

METHOD AND SYSTEM FOR CONTROLLING HOISTING MECHANISM OF OVERHEAD HOIST VEHICLE

[0001] The present application claims the benefit of priority to Chinese Patent Application No. 202210096683.X filed on January 26, 2022, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates to the field of manufacturing equipment for semiconductor wafer, and in particular to a method and a system for controlling hoisting mechanism of an overhead hoist vehicle in an automatic material handling system.

BACKGROUND

[0003] An overhead hoist vehicle in an automatic material handling system (AMHS, also referred to as overhead travelling carriage system) is configured to transport a target clamped object from a certain location to a designated location as required. Because the overhead hoist vehicle operates above the manufacturing equipment, the overhead hoist vehicle includes a relatively fixed hoisting mechanism and a liftable clamping mechanism. The hoisting mechanism is configured to control the lifting and lowering of the clamping mechanism, to enable the clamping mechanism to reach a predetermined position and perform actions, such as clamping, transporting, releasing and the like, on a target item (such as a wafer box).

[0004] In the overhead hoist vehicle in related technologies, for manufacturing needs, a belt is usually used to provide flexible connection between the clamping mechanism and the hoisting mechanism. The flexible characteristics of the belt cause a certain degree of shaking or swinging of the clamping mechanism relative to the hoisting mechanism during the process of lowering the clamping mechanism by the hoisting mechanism. Therefore, the clamping mechanism cannot accurately reach the predetermined position corresponding to the target item for clamping or releasing the target item. Moreover, in order to accurately reach the predetermined position, the position of the clamping mechanism needs to be adjusted for a plurality of times, which prolongs the clamping or releasing time for the target item, causing the entire cycle of clamping or releasing action to be prolonged and affecting manufacturing efficiency.

[0005] In view of this, there is an urgent need of a new solution for controlling the hoisting mechanism, to enable the hoisting mechanism to accurately lower the clamping mechanism to the predetermined position corresponding to the target item.

SUMMARY

[0006] The present disclosure provides a method for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt, and the method includes:

[0007] acquiring a velocity at a periphery of a reel formed by the flexible belt during movement of the clamping mechanism; and

[0008] adjusting a moving velocity of the clamping mechanism based on the velocity at the periphery, to control the clamping mechanism to move at a respective preset target moving velocity during each subsection control of a plurality of subsection controls.

[0009] The plurality of subsection controls includes:

[0010] in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

[0011] in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

[0012] in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

[0013] in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

[0014] The present disclosure further provides a method for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting and lowering of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt, and the method includes:

[0015] activating the hoisting mechanism to drive the clamping mechanism to move in response to the overhead hoist vehicle travelling to a preset position on a track; and

[0016] acquiring a moving velocity of the clamping mechanism, and performing a respective subsection control of a plurality of subsection controls according to the moving velocity.

[0017] The plurality of subsection controls includes:

[0018] in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

[0019] in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

[0020] in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

[0021] in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

[0022] The present disclosure further provides a system for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt, and the system comprises:

[0023] a first control module, configured to acquire a velocity at a periphery of a reel formed by the flexible belt during movement of the clamping mechanism; and

[0024] a first adjustment module, configured to adjust a moving velocity of the clamping mechanism based on the velocity at the periphery, to control the clamping mechanism to move at a respective preset target moving velocity during each subsection control of a plurality of subsection controls.

[0025] The plurality of subsection controls includes:

[0026] in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

[0027] in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

[0028] in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

[0029] in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

[0030] The present disclosure further provides a system for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting and lowering of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt, and the system includes:

[0031] a control mechanism, configured to activate a servo motor of the hoisting mechanism, to drive the clamping mechanism to move; and

[0032] a detection mechanism, configured to acquire a moving velocity of the clamping mechanism.

[0033] The control mechanism and the detection mechanism are further configured to cooperation to perform a respective subsection control of a plurality of subsection controls according to the moving velocity.

[0034] The plurality of subsection controls includes:

[0035] in a starting phase, the control mechanism controls the clamping mechanism to enter an acceleration phase in response to the detection mechanism detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

[0036] in the acceleration phase, the control mechanism accelerates the clamping mechanism and controls the clamping mechanism to enter a deceleration phase in response to the detection mechanism detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

[0037] in the deceleration phase, the control mechanism decelerates the clamping mechanism and controls the clamping mechanism to enter a steady phase in response to the detection mechanism detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

[0038] in the steady phase, the control mechanism controls the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039] In order to illustrate the technical solutions in the embodiments of the present disclosure more clearly, the drawings involved in the embodiments will be briefly described below. It is obvious that the drawings mentioned in the following description are only some embodiments of the present disclosure. For those of ordinary skill in the art, other drawings may be obtained in accordance with these drawings without any inventive effort.

[0040] FIG. 1 is a structural schematic diagram of a hoisting mechanism and a clamping mechanism of an overhead hoist vehicle.

[0041] FIG. 2 is a schematic diagram of a constant-velocity lifting and lowering movement of the overhead hoist vehicle.

[0042] FIG. 3 is a schematic diagram of a plurality of subsection controls of a control solution for a hoisting mechanism of an overhead hoist vehicle according to some embodiments of the present disclosure.

[0043] FIG. 4 is another schematic diagram of the plurality of subsection controls of the control solution for the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0044] FIG. 5 is still another schematic diagram of the plurality of subsection controls of the control solution for the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0045] FIG. 6 is a flowchart of a method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0046] FIG. 7 is a schematic diagram of accelerated descent in the method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0047] FIG. 8 is a schematic diagram of constant-velocity descent in the method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0048] FIG. 9 is a schematic diagram of decelerated descent in the method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0049] FIG. 10 is a schematic diagram of steady descent in the method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0050] FIG. 11 is a schematic diagram of a feedback detection using an encoder according to some embodiments of the present disclosure.

[0051] FIG. 12 is a schematic diagram of the feedback detection performed on the plurality of subsection controls using the encoder according to some embodiments of the present disclosure.

[0052] FIG. 13 is a flowchart of the method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0053] FIG. 14 is a schematic diagram of velocity compensation in the method for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

[0054] FIG. 15 is a schematic diagram of a system for controlling a hoisting mechanism of an overhead hoist vehicle according to some embodiments of the present disclosure.

[0055] FIG. 16 is another schematic diagram of a system for controlling the hoisting mechanism of the overhead hoist vehicle according to some embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0056] The following is detailed description of the embodiments of the present disclosure in conjunction with the accompanying drawings.

[0057] In the following, the embodiments of the present disclosure will be illustrated in detail using specific examples. Those skilled in the art can easily understand other advantages and benefits of the present disclosure according to the content disclosed in the present disclosure. Obviously, the described embodiments are only a part of the embodiments of the present disclosure, not all of them. The present disclosure may also be implemented or applied through different implementation methods, and the details in the present disclosure may be modified or changed based on different perspectives and applications without departing from the spirit of the present disclosure. It should be noted that, without conflict, the following embodiments and the features in the embodiments may be combined with each other. Based on the embodiments of the present disclosure, other embodiments obtained by those skilled in the art without creative effects all fall within the scope of protection of the present disclosure.

[0058] It should be noted that various aspects of the embodiments falling within the scope of the attached claims are described below. It should be evident that the aspects described in the present disclosure may be embodied in a wide variety of forms, and any specific structures and/or functions described in the present disclosure are only illustrative. Based on

the present disclosure, those skilled in the art should understand that one aspect described in the present disclosure may be implemented independent of any other aspect, and that two or more of these aspects may be combined in various ways. For example, any number and aspect described in the present disclosure may be used to implement the devices and/or practical methods. Moreover, other structures and/or functionalities other than one or more of the aspects described in the present disclosure may be used to implement the devices and/or practical methods.

[0059] It should further be noted that the diagrams mentioned in the following embodiments only illustrate the basic concept of the present disclosure in a schematic manner. The diagrams only illustrate the components related to the present disclosure and are not drawn according to the actual numbers, shapes, and sizes of the components in practice. The form, number, and scale of each component in practice may be arbitrarily changed, and the layout of the components may also be more complex.

[0060] Moreover, in the following description, specific details are provided to facilitate a thorough understanding of the examples. However, those skilled in the art shall understand that the described aspects can be implemented without these specific details. The terms “first”, “second”, or the like are only used for description and shall not be understood as indicating or implying relative importance or implying quantity of the described technical features. Therefore, a feature limited by “first”, “second”, or the like may explicitly or implicitly includes one or more features. In the description of the present disclosure, unless otherwise specified, “a plurality of” means two or more.

[0061] At present, as shown in FIG. 1, when an overhead hoist vehicle 1 travels to a predetermined position along overhead tracks, a hoisting mechanism 2 of the overhead hoist vehicle controls a clamping mechanism 4 for lifting and lowering movement, so that the clamping mechanism 4 moves to a specified height to clamp or release a target object (such as a wafer box). The hoisting mechanism 2 is connected to the clamping mechanism 4 by a flexible belt 3.

[0062] As shown in FIG. 2, the hoisting mechanism 2 controls the clamping mechanism 4 in a way, for example, that from the beginning of releasing the belt to the clamping mechanism descending to the specified height, the rotation velocity of motor remains unchanged, i.e. the clamping mechanism descends at a constant velocity. Thus, in order for smooth and shaking-free releasing of the belt, a control method using low rotation velocity has to be used, resulting in long hoisting time. Or in order to complete releasing in short time, a control method using high rotation velocity has to be used, causing the belt to shake or swing

significantly during the releasing process, which is not conducive to accurately clamping the target item. Moreover, in order to accurately clamp the target item, a plurality of adjustments to the clamping mechanism are required, which also results in an extension of the cycle of actions.

[0063] For example, in an AMHS system applicable to a semiconductor manufacturing plant, a complete semiconductor process requires approximately 400 steps to implement the entire processing process, and in these 400 steps, a cumulative number of times of handling wafer boxes is about 1200. Generally, an unoptimized AMHS system may require an average handling time of 5 to 6 minutes per time. However, an optimized AMHS system may shorten this average handling time into 2.5 to 3 minutes, even if the time saved is 2 minutes, about 2400 minutes would be saved for 1200 times. That is to say, the optimized system may save about 40 hours for wafer cycle time, which is very valuable for the rapidly changing semiconductor market.

[0064] Therefore, in the optimization of the AMHS system, optimization for each mechanical structure and action control of each step may be minimal, but it may bring a significant influence to a cycle of entire handling system.

[0065] In view of this, after conducting in-depth research and improvement exploration on the control process of the hoisting mechanism, a new hoisting control solution is proposed. As shown in FIG. 3, take the clamping mechanism being lowering to release a target object (such as a wafer box) as an example, when the overhead hoist vehicle 1 travels to a predetermined position on the overhead track, the overhead hoist vehicle 1 may control the descent of the clamping mechanism 4 using the internal hoisting mechanism 2. The predetermined position is a position where the overhead hoist vehicle stops on the track when clamping or releasing wafer boxes. A plurality of subsection controls on the velocities of the descent movement of the clamping mechanism 4 are performed, and the entire descent movement can be optimized by optimizing the plurality of subsection controls.

[0066] In some embodiments, as shown in FIG. 4, the descent movement may be divided into a starting phase, an acceleration phase, a deceleration phase and a steady phase. The starting phase may be a period during which the hoisting mechanism drives the clamping mechanism to start moving, allowing the clamping mechanism to have a starting velocity and then enter the acceleration phase. In the acceleration phase, moving velocity of the clamping mechanism 4 is increased and the clamping mechanism is lowered at a high moving velocity in a short period of time, and then the clamping mechanism enters the deceleration phase. In the deceleration phase, the moving velocity of the clamping mechanism is reduced from a high

velocity, thus the clamping mechanism may be further lowered in a short period of time. Finally, with the steady phase, the clamping mechanism 4 can stably and accurately stop at the placement position for the wafer box, which is conducive to releasing the wafer box at an accurate placement position.

[0067] In some embodiments, as shown in FIG. 5, the descent movement may be divided into a starting phase, an acceleration phase, a constant-velocity phase, a deceleration phase and a steady phase. The starting phase may be a period during which the hoisting mechanism drives the clamping mechanism to start moving, allowing the clamping mechanism to have a starting velocity and then enter the acceleration phase. In the acceleration phase, moving velocity of the clamping mechanism 4 is increased and the clamping mechanism is lowered at a high moving velocity in a short period of time, and then the clamping mechanism enters the constant-velocity phase. In the constant-velocity phase, the clamping mechanism is lowered in a high and constant velocity, thus the clamping mechanism may be further lowered in a short period of time. Then, the moving velocity of the clamping mechanism is reduced from a high velocity, thus the clamping mechanism may be further lowered in a short period of time. Finally, with the steady phase, the clamping mechanism 4 can stably and accurately stop at the placement position for the wafer box, which is conducive to fast, steady and accurate reaching at the placement position for the wafer box by the clamping mechanism 4 in a short period of time.

[0068] It should be noted that when ascent control is performed by the hoisting mechanism 2 on the clamping mechanism 4, a plurality of subsection controls similar to those for the descent control may be used. In other words, the ascent control may be divided into a starting phase, an acceleration phase, a deceleration phase and a steady phase, or divided into a starting phase, an acceleration phase, a constant-velocity phase, a deceleration phase and a steady phase. Therefore, the ascent movement and the descent movement herein are collectively referred to as movement. The descent movement may refer to a descent process during which the clamping mechanism is lowered to the wafer box to clamp the wafer box, or may refer to a descent process during which the clamping mechanism is lowered to the placement position for the wafer box after the clamping mechanism clamps and handles the wafer box to a predetermined position. The ascent movement may refer to an ascent process during which the clamping mechanism is lifted, after clamping the wafer box, to a preset position to enable the wafer box to be handled by the overhead hoist vehicle, or may refer to an ascent process during which the clamping mechanism is lifted, after releasing the clamped wafer box at the placement position, to the preset position.

[0069] Moreover, for the convenience of description, the acceleration and deceleration in the schematic diagrams for example both are linear. In practical applications, other non-linear controls may be used according to the actual control needs, and will not be describe in detail herein.

[0070] In the following, the technical solutions provided by embodiments of the present disclosure will be described in conjunction with the accompanying drawings.

[0071] The present disclosure provides a method for controlling a hoisting mechanism of an overhead hoist vehicle, applicable to an AMHS system in a semiconductor automation plant, and applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt.

[0072] As shown in FIG. 6, the method includes:

[0073] At S102, it is determined whether the overhead hoist vehicle arrives at the preset position along the track, and goes to S104 in response to the overhead hoist vehicle arriving at the preset position.

[0074] In some embodiments, during travelling of the overhead hoist vehicle along the overhead track, a travelling position of the overhead hoist vehicle along the track may be acquired in real time by the AMHS system, and whether the overhead hoist vehicle arrives at the preset position may be determined based on the real-time travelling position, so that when the overhead hoist vehicle arrives at the preset position, the internal hoisting mechanism is triggered to control the movement of the clamping mechanism. The preset position may be a stopping position of the overhead hoist vehicle on the track when there is a target object (such as a wafer box) to be clamped or released.

[0075] In some embodiments, detection marks, such as sensors, barcodes, and the like, may be set at predetermined positions on the track to quickly acquire the predetermined positions with the aid of the detection marks, thereby facilitating the overhead hoist vehicle to stop at the predetermined positions, and facilitating triggering the hoisting mechanism to control the clamping mechanism. Therefore, when the overhead hoist vehicle is traveling along the track, the control mechanism in the overhead hoist vehicle may determine in real time whether the overhead hoist vehicle arrives at the predetermined positions, and determination results may serve as the triggering condition for the control on the clamping mechanism. In this way, once the overhead hoist vehicle arrives at the predetermined positions and stops, the hoisting mechanism can quickly control the clamping mechanism to move.

[0076] At S104, movement control on the clamping mechanism by the hoisting mechanism is started, to drive the clamping mechanism to move.

[0077] In some embodiments, whether the overhead hoist vehicle arrives at the predetermined positions during travelling along the track may be set as the triggering condition, and this triggering condition may be integrated in the control mechanism to serve as the triggering condition for movement control by the control mechanism. For example, this triggering condition may be set in the programmable logic controller (PLC) of the overhead hoist vehicle. In this way, the PLC can quickly initiate the movement control on the clamping mechanism once the PLC detects that the trigger condition is met.

[0078] In some embodiments, the servo motor in the hoisting mechanism may be driven by the control mechanism (such as a PLC), such that the servo motor drives a belt shaft of the flexible belt to rotate, thereby implementing lowering movement of the clamping mechanism by releasing the belt or lifting movement of the clamping mechanism by winding the belt. Therefore, the movement control of the clamping mechanism can be achieved by controlling the drive of the hoisting mechanism.

[0079] At S106, during movement, a velocity of the movement is acquired in real time, and the plurality of subsection controls are performed according to the velocity of the movement.

[0080] The plurality of subsection controls may include a starting phase, an acceleration phase, a deceleration phase and a steady phase.

[0081] In the starting phase, the clamping mechanism is controlled to enter the acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold.

[0082] In some embodiments, at the beginning of the starting phase, a low velocity is provided to lower the belt, in order to smoothly start the movement of the clamping mechanism. Then, when the velocity reaches the first threshold smoothly, the movement may be quickly switched into the acceleration phase. It should be noted that since the starting phase uses a low velocity and the movement is smooth, the starting phase may also be referred to as a first steady phase, and the steady phase after the deceleration phase may be referred to as a second steady phase.

[0083] Because the acceleration phase follows a smooth start, the clamping mechanism can move smoothly in the acceleration phase. That is to say, the smooth movement effectively reduces movement time in the acceleration phase.

[0084] In the acceleration phase, the clamping mechanism is accelerated, and the clamping mechanism is controlled to enter the deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold.

[0085] In some embodiments, a linear acceleration control, such as an acceleration control with small changes in acceleration, may be used in the acceleration phase, which can shorten the time of acceleration movement and make the acceleration movement smoother. Then, after accelerating to a certain velocity, the clamping mechanism is switched to the deceleration phase.

[0086] In the deceleration phase, the clamping mechanism is decelerated, and the clamping mechanism is controlled to enter the steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold.

[0087] In some embodiments, when switching from the acceleration phase to the deceleration phase, a short period of smooth switching between an end of the acceleration phase and a beginning of the deceleration phase may be carried out. Then, a linear deceleration control may be used, to gradually reducing the moving velocity in the deceleration phase. In this way, the time of deceleration can be reduced, and the movement can be smoother.

[0088] In the steady phase, the movement of the clamping mechanism is controlled according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position. The predetermined position may be a stopping position of the clamping mechanism after the lifting or lowering movement. For example, when clamping a wafer box, the predetermined position may be a position where the wafer box is located, so that the clamping mechanism can easily clamp the wafer box. For example, after clamping the wafer box, the predetermined position may be a position where the clamping mechanism returns to the overhead hoist vehicle for handling the wafer box. Therefore, the predetermined position may be determined based on actual movement, and will not be described in detail here.

[0089] In some embodiments, moving velocity may be gradually transitioned from a relatively low velocity to zero according to the preset steady control strategy, and then the clamping mechanism stops at the predetermined position. The steady control strategy may be a slow deceleration control process that causes the clamping mechanism to steadily stop at the predetermined position, such as a control process that causes the clamping mechanism to transition from a low-velocity state to stopping at the predetermined position in a short period of time.

[0090] It should be noted that the first threshold, second threshold, third threshold, and preset steady control strategy mentioned above may be preset parameters after installation and

debugging in actual plant applications, or empirical data derived based on actual operating conditions. The specific values may be determined based on actual applications and will not be described in detail here.

[0091] In the embodiments of the present disclosure, the moving velocity of the clamping mechanism is detected in real time, a plurality of subsection controls are performed on the movement of the clamping mechanism according to detection results, and the plurality of subsection controls are steadily switched from one to another. In this way, the movement of the clamping mechanism can be steady, and moving time can be effectively optimized.

[0092] In some embodiments, by controlling durations of the acceleration and deceleration phases, the durations of the acceleration and deceleration phases can be relatively short. For example, the durations may be shorter than that of the steady phase. In this way, efficient short-time acceleration and deceleration movements can be achieved, and the clamping mechanism can stop at the predetermined position steadily and accurately with the aid of relatively long steady phase.

[0093] In some embodiments, according to the needs of overall movement, for example the movement has a long stroke, a constant-velocity phase may be added between the acceleration phase and the deceleration phase.

[0094] As shown in FIG. 5, the plurality of subsection controls may further include a constant-velocity phase. In the acceleration phase, the clamping mechanism is controlled to enter the constant-velocity phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to the second threshold. In the constant-velocity phase, constant-velocity control is performed on the clamping mechanism, and the clamping mechanism is controlled to enter the deceleration phase in response to a duration of the constant-velocity phase being greater than or equal to a fourth threshold.

[0095] By adding the constant-velocity phase between the acceleration phase and the deceleration phase, the clamping mechanism can switch between the acceleration phase and the deceleration phase more steadily, and the moving velocity during the constant-velocity phase is relatively high, thereby greatly reducing movement time.

[0096] In some embodiments, the operation of the servo motor may be controlled by the pulses emitted by the PLC. In other words, different control pulse frequencies may be output by the PLC for driving the servo motor, so that the rotation speed of the servo motor is controlled by the number of pulses. Therefore, the number of pulses corresponds to rotation angles of the motor, that is, frequencies of the pulses can determine the rotation speeds of the belt, thus the moving velocity may be controlled by controlling frequency of the pulses. It

should be noted that the relationship between rotation speed of the motor and frequency of the pulses may be determined based on specific motor characteristics and will not be described in detail here.

[0097] In some embodiments, as shown in FIG. 7, in the starting phase, when the hoisting mechanism 2 lowers the flexible belt 3 and the clamping mechanism 4 at a velocity greater than or equal to a certain velocity, for example the number of pulses output by the PLC is greater than or equal to a preset value, the PLC may change frequency of the pulses for controlling the servo motor according to a preset method for varying frequencies of the pulses, causing the clamping mechanism 4 to enter the accelerated descent phase, thereby enabling the steady accelerated descent of the flexible belt 3 and the clamping mechanism 4.

[0098] In some embodiments, as shown in FIG. 8, when the velocity at which the hoisting mechanism 2 lowers the flexible belt 3 and the clamping mechanism 4 triggers switching into the constant-velocity phase, the PLC may change the output frequency of the pulses according to the preset method, thereby enabling the constant-velocity descent of the flexible belt 3 and the clamping mechanism 4 at a high velocity.

[0099] In some embodiments, as shown in FIG. 9, when lowering of the flexible belt 3 and the clamping mechanism 4 by the hoisting mechanism 2 enters the decelerated descent phase steadily, the PLC may change the frequency of the pulses into that corresponding to the deceleration phase according to the preset method, thereby enabling the steady decelerated descent of the flexible belt 3 and the clamping mechanism 4.

[0100] In some embodiments, as shown in FIG. 10, after the decelerated descent, when the flexible belt 3 and the clamping mechanism 4 enter the final steady descent phase steadily, the PLC may change the frequency of the pulses into that corresponding to the steady phase according to the preset method, thereby enabling the flexible belt 3 and the clamping mechanism 4 to descend steadily and slowly, and to stop at a designated height, i.e. stop at a position facilitating clamping of the target object 5 (such as a wafer box).

[0101] In some embodiments, by acquiring the number of pulses output by the PLC, the moving velocity can be acquired, thus the plurality of subsection controls can be achieved based on the number of pulses.

[0102] In practice, as described above, the servo motor in the hoisting mechanism may be driven based on a preset number of pulses, and the flexible belt may be driven by the servo motor to release or wind the flexible belt, thereby driving the clamping mechanism. Furthermore, the number of pulses may be acquired, and the moving velocity may be determined based on the number of pulses.

[0103] In some embodiments, a feedback detection mechanism may be used to provide real-time feedback control for the moving velocity during the plurality of subsection controls.

[0104] As shown in FIG. 11, in the hoisting mechanism, a servo motor having an encoder may be used to drive the reel formed by the belt to rotate. The encoder may compare the actual stroke information of the servo motor with the pulses output by the PLC to form comparison information for the driver. For example, when the comparison information fed back by the encoder indicates that the stroke of the servo motor coincides with the pulses output by the PLC, the PLC may continuously output pulses to the driver according to the original requirements. When the comparison information fed back by the encoder indicates that there is an abnormality, the encoder may send abnormal information to the driver, and then the driver may feed the abnormal information back to the PLC. When the PLC receives the abnormal information, it indicates that the actions of previous procedure has not been completed, and instructions for the next procedure would not be sent to the driver.

[0105] In some embodiments, the method further includes: acquiring stroke data of the servo motor fed back by a stroke encoder, and determining whether the clamping mechanism moves correctly according to the stroke data of the servo motor and the preset number of pulses.

[0106] By comparing the stroke information with the number of the pulses output by the PLC using the encoder and forming the comparison information, real-time monitoring can be achieved based on the comparison information.

[0107] In some embodiments, as shown in FIG. 12, the above-mentioned real-time feedback control may be applied to the phases of the plurality of subsection controls, and the next phase can proceed only when the comparison information from the encoder indicates normality. For example, the encoder is used to determine whether the comparison information indicates normality, if yes, velocity control may continue, if no, feedback showing that the comparison information from the encoder indicates an abnormality is sent to the driver, and the PLC may handle the abnormality, such as controlling the buzzer to emit a beep alarm, displaying the problem information on a display of the overhead hoist vehicle, or the like, and then manual intervening is introduced.

[0108] In some embodiments, when it is determined that the movement is abnormal, the method further includes: stopping sending drive instructions to the hoisting mechanism, and/or issuing a voice alarm, and/or displaying alarm information. When anomalies are detected during real-time feedback detection, the anomalies are promptly addressed accordingly.

[0109] In some embodiments, two pairs of sensors may be installed in the clamping mechanism to determine the relative position between the clamping mechanism and the target object in real-time using these two pairs of sensors

[0110] In some embodiments, the method further includes: acquiring a first signal output by a first through-beam sensor and a second signal output by a second through-beam sensor, herein the first through-beam sensor is configured to detect whether the clamping mechanism stops at an abnormal position, and the second through-beam sensor is configured to detect whether the clamping mechanism stops at the predetermined position; and determining a relationship between a position of the clamping mechanism and the predetermined position according to the first signal and the second signal.

[0111] The clamping mechanism is provided with the first through-beam sensor and the second through-beam sensor, and the first through-beam sensor is disposed above the second through-beam sensor. The second through-beam sensor is configured to detect whether the clamping mechanism stops at the predetermined position, and the first through-beam sensor is configured to detect whether the clamping mechanism stops at an abnormal position. By acquiring the signals output by these two through-beam sensors and performing adjustment control in the steady phase based on the signals, control accuracy in the steady phase can be improved, and the duration required by the steady phase can be shortened, thereby effectively optimizing the entire movement duration of the lifting or lowering.

[0112] In some embodiments, the signals output by these two through-beam sensors may be used for combination control on the signals in the steady phase.

[0113] In some embodiments, determining the relationship between the position of the clamping mechanism and the predetermined position according to the first signal and the second signal, includes: determining that the clamping mechanism stops at the predetermined position in response to determining that the first signal and the second signal meet a preset judgment condition.

[0114] For example, when the lower through-beam sensor is triggered, it indicates that the flexible belt 3 and clamping mechanism 4 have been lowered into place. In this case, the PLC determines that the descent process has ended when the PLC determines that the information from the through-beam sensor is in conformity to the information from the encoder.

[0115] For example, when the upper through-beam sensor is triggered, it indicates that the descent of the clamping mechanism 4 is abnormal. For example, the clamping mechanism may descend excessively due to deviation of position of the wafer box. For example, the upper through-beam sensor may be triggered due to some certain objects are placed on the wafer box.

[0116] In some embodiments, real time detection of the movement position of the belt may be achieved using a sensor, namely a position sensor is disposed at the origin position of the reel formed by the belt and the position of the flexible belt is detected using the position sensor.

[0117] In some embodiments, before starting the movement of the clamping mechanism, the method further includes: acquiring an output result by the first position sensor, to determine whether the flexible belt is at the origin position.

[0118] Based on the same invention concept, the present disclosure further provides a method for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt, in order to adjust a moving velocity more accurately, and achieve more precise control of the moving velocity. In this way, the clamping mechanism can arrive at a predetermined position more steadily and accurately for clamping or releasing a wafer box.

[0119] In practice, in view of the fact that the belt has a certain thickness, the change in the radius of the reel formed by the belt during the rotation of the reel due to the rotation of the servo motor will cause a slight change in a moving velocity of the clamping mechanism. Therefore, in addition to considering the rotation speed of the motor, the changes in the outer diameter and velocity of the reel during the lowering process of the flexible belt is taken into account. Thus, the influence resulted from the thickness of the flexible belt on the velocity is taken into account and added to the control. In this way, the clamping performed at the predetermined position can be more accurate. Detailed references may be made to the following embodiments.

[0120] As shown in FIG. 13, the method includes:

[0121] At S201, during movement of the clamping mechanism, a velocity at a periphery of the reel formed by the flexible belt is acquired.

[0122] In practice, the velocity at the periphery of the reel may be acquired by a sensor or the like, or the velocity may be calculated with the aid of a sensor.

[0123] In practice, the PLC may output drive pulses, and the motor in the hoisting mechanism, under the control of the drive pulses, drives the reel to release or wind the flexible belt. One revolution of the motor corresponds to one revolution of the reel. Therefore, when the PLC controls the reel to release or wind the flexible belt by outputting pulses, a linear velocity at the periphery of the reel may be determined by reading the number of pulses output

by the PLC and based on rotation speed of the motor corresponding to the number of pulses. The linear velocity at the periphery of the reel corresponds to the moving velocity of the clamping mechanism.

[0124] At S203, the moving velocity of the clamping mechanism is adjusted based on the velocity at the periphery, to control the clamping mechanism to move at a respective preset target moving velocity during each subsection control of a plurality of subsection controls.

[0125] After determining the velocity at the periphery, the velocity at the periphery may be compared with a preset moving velocity, and the moving velocity of the clamping mechanism may be adjusted in real time according to a comparison result.

[0126] The plurality of subsection controls includes: a starting phase, an acceleration phase, a deceleration phase, and a steady phase. These phases may refer to the above description, and will not be described here.

[0127] By acquiring the velocity at the periphery of the reel formed by the flexible belt in real-time, i.e. the velocity corresponding to the release or winding of the flexible belt, and adjusting the moving velocity of the clamping mechanism in real-time based on the velocity at the periphery, the clamping mechanism can move at a respective preset target moving velocity in each phase. In this way, the steadiness and accuracy of the movement of the clamping mechanism can be improved.

[0128] In some embodiments, in view of the fact that the PLC controls the operation of the servo motor by outputting pulses, the number of the pulses corresponds to the rotation angle of the motor, and the servo motor drives the reel, the frequency of the pulses output by the PLC may be used to determine the rotation speed of the reel, i.e. the moving velocity of the flexible belt driven by the reel may be obtained by acquiring the rotation speed of the reel. The moving velocity of the flexible belt corresponds to the moving velocity of the clamping mechanism.

[0129] As shown in FIG. 14, during the descent process of the flexible belt 3 winding around a belt shaft 6, the outer diameter and the velocity at the periphery of the reel are constantly changing. If the frequency of the pulse emitted by the PLC is unchanged, although the rotation speed of the servo motor is constant, the linear velocity transmitted to the flexible belt 3 gradually slows down.

[0130] In practice, depending on the reel, the PLC may output a certain increment of pulses to compensate for the linear reduction of the velocity of the flexible belt transmitted from the motor rotating at a constant speed, so that the moving velocity of the flexible belt (i.e. the moving velocity of the clamping mechanism) can be controlled according to the preset velocity.

[0131] For ease of understanding, take a constant-velocity control as an example to schematically illustrate the velocity control.

[0132] Although the motor rotates one revolution and the belt also rotates one revolution, due to the thickness of the belt, the radius r of the reel after each revolution varies, resulting in varying descent height of the reel for each revolution, even though the rotation speed of the motor (i.e. the frequency of the pulses output by the PLC) keeps unchanged. That is to say, for the same period of time t , the stroke s of the clamping mechanism varies because the velocity V of the clamping mechanism varies. Therefore, the constant-velocity movement of the clamping mechanism cannot be obtained from a constant-velocity control.

[0133] Assuming that the thickness of flexible belt 3 is represented by y , the total radius, from a rotation axis to the periphery, of the reel before releasing the belt is represented by R , and a number of turns (i.e. the number of turns of the belt wound on the belt shaft) is represented by n , then the linear velocity $V = \frac{s}{t} = \frac{2\pi R}{T} = \frac{2\pi[R-(n-1)*y]}{T_n}$. Thus, to achieve a constant-velocity descent, i.e. the velocity V should remain unchanged, it is necessary to take the velocity at the periphery of the reel into account. Assuming that the descent velocity V of the belt is a constant, i.e. the belt descends at a constant velocity, a descent height of the reel for the first revolution is $2\pi R$, and a descent height of the reel for the second revolution is $2\pi [R-(n-1)*y]$. That is to say, although the velocity V remains unchanged, the stroke S is changing. Thus, the velocity V can be kept unchanged by acquiring a time difference Δt between two revolutions in real time and by calculating corresponding increment of pulses. A stroke difference $\Delta S = 2\pi R - 2\pi[R - (n - 1) * y] = 2\pi(n - 1) * y$, because the velocity is a quotient of the stroke difference divided by the time difference, it can be determined that $\Delta t = \frac{2\pi(n-1)*y}{V}$. Herein, y refers to a thickness of the flexible belt, Δt refers to the time difference between two revolutions of the reel formed by the flexible belt, and V refers to the moving velocity of the clamping mechanism.

[0134] In some embodiments, a current driving rotation velocity applied on the reel may be determined by acquiring the number of pulses output by the PLC.

[0135] Acquiring the current driving rotation velocity of the hoisting mechanism applied on the reel may include: acquiring a first number of pulses corresponding to a current moving velocity of the clamping mechanism. The first number of pulses refers to a number of pulses configured for the hoisting mechanism to control the current driving rotation velocity applied on the reel.

[0136] Adjusting the moving velocity of the clamping mechanism based on the radius and the current driving rotation velocity includes: outputting a second number of pulses according to the current driving rotation velocity, and controlling, based on the second number of pulses, the hoisting mechanism to drive the reel to rotate, to adjust the moving velocity of the clamping mechanism. The second number of pulses is, in response to the moving velocity of the clamping mechanism not changing, a sum of the first number of pulses and an increment number of pulses corresponding to the Δt . It should be noted that the increment refers to a change value of the number of pulses corresponding to Δt , therefore the increment may be a positive or negative change value.

[0137] By acquiring the number of pulses output by the PLC for controlling the clamping mechanism to descend (or ascend) from a first position to a second position, and compensating the velocity using incremental compensation based on the number of pulses, the moving velocity of the clamping mechanism can be steadily and accurately adjusted to the target moving velocity.

[0138] In some embodiments, the encoder may provide feedback on the stroke of the servo motor. In this way, velocity adjustment can be more steady, controllable, and accurate.

[0139] In some embodiments, the method further includes: acquiring a stroke of the servo motor of the hoisting mechanism, and determining whether the clamping mechanism moves correctly according to the stroke and the second number of pulses, sending a next program command in response to the clamping mechanism moving correctly, and cancelling the next program command in response to the clamping mechanism not moving correctly.

[0140] In the control adjustment for compensating the velocity, the feedback process of the encoder is the same/similar to the above description. Reference may be made to the above description and will not be described in detail.

[0141] Based on the same invention concept, embodiments of the present disclosure further provide a system for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle. The clamping mechanism and the hoisting mechanism are connected by a flexible belt.

[0142] As shown in FIG. 15, the system 1000 includes:

[0143] a control mechanism 1010, configured to activate a servo motor of the hoisting mechanism, to drive the clamping mechanism to move; and

[0144] a detection mechanism 1030, configured to acquire a moving velocity of the clamping mechanism.

[0145] The control mechanism and the detection mechanism are further configured to cooperation to perform a respective subsection control of a plurality of subsection controls according to the moving velocity.

[0146] The plurality of subsection controls includes:

[0147] in a starting phase, the control mechanism 1010 controls the clamping mechanism to enter an acceleration phase in response to the detection mechanism 1030 detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

[0148] in the acceleration phase, the control mechanism 1010 accelerates the clamping mechanism and controls the clamping mechanism to enter a deceleration phase in response to the detection mechanism 1030 detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

[0149] in the deceleration phase, the control mechanism 1010 decelerates the clamping mechanism and controls the clamping mechanism to enter a steady phase in response to the detection mechanism 1030 detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

[0150] in the steady phase, the control mechanism 1010 controls the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

[0151] In the control system, by performing the plurality of subsection controls on the clamping mechanism based on the velocity information acquired by the detection mechanism in real time, steadiness of the movement can be ensured, and duration of the movement can be optimized. Thus, the clamping mechanism can be effectively and steadily lowered in a relatively short period of time, thereby effectively shortening handling cycles in wafer production and improving production efficiency of semiconductor plants.

[0152] In some embodiments, the control mechanism includes a PLC electrically connected with the detection mechanism; and

[0153] the programmable logic controller and the detection mechanism are configured to cooperation to perform a respective subsection control of a plurality of subsection controls according to the moving velocity.

[0154] By using the PLC as the control core of the control mechanism, the PLC is more convenient, easy to operate, and has strong modifiability.

[0155] In some embodiments, a first through-beam sensor and a second through-beam sensor are disposed on the clamping mechanism, and the first through-beam sensor is disposed

above the second through-beam sensor. The second through-beam sensor is configured to detect whether the clamping mechanism stops at the predetermined position, and the first through-beam sensor is configured to detect whether the clamping mechanism stops at an abnormal position. The first through-beam sensor and the second through-beam sensor are in electrical connection with the PLC.

[0156] The PLC is further configured to: acquire a first signal output by the first through-beam sensor and a second signal output by the second through-beam sensor, and determine a relationship between a position of the clamping mechanism and the predetermined position according to the first signal and the second signal.

[0157] By controlling the steady phase using the two sets of sensors on the clamping mechanism, the steadiness of control in the steady phase can be improved, the duration of the steady phase can be shortened, and the entire ascending or descending duration can be optimized.

[0158] In some embodiments, the servo motor is electrically connected with the PLC, and the PLC is further configured to drive the servo motor of the hoisting mechanism according to a preset number of pulses and to determine the moving velocity according to the preset number of pulses.

[0159] In some embodiments, the servo motor includes a stroke encoder electrically connected with the PLC.

[0160] The PLC is further configured to acquire stroke data of the servo motor fed back by the stroke encoder, and to determine whether the clamping mechanism moves correctly according to the stroke data of the servo motor and the preset number of pulses.

[0161] In any one of the embodiments of the present disclosure, the PLC is electrically connected with an alarm circuit.

[0162] The PLC is further configured, in response to the clamping mechanism not moving correctly, to stop sending driving instructions to a driver of the servo motor, and/or issue a voice alarm, and/or display alarm information.

[0163] In any one of the embodiments of the present disclosure, a first position sensor is disposed at an origin position for the flexible belt and electrically connected with the PLC.

[0164] The PLC is further configured to acquire, before driving the servo motor of the hoisting mechanism according to the preset number of pulses, an output result by the first position sensor, to determine whether the flexible belt is at the origin position.

[0165] Based on the same invention concept, embodiments of the present disclosure further provide a system for controlling a hoisting mechanism of an overhead hoist vehicle,

applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle. Preferably, the system is applicable for velocity compensation of the lifting or lowering movement. The clamping mechanism and the hoisting mechanism are connected by a flexible belt.

[0166] As shown in FIG. 16, the system 2000 includes:

[0167] a first control module 2020, configured to acquire a velocity at a periphery of a reel formed by the flexible belt during movement of the clamping mechanism; and

[0168] a first adjustment module 2040, configured to adjust a moving velocity of the clamping mechanism based on the velocity at the periphery, to control the clamping mechanism to move at a respective preset target moving velocity during each subsection control of a plurality of subsection controls.

[0169] The plurality of subsection controls includes:

[0170] in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

[0171] in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

[0172] in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

[0173] in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

[0174] In some embodiments, the first control module is further configured to: acquire a current driving rotation velocity of the hoisting mechanism applied on the reel; and

[0175] the first adjustment module is further configured to:

[0176] acquire a radius of the reel corresponding to the current driving rotation velocity; and

[0177] adjust the moving velocity of the clamping mechanism based on the radius and the current driving rotation velocity, and the moving velocity and the radius meet: $\Delta t = \frac{2\pi(n-1)*y}{v}$.

[0178] Herein n refers to an ordinal number of one respective turn of the turns, in a direction from the periphery to the rotation axis of the reel, of the reel before releasing the belt,

y refers to a thickness of the flexible belt, Δt refers to a time difference between two revolutions of the reel, and V refers to the moving velocity of the clamping mechanism.

[0179] In some embodiments, the first control module is further configured to: acquire a first number of pulses corresponding to a current moving velocity of the clamping mechanism. The first number of pulses refers to a number of pulses configured for the hoisting mechanism to control the current driving rotation velocity applied on the reel.

[0180] The first adjustment module is further configured to: output a second number of pulses according to the current driving rotation velocity, and control, based on the second number of pulses, the hoisting mechanism to drive the reel to rotate, to adjust the moving velocity of the clamping mechanism. The second number of pulses is, in response to the moving velocity of the clamping mechanism not changing, a sum of the first number of pulses and an increment number of pulses corresponding to the Δt .

[0181] In some embodiments, the system further includes: an encoder configured to acquire a stroke of a servo motor of the hoisting mechanism.

[0182] The first control module is further configured to determine whether the clamping mechanism moves correctly according to the stroke and the second number of pulses, send a next program command in response to the clamping mechanism moving correctly, and cancel the next program command in response to the clamping mechanism not moving correctly.

[0183] The embodiments of the present disclosure are described in a progressive manner, and the same and similar parts between each embodiment may be referred to each other. Each embodiment focuses on describing the differences from other embodiments. Especially for the embodiments described later, as they correspond to the preceding embodiments, the description is relatively simple, and reference may be made to the description of the preceding embodiments for relevant details.

[0184] The above are only the specific embodiments of the present disclosure, but the scope of protection of the present disclosure is not limited to this. Any changes or replacements that are easily conceivable to those skilled in the art within the scope of disclosure of the present disclosure shall fall within the scope of protection of the present disclosure. Therefore, the protection scope of the present disclosure should be determined by the protection scope of the claims.

CLAIMS

1. A method for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle, wherein the clamping mechanism and the hoisting mechanism are connected by a flexible belt, and wherein the method comprises:

acquiring a velocity at a periphery of a reel formed by the flexible belt during movement of the clamping mechanism; and

adjusting a moving velocity of the clamping mechanism based on the velocity at the periphery, to control the clamping mechanism to move at a respective preset target moving velocity during each subsection control of a plurality of subsection controls;

wherein the plurality of subsection controls includes:

in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

2. The method according to claim 1, wherein acquiring the velocity at the periphery of the reel formed by the flexible belt, includes: acquiring a current driving rotation velocity of the hoisting mechanism applied on the reel; and

adjusting the moving velocity of the clamping mechanism based on the velocity at the periphery, includes:

acquiring a radius of the reel corresponding to the current driving rotation velocity; and

adjusting the moving velocity of the clamping mechanism based on the radius and the current driving rotation velocity, wherein the moving velocity and the radius meet: $\Delta t =$

$$\frac{2\pi(n-1)*y}{V}$$

wherein n refers to a number of turns of the reel, y refers to a thickness of the flexible belt, Δt refers to a time difference between two revolutions of the reel, and V refers to the moving velocity of the clamping mechanism.

3. The method according to claim 2, wherein acquiring the current driving rotation velocity of the hoisting mechanism applied on the reel, includes:

acquiring a first number of pulses corresponding to a current moving velocity of the clamping mechanism, wherein the first number of pulses refers to a number of pulses configured for the hoisting mechanism to control the current driving rotation velocity applied on the reel; and

wherein adjusting the moving velocity of the clamping mechanism, includes:

outputting a second number of pulses according to the current driving rotation velocity, and controlling, based on the second number of pulses, the hoisting mechanism to drive the reel to rotate, to adjust the moving velocity of the clamping mechanism;

wherein the second number of pulses is, in response to the moving velocity of the clamping mechanism not changing, a sum of the first number of pulses and an increment number of pulses corresponding to the Δt .

4. The method according to claim 3, further including:

acquiring a stroke of a servo motor of the hoisting mechanism; and

determining whether the clamping mechanism moves correctly according to the stroke and the second number of pulses, sending a next program command in response to the clamping mechanism moving correctly, and cancelling the next program command in response to the clamping mechanism not moving correctly.

5. A method for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting and lowering of a clamping mechanism of the overhead hoist vehicle, wherein the clamping mechanism and the hoisting mechanism are connected by a flexible belt, and wherein the method comprises:

activating the hoisting mechanism to drive the clamping mechanism to move in response to the overhead hoist vehicle travelling to a preset position on a track; and

acquiring a moving velocity of the clamping mechanism, and performing a respective subsection control of a plurality of subsection controls according to the moving velocity;

wherein the plurality of subsection controls includes:

in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

6. The method according to claim 5, wherein activating the hoisting mechanism to drive the clamping mechanism to move, includes: driving a servo motor of the hoisting mechanism according to a preset number of pulses, wherein the servo motor is configured to drive the flexible belt to release or wind, to drive the clamping mechanism; and

acquiring the moving velocity of the clamping mechanism, includes: acquiring the preset number of pulses, and determining the moving velocity according to the preset number of pulses.

7. The method according to claim 6, further including:

acquiring stroke data of the servo motor fed back by a stroke encoder; and

determining whether the clamping mechanism moves correctly according to the stroke data of the servo motor and the preset number of pulses.

8. The method according to claim 5, wherein the plurality of subsection controls further includes: in a constant-velocity phase, performing constant-velocity control on the clamping mechanism, and controlling the clamping mechanism to enter the deceleration phase in response to a duration of the constant-velocity phase being greater than or equal to a fourth threshold; and

in the acceleration phase, controlling the clamping mechanism to enter the constant-velocity phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to the second threshold.

9. The method according to claim 5, further including:

acquiring a first signal output by a first through-beam sensor and a second signal output by a second through-beam sensor, wherein the first through-beam sensor is configured to detect whether the clamping mechanism stops at an abnormal position, and the second through-beam sensor is configured to detect whether the clamping mechanism stops at the predetermined position; and

determining a relationship between a position of the clamping mechanism and the predetermined position according to the first signal and the second signal.

10. The method according to claim 9, wherein determining the relationship between the position of the clamping mechanism and the predetermined position according to the first signal and the second signal, includes:

determining that the clamping mechanism stops at the predetermined position in response to determining that the first signal and the second signal meet a preset judgment condition.

11. A system for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting or lowering movement of a clamping mechanism of the overhead hoist vehicle, wherein the clamping mechanism and the hoisting mechanism are connected by a flexible belt, and wherein the system comprises:

a first control module, configured to acquire a velocity at a periphery of a reel formed by the flexible belt during movement of the clamping mechanism; and

a first adjustment module, configured to adjust a moving velocity of the clamping mechanism based on the velocity at the periphery, to control the clamping mechanism to move at a respective preset target moving velocity during each subsection control of a plurality of subsection controls;

wherein the plurality of subsection controls includes:

in a starting phase, controlling the clamping mechanism to enter an acceleration phase in response to detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

in the acceleration phase, accelerating the clamping mechanism, and controlling the clamping mechanism to enter a deceleration phase in response to detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

in the deceleration phase, decelerating the clamping mechanism, and controlling the clamping mechanism to enter a steady phase in response to detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

in the steady phase, controlling the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

12. The system according to claim 11, wherein the first control module is further configured to: acquire a current driving rotation velocity of the hoisting mechanism applied on the reel; and

the first adjustment module is further configured to:

acquire a radius of the reel corresponding to the current driving rotation velocity; and
adjust the moving velocity of the clamping mechanism based on the radius and the current driving rotation velocity, wherein the moving velocity and the radius meet: $\Delta t = \frac{2\pi(n-1)*y}{V}$

wherein n refers to a number of turns of the reel, y refers to a thickness of the flexible belt, Δt refers to a time difference between two revolutions of the reel, and V refers to the moving velocity of the clamping mechanism.

13. The system according to claim 12, wherein the first control module is further configured to:

acquire a first number of pulses corresponding to a current moving velocity of the clamping mechanism, wherein the first number of pulses refers to a number of pulses configured for the hoisting mechanism to control the current driving rotation velocity applied on the reel; and

wherein the first adjustment module is further configured to:

output a second number of pulses according to the current driving rotation velocity, and control, based on the second number of pulses, the hoisting mechanism to drive the reel to rotate, to adjust the moving velocity of the clamping mechanism;

wherein the second number of pulses is, in response to the moving velocity of the clamping mechanism not changing, a sum of the first number of pulses and an increment number of pulses corresponding to the Δt .

14. The system according to claim 13, further including:

an encoder, configured to acquire a stroke of a servo motor of the hoisting mechanism;

wherein the first control module is further configured to determine whether the clamping mechanism moves correctly according to the stroke and the second number of pulses, send a next program command in response to the clamping mechanism moving correctly, and cancel the next program command in response to the clamping mechanism not moving correctly.

15. A system for controlling a hoisting mechanism of an overhead hoist vehicle, applicable for the hoisting mechanism of the overhead hoist vehicle to control lifting and lowering of a clamping mechanism of the overhead hoist vehicle, wherein the clamping mechanism and the hoisting mechanism are connected by a flexible belt, and wherein the system comprises:

a control mechanism, configured to activate a servo motor of the hoisting mechanism, to drive the clamping mechanism to move; and

a detection mechanism, configured to acquire a moving velocity of the clamping mechanism;

wherein the control mechanism and the detection mechanism are further configured to cooperation to perform a respective subsection control of a plurality of subsection controls according to the moving velocity;

wherein the plurality of subsection controls includes:

in a starting phase, the control mechanism controls the clamping mechanism to enter an acceleration phase in response to the detection mechanism detecting that the moving velocity of the clamping mechanism is greater than or equal to a first threshold;

in the acceleration phase, the control mechanism accelerates the clamping mechanism and controls the clamping mechanism to enter a deceleration phase in response to the detection mechanism detecting that the moving velocity of the clamping mechanism is accelerated to a second threshold;

in the deceleration phase, the control mechanism decelerates the clamping mechanism and controls the clamping mechanism to enter a steady phase in response to the detection mechanism detecting that the moving velocity of the clamping mechanism is decelerated to a third threshold; and

in the steady phase, the control mechanism controls the clamping mechanism according to a preset steady control strategy, to control the clamping mechanism to stop at a predetermined position.

16. The system according to claim 15, wherein the control mechanism includes a programmable logic controller electrically connected with the detection mechanism; and

the programmable logic controller and the detection mechanism are configured to cooperation to perform a respective subsection control of the plurality of subsection controls according to the moving velocity.

17. The system according to claim 16, wherein the servo motor is electrically connected with the programmable logic controller, and the programmable logic controller is further configured to drive the servo motor of the hoisting mechanism according to a preset number of pulses and to determine the moving velocity according to the preset number of pulses.

18. The system according to claim 17, wherein the servo motor includes a stroke encoder electrically connected with the programmable logic controller;

the programmable logic controller is further configured to acquire stroke data of the servo motor fed back by the stroke encoder, and to determine whether the clamping mechanism moves correctly according to the stroke data of the servo motor and the preset number of pulses.

19. The system according to claim 18, wherein the programmable logic controller is electrically connected with an alarm circuit; and

the programmable logic controller is further configured, in response to the clamping mechanism not moving correctly, to stop sending driving instructions to a driver of the servo motor, and/or issue a voice alarm, and/or display alarm information.

20. The system according to any one of claims 16 to 19, further including a first position sensor disposed at an origin position for the flexible belt and electrically connected with the programmable logic controller;

the programmable logic controller is further configured to acquire, before driving the servo motor of the hoisting mechanism according to the preset number of pulses, an output result by the first position sensor, to determine whether the flexible belt is at the origin position.