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Arrangement for the recording by measurement of load pendulum oscillations in cranes

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The invention relates to an arrangement for the recording by measurement of load oscillations in cranes.

Cranes, such as, for example, container cranes, serve for picking up loads at predetermined locations, for conveying them over a known distance and for depositing them at a fixed location. The automation of these operations presents the problem that, as a result of the necessary starting and braking, the load is incited to execute undesirable oscillating movements which, on account of the low internal damping of the system, die out only slowly and consequently considerably impede and delay the pickup and positionally accurate lowering of the load. Since the conveying capacity is to a great extent determined by how quickly a picking-up/depositing operation can be carried out, attempts must be made, in the interests of a high conveying capacity, to cause these movements to take place in a manner controlled by regulating measures, to reduce them to a tolerable amount or even to utilise them. If the oscillating movement of the load can not be predicted directly, for example by computer simulation, it is necessary, for compensating the load oscillations and for the load positioning regulation, to record the actual oscillating movement, that is to say the actual position of the load which changes in time.

However, this problem has hitherto been solved only partially. Thus, there are mechanical methods, in which the oscillating ropes, on which the load is suspended, displace yokes which are arranged underneath the rope deflection or the rope drum. By means of such a mechanism, the instantaneous angle of oscillation or its rate of change can be recorded with sufficient accuracy

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for compensating the load oscillation. However, the accuracy is not sufficient for load positioning regulations. Furthermore, the known system is mechanically sensitive and necessitates a high outlay in terms of maintenance.

It has already been proposed to record the said quantities by means of the laser technique, laser distance profile-measuring instruments arranged on the crane sensing the outer edges of the load within a predetermined sensing angle range. According to the current state of the art, however, it is not yet possible to achieve simultaneously very high measuring accuracies and short measuring times over a relatively large sensing angle range. In order to acquire high measuring accuracy along with still tolerable measuring times, it is therefore necessary to restrict the sensing angle range to a few degrees. In this case, however, there is the risk that, in the event of pronounced oscillating movements, the load will escape from the viewing field of a laser distance profile-measuring instrument.

The object on which the invention is based is to make it possible to record load oscillations in cranes with high accuracy and reliability.

The object is achieved, according to the invention, in that, in the arrangement of the type specified in the introduction, a marking with a reflecting surface is arranged in the region of the load, in that a lighting device directed on to the marking is arranged on the crane, in that, furthermore, a line-scan camera likewise directed on to the marking and having an image sensor row oriented longitudinally relative to the direction of oscillation is arranged on the crane, and in that the line-scan camera is followed by an evaluation device which determines load position data from the signal of the image sensor row. At the same time, the marking can be attached directly to the load or preferably to a load pickup frame (spreader). The lighting device can in the simplest way be a spotlight. In the case of oscillating movements in the direction of extension of the image



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sensor row, the marking is located constantly in the viewing field of the line-scan camera, the reflecting surface being very bright in the view of the camera on account of the lighting; this allows short exposure times and therefore short measuring times. An essential contribution is also made to the latter by the fact that image recording and processing does not take place over an area, but only along a line, in which, in particular, the oscillating movement of the load occurs. This takes account of the fact that, particularly in the case of cranes with a trolley drive, but also in the case of cranes with a corresponding suspension of the load on two or more ropes, the oscillating movement caused by the conveyance of the load takes place essentially in only one direction.

So that the marking does not escape from the viewing field of the camera in the case of undesirable oscillating movements transverse to the oscillating movement to be recorded, there is advantageously provision for the reflecting surface to have a predetermined minimum extension in the direction transverse to the orientation of the image sensor row.

In the event that, as, for example, in slewing cranes, oscillating movements occur in different directions and are also to be recorded, there can be provision, within the scope of the invention, for varying the extension of the reflecting surface transversely to the orientation of the image sensor row. In this case, the component of the oscillating movement in the direction of the image sensor row is determined from the position of the image of the reflecting surface on the image sensor row, and the movement component running transversely thereto is determined by means of the extension of the reflecting surface imaged on the image sensor row. Although the load oscillation is thus recorded two-dimensionally, only a single one-dimensional image sensor row is necessary for this purpose.

According to an alternative design of the arrangement according to the invention, there is provided



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transversely to the orientation of the image sensor row
a further image sensor row which is followed by a further
evaluation device. This further image sensor row can be
an integral part of a second or the same line-scan camera
5 which is directed onto the marking or a further marking.
The position data supplied by the two evaluation devices
reproduce the respective component of the oscillating
movement in the respective directions of the two sensor
rows oriented at right angles to one another, there being
10 the advantage that the two movement components are
recorded in each case by means of the same measuring
methods and therefore with the same measuring accuracy.

The recording of possible rotational movements of
the load advantageously becomes possible in that parallel
15 to the image sensor row an additional image sensor row
with an additional evaluation device is provided, in that
the marking is so far extended in the direction trans-
verse to the image sensor row or an additional marking
spaced from the marking in the direction transverse to
20 the image sensor row is provided, so that the said
additional marking is recorded optically by the addi-
tional image sensor row, the rotational movement of the
load about the axis of oscillation being detected from
the difference between the position data supplied by the
25 two evaluation devices.

In order to ensure that the marking appears as
bright as possible in the view of the line-scan camera
and therefore the attainable measuring times are as short
as possible, the lighting device and the line-scan camera
30 are preferably arranged directly next to one another, the
reflecting surface of the marking consisting of triple
reflector elements. This ensures that the light falling
from the lighting device on to the reflecting surface is
reflected into the line-scan camera in the direction of
35 light incidence and therefore irrespective of the par-
ticular angle of incidence of the light onto the
reflective surface which is dependent on the lifting
height and the oscillating movement. So that the oscil-
lating movement of the load can be evaluated more simply,



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the lighting device and the line-scan camera are preferably arranged in the immediate vicinity of the oscillatory suspension and the marking vertically underneath the load in the position of rest of the latter.

5 So that, instead of the oscillation travel dependent on the lifting height, that is to say on the oscillation length, the angle of oscillation independent thereof can be recorded, in a development of the arrangement according to the invention a measuring device for
10 determining the respective oscillation length is provided, the measurement signal from the measuring device being evaluated in the evaluation device together with the signal from the image sensor row in order to determine the angle of oscillation and/or the instantaneous
15 load position. The measuring device can, for example, be an incremental angle encoder or absolute encoder on the rope drum of the crane; it is also possible to determine the oscillation length by laser distance measurement, in which, in contrast to the laser angle measurement
20 mentioned in the introduction, short measuring times can be achieved.

 According to an advantageous development of the arrangement according to the invention, there is provision for a reflecting surface to be adjacent in the
25 direction of oscillation to a non-reflecting, preferably matt-black surface, and, in order to determine the position of the marking, for the evaluation device to scan for the signal from the image sensor row after the occurrence of the change in brightness having the highest
30 contrast in each case. In this way, therefore, the edge of the reflecting surface is used for determining the position, with the result that high measurement resolution is achieved. At the same time, on the one hand, the extension of the reflecting surface has such a large
35 dimension that sufficient image sensor elements of the image sensor row are illuminated in order to achieve sufficient measuring accuracy; on the other hand, however, the superficial extension of the reflecting surface is not too large, because the edges of the reflecting



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surface may otherwise escape from the viewing field of the line-scan camera during the oscillation of the load. Since the determination of the position of the marking does not take place via a determination of brightness, but via a determination of contrast in the brightness jump at the edge of the reflecting surface in relation to the non-reflecting surface, there is little risk of incorrect measurements on account of other disturbing light sources; moreover, the exposure time can be regulated according to the brightest region and not according to the brightness average in the viewing field of the camera, with the result that very short exposure times and therefore measuring times are achieved.

A further increase in measuring accuracy and measuring reliability is achieved in that reflecting surface has a predetermined extension in the direction of oscillation, and in that the evaluation device scans for the signal from the image sensor row after the occurrence of the two changes in brightness having the highest contrast in each case and determines the position of the center of the marking from the center between the two changes in brightness. In this way, therefore, the two outer edges of the reflecting surface are recorded in the direction of extension of the image sensor row and the position of the marking is derived from the center between the two edges.

According to an advantageous development of the arrangement according to the invention, there is provision for arranging on the crane at least one laser distance profile-measuring instrument which, within a sensing angle range opened longitudinally relative to the direction of oscillation, generates a laser beam directed onto an outer edge of the load, said outer edge running transversely relative to the direction of oscillation, and which determines further load position data from the returning laser light, and for the line-scan camera and the laser distance profile-measuring instrument to have a linking device for linking the position data supplied by the line-scan camera and the further position data



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supplied by the laser distance profile-measuring instrument. In this way, the advantages afforded in the determination of position by means of laser distance profile-measuring instruments are associated with those of the
5 determination of position by means of a line-scan camera, the respective disadvantages of the two measuring methods being eliminated simultaneously. Thus, the laser distance profile-measuring instruments allow the instantaneous
10 determination of position of the load both in the horizontal and in the vertical direction, whilst, in the final phase of the approach of the load to the target, the position of the target can also be recorded. On the other hand, if there are still sufficiently short measuring times, high measuring accuracy necessitates a small
15 sensing angle range, so that, in the event of pronounced oscillations, the load may escape from the sensing angle range. For oscillation damping regulation and positioning regulation, the measuring times obtainable are always still relatively long. The line-scan camera has the
20 advantage of a larger recording angle and shorter measuring times. However, with a line-scan camera, only changes in position of the load in the horizontal direction can be recorded. The abovementioned development of the arrangement according to the invention now joins the said
25 advantages together, whilst, at the same time eliminating the disadvantages.

In the simplest instance, the linking device has a changeover device which allows a changeover between the position data of the laser distance profile-measuring
30 instrument and those of the line-scan camera. In this case, a changeover from the laser distance profile-measuring instrument to the line-scan camera takes place when the load escapes from the sensing angle range of the laser distance profile-measuring instrument or when the
35 measuring times of the laser distance profile-measuring instrument are too slow on account of very rapid oscillating movements of the load.

Preferably, a reciprocal plausibility monitoring and/or correction of the position data of the laser



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distance profile-measuring instrument and the line-scan camera is carried out in the linking device.

Since substantially shorter measuring times are achieved with the line-scan camera than with the laser distance profile-measuring instrument, there is advantageously provision, in the linking device, for inserting the position data coming from the line-scan camera as intermediate values between the further position data coming from the laser distance profile-measuring instrument.

In addition to the laser distance profile-measuring instrument and the line-scan camera, ultrasonic sensors can be arranged in the region of the load for direct collision monitoring in the direction of oscillation.

To explain the invention, reference is made below to the figures of the drawing; in particular:

- Fig. 1 shows a container crane having the arrangement according to the invention a marking, comprising a spotlight and a line-scan camera,
- Fig. 2 shows an example of the arrangement of the marking in relation to the orientation of the line-scan camera,
- Fig. 3 shows a block diagram of the line-scan camera,
- Figs. 4 and 5 show different examples of the shaping or arrangement of the marking in relation to the line-scan camera,
- Fig. 6 shows a container crane, as in Figure 1, which is additionally equipped with laser distance profile-measuring instruments,
- Fig. 7 shows the crane according to Figure 6 in a side view rotated through 90°,
- Fig. 8 shows a top view of the load suspended on the crane according to Figure 6, and
- Fig. 9 shows the block diagram of a control structure for the crane according to



Figure 6.

Figure 1 shows diagrammatically a travelling trolley 1 which is movable along a jib 2 of a container crane, said jib being shown only partially here. Arranged on the trolley 2 are lifting winches 3, on which a load pickup frame (spreader) 5 for a load 6 to be transported, here a container, is suspended via ropes 4. As a result of the starting and braking of the travelling trolley 1, but also as a result of external disturbing influences, such as, for example, wind forces, the load 6 may be set into an oscillating movement, as illustrated by the deflection, represented by broken lines, of the load 6 through an angle of oscillation α or over a distance x.

So that the oscillating movement of the load 6 can be measured, a marking 7 is attached to the load pickup frame 5, said marking being illuminated by a spotlight 8 which, in the position of rest of the load 6, is held vertically above the latter on the travelling trolley 1, the light reflected by the marking 7 being recorded by a line-scan camera 9 arranged directly next to or in the spotlight 8.

Figure 2 shows, in a diagrammatic perspective representation, the load pickup frame 5 suspended on the ropes 4 and having the marking 7 which is arranged on it and which consists of a rectangular reflecting surface 10 which is oriented with one edge side parallel to the direction of oscillation x and which is surrounded by a non-reflecting surface 11. The reflecting surface 10 consists of a multiplicity of triple reflector elements, not shown here, which reflect light striking them in the direction from which it has come. This ensures that the light emitted by the spotlight 8 is reflected by the reflecting surface into the line-scan camera 9 directly adjacent to the spotlight 8, specifically irrespective of the particular amount of oscillatory deflection x. The line-scan camera 9 is arranged on the travelling trolley 1 in such a way that its sensing plane intersects the marking 7 longitudinally relative to the direction of



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oscillation x , as indicated by the dot-and-dash line 12 which designates that region of the marking 7 recorded by the line-scan camera 9.

As shown in Figure 3, the line-scan camera 9 has an image sensor row 13 with a multiplicity of image sensor elements 14 which are located next to one another and the image information of which is transferred in parallel into a shift register 15 and is transmitted from there serially to an evaluation device 16. To record the position of the marking 7, the evaluation device 16 scans the serial signal S from the image sensor row 13 for the occurrence of the two changes in brightness having the highest contrast in each case and thereby detects the edges of the reflecting surface 10 which run transversely relative to the sensing direction 12. From the center between the two detected changes in brightness, the position of the center of the marking 7 is determined in the evaluation device and is made available as an output signal A via the output 17 of the evaluation device 16 for further processing, for example within the framework of load positioning regulation or a compensation of the oscillatory vibrations. An oscillating movement over the distance x results in a corresponding displacement in the signal trend S' from the image sensor row 13, the distance x being detected from this in the evaluation device 16. To record the angle of oscillation α , the lifting height and therefore the oscillation length l are measured by means of an incremental angle encoder 18 or an absolute encoder on one of the rope winches 3 and are fed to the evaluation device 16, in which the angle of oscillation is determined as $\alpha = \arcsin x/l$. So that the marking 7 does not escape from the viewing field of the line-scan camera 9 in the event of undesirable oscillating movements transverse to the oscillating movement x to be recorded, the marking 7 has a predetermined minimum width in the direction transverse to the orientation 12 of the image sensor row 13.

As shown in Figure 4, oscillating movements transverse to the orientation 12 of the image sensor row



13 can also be recorded, in that the reflecting surface 19 has a width varying transversely to the orientation 12 of the image sensor row 13. In this case, the component x of the oscillating movement in the direction of the image sensor row 13 is determined from the position of the image of the reflecting surface 19 on the image sensor row and the movement component y running transversely thereto is determined via the edge distance of the reflecting surface 19, said edge distance being recorded by the image sensor row 13.

Alternatively to this, are indicated in Figure 5 by a further dot-and-dash line 20, a further image sensor row, which is arranged transversely to the first image sensor row 13 and which records in the y direction in the same way as these oscillating movements, can be provided. Rotational movements of the marking 7 are recorded by arranging parallel to the image sensor row 13 and at a distance from this an additional image sensor row which records optically that region of the marking 7 designated by 21. In this case, as described with reference to Figure 2, the center between the edges of the reflecting surface 10 which are intersected by the two sensing directions 12 and 21 is determined in each case in the sensing direction 12 and in the sensing direction 21. A rotational movement of the load can thus be detected from the difference between the output signals from the evaluation devices following the two parallel image sensor rows.

Figure 6 shows a container crane which differs from the crane shown in Figure 1 by virtue of an additional two laser distance profile-measuring instruments 22 and 23 which are arranged on the travelling trolley 1 above the two outer edges 24 and 25 of the load pickup frame 5 or of the load 6 which run transversely to the direction of movement x of the trolley 1. The two laser distance profile-measuring instruments 22 and 23 make it possible to measure the respective instantaneous load position in relation to the environment of the load 6, so that a positionally



accurate depositing of the load 6 on an already set-down further container (target container) 26 is possible. Each of the two laser distance profile-measuring instruments 22 and 23 generates in each case a laser beam 27 and 28 which is deflected in a sensing angle measuring range opened longitudinally relative to the direction of oscillation x and intersecting perpendicularly the outer edge 24 and 25 located opposite the respective laser distance profile-measuring instrument 22 and 23. In Figure 6, those locations on the load pickup frame 5 or load 6 and its environment which the laser beams 27 and 28 strike are emphasized by a greater line thickness. By an evaluation of the transit time of the laser light and of the respective instantaneous angle of emission of the laser beam 27 or 28, it is possible, for each location which the laser 27 or 28 strikes, to determine its position coordinates in the horizontal x direction and the vertical y direction. As shown in Figure 6, when the load 6 approaches the target container 26, the laser beams 27 and 28 also record regions of the target container 26 as long as the load 6 is not positioned exactly above this. As soon as the two laser beams 27 and 28 no longer strike the target container 26, the container 6 is positioned directly above the target container 26 and can be lowered on to this.

The optimum position of the two laser distance profile-measuring instruments 22 and 23 in the x direction is not directly above the respective outer edges 24 and 25 of the load pickup frame 5 or of the load 6, but somewhat outside these, so that no dead angle inaccessible to the laser beams 27 and 28 is obtained underneath the outer edges 24 and 25. Furthermore, as the top view of the load pickup frame 5 together with the load 6 according to Figure 8 shows, the two laser distance profile-measuring instruments 22 and 23 are arranged with their sensing angle ranges 27 and 28 transversely to the x direction, that is to say offset in the z direction. It is thereby possible to measure not only oscillating movements in the x direction, but also rotational oscil-



lations of the load 6 which are expressed in that the x coordinates, measured by the laser beam 27 and 28, of the outer edges 24 and 25 change differently in time. The load pickup frame 5 is hydraulically adjustable in its longitudinal direction in the z direction and can thus be matched to the current container length. Since the container 6 may be open at the top or be covered by an irregular tarpaulin, the outer edges 24 and 25 can be sensed by means of the laser beams 27 and 28 most reliably where the outer walls of the container 6 which are parallel to the x direction run between the outer edges 24 and 25. So that the outer edges 24 and 25 can be sensed at these locations in the case of different container lengths, therefore, the two laser distance profile-measuring instruments 22 and 23 are arranged displaceably in the z direction on the travelling trolley 1.

By means of the two laser profile-measuring instruments 22 and 23, it is not yet possible, according to the current state of the art, to achieve simultaneously very high measuring accuracies and short measuring times over a relatively large sensing angle range. In order to obtain high measuring accuracy along with still tolerable measuring times, it is therefore necessary to restrict the sensing angle range to a few degrees. There is the risk, in this case, that the load 6 will escape from the viewing field of the laser distance profile-measuring instruments 22 or 23 in the event of pronounced oscillating movements. Moreover, the measuring times attainable in the case of a small sensing angle range are also relatively long for the purpose of using the measured values obtained for automatic load oscillation damping regulation or load positioning regulation.

The marking 7 is therefore attached to the load frame 5, said marking being illuminated by the spotlight 8 which, in the position of rest of the load 6, is held vertically above the latter on the travelling trolley 1, the light reflected by the marking 7 being recorded by



the line-scan camera 9 arranged directly next to or in the spotlight 8. The line-scan camera 9 is arranged on the travelling trolley 1 in such a way that its sensing plane 29 intersects the marking 7 longitudinally relative to the direction of oscillation x . By means of a line-scan camera, the position of the load 6 in the x direction can still be recorded even in the case of pronounced oscillating movements of the load 6, as already described with reference to Figures 1 to 3.

For collision monitoring in the x direction, ultrasonic sensors 30 are additionally arranged in the region of the two outer edges 24 and 25 of the load pickup frame 5.

In the arrangement of the laser distance profile-measuring instruments 22, 23 and of the line-scan camera 9, it was assumed that load oscillations take place mainly in the direction of movement x of the travelling trolley 1. If possible oscillations transverse thereto are also to be recorded, this can be carried out in the z direction by means of a further arrangement of two laser distance profile-measuring instruments and of a line-scan camera.

Figure 9 shows the block diagram of a control structure for the container crane according to Figure 6.

The two laser distance profile-measuring instruments 22 and 23 are connected to a common device 31 for data preprocessing which, from the sensed values obtained from the load 6 and its environment within the sensing angle ranges 27 and 28, determines the coordinate x_i and y_i of all the recorded edges $i=1...n$ of the regions emphasized by greater line thicknesses in Figure 6. These edge coordinates determined in the system of coordinates of the travelling trolley 1 are fed to a unit 32 for coordinate extraction, in which, from the edge coordinates and from outer dimensions of the containers 6 and 26 and of the load pickup frame 5 which are communicated to a master control unit 33, the position coordinates x_s , y_s of the load pickup frame 5, the load coordinates x_c , y_c of the load 6 and/or the coordinates



x_z , y_z of the target container 26, on which the load 6 is to be set down, are calculated. In addition to these position coordinates, the angles of rotation of the load pickup frame 5, of the load 6 and of the target container 5 26 in relation to the travelling trolley 1 are also calculated. Finally, the unit 32 supplies the coordinates of possible collision objects which may be located in front of or behind the target container 6, as seen in the direction of movement x .

10 In a further unit 34, the position coordinates determined with reference to the travelling trolley 1 can be converted into crane-related or land-related coordinates, for which purpose the current positions of the travelling trolley and of the container crane are in 15 each case communicated to the unit 34 by a trolley position measuring device 35 and a crane position measuring device 36 respectively. The coordinate values thus converted are fed to the master control unit 33 as actual position values for the crane control.

20 Furthermore, the position coordinates calculated in the unit 34 are fed to a device 37 for oscillation damping regulation and positioning regulation, which, in dependence on the coordinate values and on travel data communicated by the control unit 33, such as, for 25 example, current speed and acceleration values of the travelling trolley 1 and of the lifting winches 3, carries out a time-optimum control of the drive 38 for the travelling trolley 1 and of the drive 39 for the lifting winches 3, said control damping oscillations of 30 the load 6.

The position of the load pickup frame 5 or of the load 6 recorded by the line-scan camera 9 and converted into an x coordinate in the signal evaluation unit 16 is fed to the master control device 26 [sic] and to the 35 device 37 as an additional or alternative value to the corresponding position value determined by the laser distance profile-measuring instruments 22 and 23. For this purpose, the load position values in the x direction, coming from the laser distance profile-measur-

ing instruments 22 and 23 and from the line-scan camera 9, are interlinked in a linking device 40, before they are fed to the control unit 33 and to the device 37. The interlinking consists, in the simplest instance, of a changeover between the two values, in this case a changeover being made from the laser distance profile-measuring instruments 22 and 23 to the line-scan camera 9 whenever the load pickup frame 5 or the load 6 escapes from the sensing angle ranges 27 and 28. Furthermore, the position values supplied by the laser distance profile-measuring instruments 22 and 23 and the line-scan camera 9 may be used redundantly, a reciprocal plausibility check and/or correction of the values taking place by means of the values obtained redundantly. The position values obtained from the line-scan camera 9 at a substantially higher measuring rate serve for completing the position values coming from the laser distance profile-measuring instruments 22 and 23 at a lower measuring rate, so that, particularly in the case of rapidly changing load positions, such as, for example, violent oscillating movements, accurate measured values are available at the necessary high measuring rate for oscillation damping regulation and positioning regulation in the unit 37.

As indicated by broken lines in Figure 9, the linking device 40' can also be arranged in front of the unit 34 in the signal path.

For direct collision monitoring, the ultrasonic sensors 30 are connected directly to the control unit 33.

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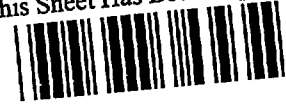




Patent claims

1. Arrangement for the recording by measurement of load pendulum oscillations in cranes, characterized in that a marking (7) with a reflecting surface (10) is arranged in the region of the load (6), in that a lighting device (8) directed onto the marking (7) is arranged on the crane, in that, furthermore, a line-scan camera (9) likewise directed onto the marking (7) and having an image sensor row (13) oriented longitudinally relative to the direction of oscillation (x) is arranged on the crane, and in that the line-scan camera (9) is followed by an evaluation device (16) which determines load position data from the signal (S, S') of the image sensor row (13).
2. Arrangement according to Claim 1, characterized in that the reflecting surface (10) has a predetermined minimum extension in the direction transverse to the orientation (12) of the image sensor row (13).
3. Arrangement according to Claim 1 or 2, characterized in that the extension of the reflecting surface (19) varies transversely to the orientation (12) of the image sensor row (13).
4. Arrangement according to Claim 1 or 2, characterized in that a further image sensor row (20) followed by a further evaluation device is provided transversely to the orientation (12) of the image sensor row (13).
5. Arrangement according to one of the preceding claims, characterized in that an additional image sensor row (21) having an additional evaluation device is provided parallel to the image sensor row (13), in that the marking (7) is so far extended in the direction transverse to the image sensor row (13) or an additional marking spaced from the marking in the direction transverse to the image sensor row is provided, so that it is recorded optically by the additional image sensor row (21), and in that a rotational movement of the load (6) about the axis of oscillation is detected from the difference between the position data supplied by the two





evaluation devices.

6. Arrangement according to one of the preceding claims, characterized in that the lighting device (8) and the line-scan camera (9) are arranged directly next to one another, and in that the reflecting surface (10) of the marking (7) consists of triple reflector elements.

7. Arrangement according to one of the preceding claims, characterized in that the lighting device (8) and the line-scan camera (9) are arranged in the immediate vicinity of the oscillatory suspension and, in the position of rest of the load (6), the marking (6) is arranged vertically below the latter.

8. Arrangement according to one of the preceding claims, characterized in that a measuring device (18) for determining the respective oscillation length (1) is provided, and in that the measurement signal from the measuring device (18) is evaluated in the evaluation device (16) together with the signal (S) from the image sensor row (13) in order to determine the angle of oscillation (α) and/or the instantaneous load position.

9. Arrangement according to one of the preceding claims, characterized in that the reflecting surface (10) is adjacent in the direction of oscillation to a non-reflecting, preferably matt-black surface (11), and in that, to determine the position of the marking (7), the evaluation device (16) scans the signal from the image sensor row (13) for the occurrence of the change in brightness having the highest contrast.

10. Arrangement according to Claim 9, characterized in that the reflecting surface (10) has a predetermined extension in the direction of oscillation (x), and in that the evaluation device (16) scans the signal (S, S') from the image sensor row (13) for the occurrence of the two changes in brightness having the highest contrast in each case and determines the position of the center of the marking (7) from the center between the two changes in brightness.

11. Arrangement according to one of the preceding claims, characterized in that there is arranged on the





- crane at least one laser distance profile-measuring instrument (2, 23) which, within a sensing angle range (27, 28) opened longitudinally relative to the direction of oscillation (x), generates a laser beam directed onto an outer edge (24, 25) of the load (5, 6), said outer edge running transversely to the direction of oscillation (x), and which determines further position data of the load (5, 6) from the returning laser light, and in that the line-scan camera (9) and the laser distance profile-measuring instrument (22, 23) [sic] a linking device (40) for linking the position data supplied by the line-scan camera (9) and the further position data supplied by the laser distance profile-measuring instrument (22, 23).
12. Arrangement according to Claim 11, characterized in that the linking device (40) has a changeover device which allows a changeover between the position data of the laser distance profile-measuring instrument (22, 23) and those of the line-scan camera (9).
13. Arrangement according to Claim 11 or 12, characterized in that a reciprocal plausibility check and/or correction of the position data from the laser distance profile-measuring instrument (22, 23) and the line-scan camera (9) is carried out in the linking device (40).
14. Arrangement according to Claim 11 or 13, characterized in that, in the linking device (40), the position data coming from the line-scan camera (9) are inserted as intermediate values between the further position data coming from the laser distance profile-measuring instrument (22, 23).
15. Arrangement according to one of the preceding claims, characterized in that ultrasonic sensors (30) are arranged in the region of the load (6) for collision monitoring in the direction of oscillation (x).

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