive rope 44 through a reducer mechanism, which includes at least two gears, and the first drive ropes 44 can be tightened or loosened by adjusting the rope drive motor 452 and the reduction mechanism.

[0061] As shown in FIGS. 5 and 6, the flexible arm 43 is further provided with a universal joint device 46, which includes three connecting rods 461 and two universal joint bases 463. The two universal joint bases 463 are installed at two ends of the flexible arm 43, respectively. The two ends of the connecting rod 461 are rotatably connected to the two universal joint bases

463, and the first drive ropes 44 are connected to the two universal joint bases 463. The rope drive motor 452 drives the first drive ropes 44 to move, adjusting a relative position relationship between the two universal joint bases 463, so that the flexible arm 43 can tilt to one side, achieving two-dimensional tilting and swinging. In the embodiment, the connecting rods 461 form a three-link parallel structure, but the present disclosure is not limited to this. The number and arrangement of the connecting rods 461 can be adjusted according to various needs. Through the universal joint device 46, the flexible arm 43 can be adjusted to tilt forward or backward, or tilt left and right, or tilt in other directions. Thus, the universal joint device 46 can adjust the flexible arm 43 to tilt toward one side, and the universal joint device 46 can flexibly adjust the incline angle of the flexible arm 43, drive the movement of different drive ropes by controlling the driving mode of the rope driving motor 452, and also realize a three-dimensional rotation of the flexible arm 43 relative to the flexible arm connecting portion 47. The rope in the embodiment can use steel wire rope or other types of ropes with higher strength. The housing of the flexible arm 43 is preferably made of materials with a certain flexibility, such as silicone, rubber, plastic with a certain flexibility, etc.

[0062] As shown in FIGS. 5 and 6, the universal joint device 46 further includes two universal bearings 465, a transmission shaft 462 and a second drive rope 464, the second drive rope 464 is configured to drive the transmission shaft 462 of the universal joint device 46. Two ends of the transmission shaft 462 are rotatably connected to the universal joint bases 463 through the universal bearings 465, and one end of the transmission shaft 462 is connected to the racket connecting portion 42. The second drive rope 464 is connected to the transmission shaft 462 through a gear mechanism 466, and the second drive rope 464 is connected to the rope drive motor 452 in the racket support seat 49. The controller assembly 2 controls the movement of the second drive rope 464 through the rope drive motor 452, and the gear mechanism 466 converts the motion of the second drive rope 464 into the rotational motion of

the transmission shaft 462. The second drive rope 464 can drive the transmission shaft 462 to rotate, thereby driving the ball racket to rotate through the racket connecting portion 42. The second drive rope 464 and the first drive ropes 44 can adjust the three-dimensional posture of the ball racket. The rope drive motor 452 can be connected to a reducer mechanism, which includes at least two gears, and the second drive rope 464 can be tightened or loosened by adjusting the rope drive motor 452 and the reducer mechanism.

[0063] FIG. 8 is a schematic view of setting the training robot of the present disclosure in a badminton training ground J100. The training robot J400 is arranged on a side of the ground J100, and the user J300 stands on the other side of the ground J100. When a user J300 hits a shuttlecock J500, the training robot J400 can respond in time. In the serving mode, the training robot J400 can also serve balls based on a position of the user J300. A camera J200 and a radar J600 can also be arranged around the ground J100 to collect the user's motion data and a trajectory of a ball. The controller assembly of the training robot J400 can obtain collected data of the camera J200 and the radar J600, and analyze the collected data to obtain serving strategy and hitting strategy. In the case that the training robot J400 has a moving mechanism, it can also move freely in the ground J100 as needed.

[0064] As shown in FIG. 9, an embodiment of the present disclosure further provides a control method of the training robot. The method includes the following steps:

[0065] S100: determining whether a current mode is a hitting mode or a serving mode.

[0066] If the current mode is the hitting mode, S200: obtaining the user's motion data and trajectory of a ball, analyzing to generate a hitting strategy of the hitting mechanism, and S300: controlling the hitting mechanism to hit the ball based on the hitting strategy. Wherein, the user's motion data includes data such as user's motion speed, moving direction, swing height, hitting speed, hitting posture, etc. The trajectory of the ball includes three-dimensional coordinates of the ball at various times.

[0067] If the current mode is the serving mode, S400: controlling the clamping device of the serving mechanism to get a ball from the ball cage and place the ball on the throwing device, S500: controlling the throwing device to throw the ball upwards, and S600: controlling the hitting mechanism to hit the thrown ball.

[0068] In the embodiment, the steps of S400 to S600: controlling the clamping device of the serving mechanism to get the ball from the ball cage and place the ball on the throwing device, controlling the throwing device to throw the ball upwards, and controlling the hitting mechanism to hit the thrown ball, including the following steps.

[0069] Obtaining the user's motion data.

[0070] Obtaining the user's training level and generating the serving strategy based on the user's motion data and the training level. The serving strategy includes serving frequency, serving position range, landing point range, and serving speed. The serving position range here refers to the position range of the ball when it was thrown out, and the landing point range refers to the position range of the ball when it lands on the opponent's ground.

[0071] Controlling the clamping device of the serving mechanism according to the serving frequency to get a ball from the ball cage and place the ball on the throwing device, and controlling the throwing device to throw the ball upwards.

[0072] Controlling the hitting mechanism to hit the thrown ball based on the serving position range and the serving speed.

[0073] Therefore, the present disclosure can generate different serving strategies based on the user's motion data and the user's training level, thereby better adapting to the training levels of different users. The serving strategy can be executed by controlling the speed of the clamping device to adapt to the serving frequency, and by controlling the hitting speed, posture, and force of the thrown ball of the hitting mechanism to adapt to the serving position range and the serving speed. Therefore, the serving strategy includes not only the control strategy of the

hitting speed of the ball racket, but also the control strategy of the ball clamping speed of the clamping device. For example, for users with a high training level, the serving range may be wider and the serving speed may be faster, while for users with a low training level, the serving range may be smaller and the serving speed may be slower.

[0074] The present disclosure can be applied to a continuous serving training of one user, as well as to a continuous serving training of a plurality of users. When a user arrives at a designated position and determines the presence of the user based on the captured image of the camera, the user's training level can be obtained (for example, determining the identity of the user with facial recognition and then obtaining the user's preset training level, or obtaining the user's voice input training level or other user's manual input training level). Based on the user's training level, a serving strategy can be quickly generated to start serving. When the user changes, the serving strategy can be adjusted based on the new user's training level and motion data to continue serving.

[0075] The user referred to in the present disclosure refers to the trainee, namely the sportsman who needs to train with the training robot, which can be an amateur, a professional athlete, and so on. The control method of the training robot can be implemented by the controller assembly of the training robot, and the controller assembly performs the steps S100 to S600 mentioned above.

[0076] In another alternative implementation, the control method of the training robot can also be implemented by a cloud server and the controller assembly of the training robot. For example, the controller assembly of the training robot performs step S100 to determine whether a current mode is a hitting mode or a serving mode. Here the step of determining whether the current mode is the hitting mode or the serving mode can be performed by determining whether the current training mode is set to be the hitting mode or the serving mode, or determining which mode the user chooses. If the current mode is the hitting mode, the

controller assembly performs step S200 to obtain the user's motion data and the trajectory of the ball, and then send the user's motion data and the trajectory of the ball, as well as the current position of the training robot, to the cloud server. The cloud server analyzes and generates the hitting strategy of the hitting mechanism, and sends the hitting strategy to the controller assembly. Then, the controller assembly performs step S300 to control the hitting mechanism to hit the ball according to the hitting strategy. If the current mode is a serving mode, the controller assembly obtains the user's motion data and training level, and sends the user's motion data, training level, and current position of the training robot to the cloud server. The cloud server analyzes and obtains the serving strategy of the hitting mechanism. The serving strategy includes serving frequency, serving position range, landing point range, and serving speed. Then the cloud server sends the serving strategy to the controller assembly. The controller assembly controls the hitting mechanism to hit the thrown ball based on the serving strategy.

[0077] Furthermore, in step S200, when analyzing to generate the hitting strategy of the hitting mechanism, the step S200 further includes obtaining the user's training level, selecting the hitting strategy based on the user's motion data, the trajectory of the ball, and the training level. By selecting different hitting strategies based on different training levels, different training needs of the users can be met.

[0078] The training level can be evaluated based on user's data, for example, the user's data includes user's identity data and user's training data. The user's identity data includes, for example, the user's age, gender, height and weight, and the user's experience in the ball game. The user's training data includes, for example, data related to the training process, such as the user's response speed, success rate, hitting speed, single training duration, etc. The training level can be obtained after inputting the user's data into a rating model of the training level. In addition, the training level can also be a level that the user chooses to challenge.

[0079] Furthermore, in the control method of the training robot, after collecting the user's motion data, it is possible to analyze the user's motion data and determine a standardization level of user's action. Here, determining a standardization level of user's action includes determining whether the user's action is accurate, whether the user's action meets action specification requirements, and so on. In practical applications, for example, positions of the user's key points can be detected based on captured images of the camera or radar detection data to determine the user's posture when hitting a ball, and the user's posture is compared with standard normative actions.

[0080] For users who do not meet preset action specification requirements, correction information can be generated and sent to the user. The correction information can be sent to the user's mobile terminal. In another embodiment, a display screen can be provided in the badminton training ground to display the correction information for the user's reference.

[0081] An embodiment of the present disclosure also provides a control system applied to the control method of the training robot, wherein the system includes:

[0082] a central controller, wherein when the current mode is the hitting mode, the central controller is configured to obtain the user's motion data and the trajectory of the ball, analyze to obtain the hitting strategy of the hitting mechanism, and send a hitting command comprising the hitting strategy to the hitting mechanism, when the current mode is the serving mode, the central controller is configured to send a serving command to the serving mechanism in the serving mode, and send the hitting command to the hitting mechanism;

[0083] a hitting controller configured to control the hitting mechanism to hit the ball based on an obtained hitting command;

[0084] a serving controller configured to control the clamping device of the serving mechanism to get the ball from the ball cage and place the ball on the throwing device based on an obtained serving command, and control the throwing device to throw the ball upwards.

[0085] In the control system of the training robot, the various functions of the central controller, the hitting controller, and the serving controller can be achieved using the specific steps of the control method of the training robot, which will not be repeated here.

[0086] The training robot, the control method, and the control system provided by the present disclosure have the following advantages.

[0087] The present disclosure provides a training robot, wherein the hitting mechanism can hit the balls in different postures and at different speeds, thereby achieving more kinds of hitting modes. The serving mechanism can serve the ball rapidly and continuously at variable speeds through cooperation of the ball cage, the clamping device, and the throwing device. When the serving mechanism and hitting mechanism are cooperated in the serving mechanism, the ball is thrown up by the throwing device, then can be hit by the hitting mechanism in different postures and at different speeds, achieving more kinds of serving modes. Therefore, the present disclosure can meet user's different training needs, and provide the users with a better training experience.

[0088] The above is a detailed description of the present disclosure in connection with the specific preferred embodiments, and the specific embodiments of the present disclosure are not limited to the description. Modifications and substitutions can be made without departing from the spirit and scope of the present disclosure.

WHAT IS CLAIMED IS:

1. A training robot comprising:

a base;

a serving mechanism provided above the base, and comprising a ball cage, a clamping device, and a throwing device, the clamping device being configured to get a ball from the ball cage and place the ball on the throwing device, and the throwing device being configured to throw the ball out;

a hitting mechanism provided above the base, and comprising a racket, a connecting arm, and a racket support rod, the racket being connected to the racket support rod through the connecting arm;

a controller assembly configured to control the serving mechanism and the hitting mechanism.

2. The training robot according to claim 1, wherein the serving mechanism further comprises a cage bracket and a cage support seat, the ball cage is detachably fixed to the cage support seat through the cage bracket, and the cage support seat is located on an upper surface of the base.

3. The training robot according to claim 1, wherein the ball cage comprises a plurality of ball cartridges, which are installed on a cage bracket and being rotatable relative to the cage bracket to align a ball outlet of one ball cartridge with the clamping device.

4. The training robot according to claim 3, wherein the serving mechanism further comprises a cage support seat and a first sensor provided on the cage support seat, the cage brackets are installed on the cage support seat, and the first sensor is configured to detect

whether there is a ball in the ball cartridge aligned with the clamping device;

the controller assembly is configured to obtain detection data of the first sensor and control the ball cage to rotate when there is no ball in the ball cartridge aligned with the clamping device.

5. The training robot according to claim 1, wherein the throwing device comprises a carrying platform and a platform support rod, and the controller assembly is configured to control the platform support rod to throw the ball in the carrying platform upwards, and control the racket of the hitting mechanism to hit the thrown ball.

6. The training robot according to claim 1, wherein the serving mechanism further comprises a cage support seat, the clamping device comprises two clamping arms and a movable seat, and the clamping arms are rotatably fixed to the cage support seat through the movable seat.

7. The training robot according to claim 1, wherein the serving mechanism is located in front of the hitting mechanism, the clamping device is located in front of the ball cage, the throwing device is arranged in front of the clamping device, a lower end of the ball cage tilts forward relative to an upper end of the ball cage, and a ball outlet on the lower end of the ball cage is aligned with the clamping device.

8. The training robot according to claim 1, wherein the connecting arm is a flexible arm, the racket is connected to the flexible arm through a racket connecting portion, and the racket is detachably connected to the racket connecting portion;

the flexible arm is fixed to the racket support seat sequentially through a flexible arm

connecting portion and the racket support rod, and the racket support seat is located on an upper surface of the base.

9. The training robot according to claim 8, wherein at least two first drive ropes extending in a length direction of the flexible arm are provided in the flexible arm, and the flexible arm connecting portion is provided with pulleys in one-to-one correspondence to the first drive ropes;

the first drive ropes are wound around the pulleys, and one end of the first drive rope is connected to an upper portion of the flexible arm, the other end of the first drive rope passes through the racket support rod and is connected to the racket support seat, the racket support seat is provided with a rope drive motor, and the controller assembly is configured to control the rope drive motor to move the first drive ropes, thereby adjusting a posture of the flexible arm;

the flexible arm is provided with a universal joint device, the universal joint device comprises at least one connecting rod and two universal joint bases, the two universal joint bases are arranged at two ends of the flexible arm, respectively, two ends of the connecting rod are rotatably connected with the two universal joint bases, respectively, the first drive ropes are connected with the two universal joint bases, and when driving the first drive ropes to move, a relative position relationship between the two universal joint bases is adjusted to make the flexible arm tilt to one side of and/or rotate relative to the flexible arm connecting portion;

the universal joint device further comprises a second drive rope, two universal bearings and a transmission shaft, two ends of the transmission shaft are connected to the two universal joint bases through the universal bearings, respectively, and one end of the transmission shaft is connected with the racket connecting portion, the second drive rope is configured to drive the transmission shaft to rotate, so that the racket connecting portion drives the racket to rotate

relative to the flexible arm.

10. The training robot according to claim 1, wherein a camera is further provided above the base, and the camera is configured to communicate with the controller assembly to transmit collected images to the controller assembly; and/or

a second sensor is further provided on a side of or above the base, and the second sensor is configured to detect a position of a ball and communicate with the controller assembly to transmit detection data to the controller assembly.

11. The training robot according to claim 1, wherein a bottom of the base is provided with a moving mechanism, and the controller assembly is further configured to control movement of the moving mechanism to move the training robot to a designated position.

12. A control method of the training robot according to any one of claims 1 to 11, wherein the method comprises the following steps:

determining whether a current mode is a hitting mode or a serving mode;

if the current mode is the hitting mode, obtaining user's motion data and trajectory of a ball, analyzing to obtain a hitting strategy of the hitting mechanism, and controlling the hitting mechanism to hit the ball based on the hitting strategy, the hitting strategy comprising racket hitting posture, racket hitting speed, and landing point range of the ball;

if the current mode is the serving mode, controlling the clamping device of the serving mechanism to get a ball from the ball cage and place the ball on the throwing device, controlling the throwing device to throw the ball upwards, and controlling the hitting mechanism to hit the thrown ball.

13. The control method of the training robot according to claim 12, wherein the step of controlling the clamping device of the serving mechanism to get a ball from the ball cage and place the ball on the throwing device, controlling the throwing device to throw the ball upwards, and controlling the hitting mechanism to hit the thrown ball comprises the following steps:

obtaining user's motion data;

obtaining a training level of the user and determining a serving strategy based on the user's motion data and the training level, the serving strategy comprising serving frequency, serving position range, landing point range, and serving speed;

controlling the clamping device of the serving mechanism according to the serving frequency to take out the ball from the ball cage and place the ball on the throwing device, and controlling the throwing device to throw the ball upwards;

controlling the hitting mechanism to hit the thrown ball based on the serving position range and the serving speed.

14. A control system applied to the control method of the training robot according to claims 12 or 13, wherein the system comprises:

a central controller, wherein when the current mode is the hitting mode, the central controller is configured to obtain the user's motion data and the trajectory of the ball, analyze to obtain the hitting strategy of the hitting mechanism, and send a hitting command comprising the hitting strategy to the hitting mechanism, when the current mode is the serving mode, the central controller is configured to send a serving command to the serving mechanism in the serving mode, and send a hitting command to the hitting mechanism;

a hitting controller configured to control the hitting mechanism to hit the ball based on an obtained hitting command;

a serving controller configured to control the clamping device of the serving mechanism

to get the ball from the ball cage and place the ball on the throwing device based on an obtained serving command, and control the throwing device to throw the ball upwards.