

DESCRIPTION

Title of Invention

PICKING CONTROL SYSTEM

Technical Field

[0001]

The present invention relates to a picking control system using a marker including a two-dimensional matrix code.

Background Art

[0002]

Hitherto, in a stage of shipment from a factory, a distribution base, or the like, work such as sorting of cargos, transshipment, or unloading has been automated by a robot.

[0003]

For example, Patent Literature 1 has already been proposed as a technology for automatically confirming and measuring a box-shaped picking target object to be gripped. Patent Literature 1 discloses a configuration in which a box-shaped picking target object to be gripped is accurately grasped by using two pieces of information of a two-dimensional image captured by a two-dimensional camera

and three-dimensional point cloud information acquired by a three-dimensional camera or the like in combination.

Citation List

Patent Literature

[0004]

Patent Literature 1: JP 2019-136828 A

Summary of Invention

Technical Problem

[0005]

Incidentally, there is a picking robot that performs picking work after being conveyed to an arbitrary work place by an automatic guided vehicle (AGV) or an autonomous mobile robot (AMR). There are various algorithms for causing the AGV or the AMR to autonomously travel, but there may be deviations from a control content in an actual environment. Therefore, a relative positional relationship between the picking robot conveyed by the AGV or the AMR and a basket-shaped object accommodating the picking target object is not constant, and there is a problem that it is necessary to control an operation after grasping the relative positional relationship each time.

[0006]

Further, in Patent Literature 1 described above, two

pieces of information of the two-dimensional image captured by the two-dimensional camera and the three-dimensional point cloud information acquired by the three-dimensional camera or the like are used in combination. However, since a processing load increases in a configuration in which the pieces of information are always used in combination, a configuration capable of controlling a picking operation only with a two-dimensional image has been desired.

[0007]

The present invention has been made in view of the above problems, and an object of the present invention is to provide a picking control system capable of grasping a relative positional relationship between a picking robot and a basket-shaped object based on two-dimensional captured image data and controlling a picking operation.

Solution to Problem

[0008]

A picking control system according to the present invention is a picking control system including: a picking robot that includes a two-dimensional camera for two-dimensionally photographing a picking target object and a hand unit that picks the picking target object, and performs picking work at an arbitrary work place; a control device that controls a picking operation of the picking

robot; and a conveyance tool that is a transfer source of the picking target object or a transfer destination of the picking target object and includes a portion for accommodating the picking target object, in which the conveyance tool includes markers including predetermined identification symbols at a plurality of positions, and is configured to acquire control support information usable for controlling an operation of the picking robot based on the identification symbols of the respective markers, and the control device includes: photographing means that acquires captured image data obtained by photographing the conveyance tool by the two-dimensional camera; positional relationship specifying means that specifies the marker included in the captured image data, specifies a position and a photographing angle of the two-dimensional camera based on how the marker appears, and further specifies a relative positional relationship between the conveyance tool and the picking robot; control support information acquisition means that acquires the control support information by reading the identification symbol as the marker appearing on the captured image data; control content determination means that determines a control content of the operation of the picking robot by using information regarding the relative positional relationship between the conveyance tool and the picking robot and the

control support information; and control execution means that performs control of the picking robot based on the determined control content.

[0009]

A picking control system according to the present invention is a picking control system including: a picking robot that includes a two-dimensional camera for two-dimensionally photographing a picking target object and a hand unit that picks the picking target object, and performs picking work after being conveyed to an arbitrary work place by an automatic guided vehicle (AGV) or an autonomous mobile robot (AMR); a control device that controls a picking operation of the picking robot; and a conveyance tool that is a transfer source of the picking target object or a transfer destination of the picking target object and includes a portion for accommodating the picking target object, in which the conveyance tool includes markers including predetermined identification symbols at a plurality of positions, and is configured to acquire control support information including at least coordinate position information of the plurality of markers as information usable for controlling an operation of the picking robot based on the identification symbols of the respective markers, and the control device includes: photographing means that acquires captured image data

obtained by photographing the conveyance tool by the two-dimensional camera; control support information acquisition means that acquires the control support information by reading the identification symbol as the marker appearing on the captured image data; positional relationship specifying means that specifies the marker included in the captured image data, specifies a coordinate position of each marker in the captured image data, specifies a coordinate position and a photographing angle of the two-dimensional camera by solving a perspective n-point (PnP) problem based on the coordinate position information of the plurality of markers acquired as the control support information and coordinate position information of the plurality of markers on the captured image data, and further specifies a relative positional relationship between the conveyance tool and the picking robot; control content determination means that determines a control content of the operation of the picking robot by using information regarding the relative positional relationship between the conveyance tool and the picking robot and the control support information; and control execution means that performs control of the picking robot based on the determined control content.

[0010]

Further, in the picking control system according to

the present invention, the conveyance tool records, as the control support information acquirable based on the identification symbol, information regarding an outer shape including a dimension of the conveyance tool and/or information regarding an installation position of the marker with respect to the conveyance tool as the control support information.

[0011]

Further, in the picking control system according to the present invention, the control content determination means estimates an approach distance to the accommodated picking target object based on the information regarding the outer shape including the dimension of the conveyance tool acquired as the control support information, and uses the approach distance for determining control amounts of the picking operation of the picking robot and a placement operation in a picking state.

[0012]

Further, in the picking control system according to the present invention, the conveyance tool records, as the control support information acquirable based on the identification symbol, information indicating an outer shape of the picking target object accommodated in the conveyance tool as the control support information.

[0013]

Further, in the picking control system according to the present invention, the control content determination means estimates a posture of the picking target object appearing on the captured image data based on the information indicating the outer shape of the picking target object acquired as the control support information, determines an optimum picking position in the estimated posture of the picking target object, and determines a control amount of the picking operation of the picking robot.

Advantageous Effects of Invention

[0014]

According to the present invention, the markers having predetermined identification codes are provided at a plurality of positions of the conveyance tool, and the control support information usable for controlling the operation of the picking robot can be acquired based on the identification symbol of each marker, whereby not only the relative positional relationship can be specified in the control device based on how the marker appears in the two-dimensional captured image data, but also position correction accuracy and picking accuracy can be improved by using the control support information.

Brief Description of Drawings

[0015]

Fig. 1 is an explanatory view for describing an overall configuration of a picking control system corresponding to at least one embodiment of the present invention.

Fig. 2 is a perspective view illustrating an example of a configuration of a basket-shaped object in the picking control system corresponding to at least one embodiment of the present invention.

Fig. 3 is an explanatory view for describing an example of control based on how the basket-shaped object appears in the picking control system corresponding to at least one embodiment of the present invention.

Fig. 4 is a block diagram illustrating an example of a configuration of a control device in the picking control system corresponding to at least one embodiment of the present invention.

Fig. 5 is a flowchart illustrating an example of a flow of operation control in the picking control system corresponding to at least one embodiment of the present invention.

Fig. 6 is a perspective view illustrating another example of the configuration of the basket-shaped object in the picking control system corresponding to at least one

embodiment of the present invention.

Fig. 7 is an explanatory diagram for describing a mechanism for determining a deviation amount of a relative positional relationship in another example of the configuration of the basket-shaped object in the picking control system corresponding to at least one embodiment of the present invention.

Fig. 8 is a perspective view illustrating another example of a configuration of a tool for conveyance in the picking control system corresponding to at least one embodiment of the present invention.

Description of Embodiments

[0016]

[First Embodiment]

Hereinafter, an example of a picking control system according to a first embodiment of the present invention will be described with reference to the drawings.

[0017]

Fig. 1 is an explanatory diagram for describing an overall configuration of a picking control system corresponding to at least one embodiment of the present invention. As illustrated in Fig. 1, a picking control system 100 includes at least a picking robot 10, a two-dimensional camera 20, a hand unit 30 included in the

picking robot 10, an automatic guided vehicle 40, and a basket-shaped object 50A. Although not illustrated, the picking control system 100 includes a control device 80 for controlling the picking robot 10. The picking control system 100 in this example is characterized in that a plurality of markers 60 each including a two-dimensional matrix code, for example, four markers 60A to 60D, are provided for the basket-shaped object 50A and used for controlling the picking robot 10.

[0018]

The picking robot 10 is a robot that includes the two-dimensional camera 20 for two-dimensionally photographing a picking target object and the hand unit 30 for picking the picking target object, and performs picking work after being conveyed to an arbitrary work place by an automatic guided vehicle (AGV) or an autonomous mobile robot (AMR). In this example, it is assumed that the picking robot 10 is conveyed to an arbitrary work place by the automatic guided vehicle 40 such as the AGV or the AMR and then performs the picking work, and the picking robot 10 may be installed separately from the automatic guided vehicle 40 at a conveyance destination, or may be an inseparable picking robot 10 integrated with the automatic guided vehicle 40.

[0019]

The two-dimensional camera 20 is configured to two-dimensionally photograph the basket-shaped object 50A accommodating a picking target object 70 or the basket-shaped object 50A to which the picking target object 70 is to be transferred. As long as the picking target object 70 can be photographed, an installation position and a photographing angle can be variously set. Specifically, it is conceivable to install the two-dimensional camera 20 in the vicinity of the hand unit 30 at a distal end of the picking robot 10. The vicinity of the hand unit 30 is a position that can be moved integrally with the hand unit, and refers to a position that does not affect the picking work even if moved in conjunction with the hand unit. The photographing by the two-dimensional camera 20 is controlled by the control device 80 described below.

[0020]

The hand unit 30 is configured to pick the picking target object 70. Although a configuration in which the hand unit 30 illustrated in Fig. 1 grips by pinching is exemplified, any configuration may be used as long as the picking target object 70 can be picked, and for example, the hand unit 30 having a configuration in which the picking target object 70 is sucked and lifted may be used.

[0021]

Fig. 2 is a perspective view illustrating an example

of a configuration of the basket-shaped object in the picking control system corresponding to at least one embodiment of the present invention. Here, the basket-shaped object 50 refers to a container having a space for accommodating the picking target object 70. Any object may be used as long as at least one or more picking target objects 70 can be accommodated in the object. In the example illustrated in Fig. 2, the basket-shaped object 50 is the basket-shaped object 50A opened only on a top surface. However, the basket-shaped object 50 includes a basket cart or the like that is opened on a top surface and a side surface and can be moved by wheels. In the basket-shaped object 50A illustrated in Fig. 2, four markers 60A to 60D are provided at four corners of an opening portion. In the marker 60, control support information usable for controlling an operation of the picking robot 10 is recorded as the two-dimensional matrix code. In a case where the plurality of markers 60 are provided, the same control support information may be recorded in all the markers, or different pieces of control support information may be recorded in the respective markers. In an example in which the pieces of control support information are different from each other, it is conceivable to register a positional relationship between the plurality of markers and to record which marker corresponds to which piece of

control support information in a distinguishable manner. As an example of the control support information, information indicating that the plurality of markers 60 are used together, information indicating a reference marker (for example, when one of the four markers provided at the four corners serves as the reference marker), information regarding a size of the basket-shaped object 50A, identification information for identifying the basket-shaped object 50A, information for specifying the picking target object to be accommodated in the basket-shaped object 50A, image information (for example, a plurality of images indicating a posture that may be taken when accommodated) of the picking target object to be accommodated in the basket-shaped object 50A, information regarding a size of the picking target object to be accommodated in the basket-shaped object 50A, information regarding a shape of the picking target object to be accommodated in the basket-shaped object 50A, and the like can be considered.

[0022]

In addition to a method of directly recording the control support information in the marker itself, link information to a server in which the corresponding control support information is stored may be recorded. Specifically, a control method in which after position

correction is performed with the marker, an inquiry is made to the server based on the link information obtained from the marker to acquire the control support information, and picking is performed using information of the picking target object as the control support information acquired from the server, or an inner dimension or a depth information of a box as the control support information is read and the picked target object (placing target object) is arranged so as to fit the box may be used.

[0023]

Fig. 3 is an explanatory diagram for describing an example of control based on how the basket-shaped object appears in the picking control system corresponding to at least one embodiment of the present invention. In the picking control system according to the present example, processing of estimating a relative positional relationship between the hand unit 30 on which the two-dimensional camera 20 is installed and the basket-shaped object 50A is executed based on a positional relationship in which the plurality of markers 60 in captured image data obtained by photographing using the two-dimensional camera 20 appear. As an example, as illustrated in Fig. 3, in a case where the four markers 60A to 60D installed at the four corners of a rectangle of the basket-shaped object 50A form a distorted shape (a trapezoid or the like) in the captured

image data, the distorted shape indicates that photographing has been performed from an oblique angle, and thus, position correction can be performed to adjust a photographing position such that the four markers 60A to 60D form a rectangle without distortion.

[0024]

More specifically, on the premise that coordinate information (marker coordinate system) of the four markers 60A to 60D on a marker installation plane has been grasped, a coordinate position and a photographing angle (camera coordinate system) of the two-dimensional camera 20 can be specified based on a known algorithm from a deviation amount from the coordinate information of the four markers 60A to 60D on the captured image data. Furthermore, if a conversion formula can be acquired by performing calibration based on a known algorithm between coordinate information of the two-dimensional camera 20 and coordinate information of the picking robot 10 (or the automatic guided vehicle 40 integrated with the picking robot 10), relative coordinate information of the picking robot 10 with respect to the basket-shaped object 50A can be acquired based on how the four markers 60A to 60D appear on the captured image data.

[0025]

As an example, first, the coordinate information

(marker coordinate system) of the four markers 60A to 60D on the marker installation plane is recorded in the two-dimensional matrix code as the control support information. Next, the coordinate information (camera coordinate system) of the four markers 60A to 60D on the captured image data is extracted. In a case where coordinate positions of the four markers 60A to 60D on the captured image data are (x_1, y_1) , (x_2, y_2) , (x_3, y_3) , and (x_4, y_4) , and coordinates of the four markers 60A to 60D on the marker installation plane are (X_1, Y_1) , (X_2, Y_2) , (X_3, Y_3) , and (X_4, Y_4) , position coordinates of the camera can be obtained by solving a perspective 4-point (P4P) problem. Even in a situation where one of the four markers does not appear on the captured image data, a perspective n-point (PnP) problem can be solved if n is 3 or more, and thus, the position coordinates of the camera can be obtained if three markers appear on the captured image data. In this manner, when the position coordinates of the camera are obtained, a coordinate position of the picking robot 10 itself can be obtained based on the posture of the picking robot 10 on which the camera is installed.

[0026]

Fig. 4 is a block diagram illustrating an example of a configuration of the control device in the picking control system corresponding to at least one embodiment of

the present invention. The control device 80 is configured to control a picking operation of the picking robot. The control device 80 may be configured by any means as long as control described below can be performed, and is implemented by, for example, a computer, a microcomputer, a programmable logic controller (PLC), or a combination thereof. Among these, the computer includes a central processing unit (CPU), a memory, and a storage such as a hard disk drive or a solid state drive (SSD), which are normally included in a general computer, includes an input device such as a mouse or a keyboard, an output device such as a display or a printer, and a communication device for connecting to a communication network, and may have a configuration these are connected via a bus. Processing in each unit of the control device 80 is implemented by reading a program for executing the processing in each unit from the memory and executing the program in the CPU, a graphics processing unit (GPU), or a field programmable gate array (FPGA) that functions as a control circuit (processing circuit or processing circuitry). In other words, a processor (processing circuit) is configured to be able to execute each processing of each device by executing the program. In addition, it goes without saying that various data used for the control device 80 and various data obtained as a result of processing by the control

device 80 are appropriately stored in a storage unit (not illustrated).

[0027]

As illustrated in Fig. 4, the control device 80 includes a photographing unit 81, a positional relationship specifying unit 82, a control support information acquisition unit 83, a control content determination unit 84, and a control execution unit 85.

[0028]

The photographing unit 81 has a function of acquiring the captured image data obtained by photographing the basket-shaped object 50A by the two-dimensional camera 20. In a case where a predetermined photographing condition is satisfied, the photographing by the two-dimensional camera 20 is performed in the photographing unit 81 to acquire the captured image data.

[0029]

The positional relationship specifying unit 82 has a function of specifying the markers included in the captured image data and specifying a relative positional relationship between the basket-shaped object and the picking robot based on how the markers appear and the position and the photographing angle of the two-dimensional camera. As an example, on the premise that the coordinate information of the plurality of markers 60 on the marker

installation plane has been gripped, the coordinate position and the photographing angle of the two-dimensional camera 20 are specified based on a known algorithm from the deviation amount from the coordinate information of the plurality of markers 60 on the captured image data, and the conversion formula is acquired by performing the calibration based on a known algorithm between the coordinate information of the two-dimensional camera 20 and the coordinate information of the picking robot 10, whereby the relative coordinate information of the picking robot 10 with respect to the basket-shaped object 50A is acquired based on how the plurality of markers 60 appear on the captured image data.

[0030]

The control support information acquisition unit 83 has a function of reading the two-dimensional matrix code as the marker appearing on the captured image data to acquire the control support information.

[0031]

The control content determination unit 84 has a function of determining a control content of the operation of the picking robot by using information regarding the relative positional relationship between the basket-shaped object and the hand unit and the control support information.

[0032]

The control execution unit 85 has a function of performing control of the picking robot based on the determined control content.

[0033]

Fig. 5 is a flowchart illustrating an example of a flow of operation control in the picking control system corresponding to at least one embodiment of the present invention. As illustrated in Fig. 5, the operation control is started when the control device 80 of the picking control system 100 acquires the captured image data obtained by photographing the basket-shaped object 50A (step S101). Next, the control device 80 specifies the position of the marker appearing on the captured image data (step S102). Next, the control device 80 specifies the relative positional relationship between the basket-shaped object and the picking robot based on how the marker appears (step S103). Next, the control device 80 reads the two-dimensional matrix code as the marker to acquire the control support information (step S104). Next, the control device 80 determines the control content by using positional relationship information and the control support information (step S105). Then, the control device 80 controls the picking robot based on the determined control content (step S106), and ends operation control.

[0034]

Next, a specific example of a method of using the control support information will be described. As an example, it is conceivable to record information regarding an outer shape including a dimension of the basket-shaped object 50A and/or information regarding an installation position of the marker with respect to the basket-shaped object 50A in the marker 60 including the two-dimensional matrix code. Then, it is conceivable that the control content determination unit 84 of the control device 80 estimates an approach distance to the accommodated picking target object 70 based on the information regarding the outer shape including the dimension of the basket-shaped object 50A acquired as the control support information, and uses the approach distance for determining control amounts of the picking operation of the picking robot 10 and a placement operation in a picking state.

[0035]

As another example, it is conceivable to record information indicating an outer shape of the picking target object accommodated in the basket-shaped object 50A in the marker 60 including the two-dimensional matrix code. Then, it is conceivable that the control content determination unit 84 of the control device 80 estimates a posture of the picking target object appearing on the captured image data

based on the information indicating the outer shape of the picking target object 70 acquired as the control support information, determines an optimum picking position in the estimated posture of the picking target object, and determines the control amount of the picking operation of the picking robot.

[0036]

As described above, with the picking control system 100 according to the present invention, the captured image data obtained by photographing the basket-shaped object by the two-dimensional camera is acquired, the marker included in the captured image data is specified, the position and the photographing angle of the two-dimensional camera are specified based on how the marker appears, the relative positional relationship between the basket-shaped object and the picking robot is further specified, the two-dimensional matrix code as the marker appearing on the captured image data is read to acquire the control support information, the control content of the operation of the picking robot is determined using the information regarding the relative positional relationship between the basket-shaped object and the picking robot and the control support information, and the control of the picking robot is performed based on the determined control content, so that the relative positional relationship can be specified in

the control device based on how the marker appears on the two-dimensional captured image data, and at the same time, position correction accuracy and picking accuracy can be improved by using the control support information.

[0037]

[Second Embodiment]

In the first embodiment, a container that is opened only on a top surface has been described as an example of the basket-shaped object 50A, but the present invention is not limited thereto.

[0038]

Fig. 6 is a perspective view illustrating another example of the configuration of the basket-shaped object in the picking control system corresponding to at least one embodiment of the present invention. In Fig. 6, as another example of the basket-shaped object 50, a basket-shaped object 50B as a basket cart is illustrated. In the basket-shaped object 50B, a top surface and a side surface are opened, and markers 60E and 60F are provided at two positions on a strut horizontally provided on a back side when an opened portion is viewed from the front.

[0039]

Fig. 7 is an explanatory diagram for describing a mechanism for determining a deviation amount of a relative positional relationship in another example of the

configuration of the basket-shaped object in the picking control system corresponding to at least one embodiment of the present invention. In a case where the basket cart as illustrated in Fig. 6 is photographed from a side, positions of the markers 60E and 60F in a height direction do not significantly change, and as illustrated in Fig. 7, as an inclination θ of the basket cart increases, photographing is performed in a state where a distance between the two markers 60E and 60F appearing in captured image data is shortened. That is, the inclination θ of the basket cart can be estimated from information regarding the distance between the two markers 60E and 60F. If the inclination θ of the basket cart can be specified, a control content for causing the picking robot 10 to face the basket cart can be determined.

[0040]

[Third Embodiment]

In the first and second embodiments, the basket-shaped objects 50A and 50B have been described as examples, but the present invention is not limited thereto.

[0041]

Fig. 8 is a perspective view illustrating another example of a configuration of a conveyance tool in the picking control system corresponding to at least one embodiment of the present invention. Fig. 8 illustrates a

pallet 50C as an example of the conveyance tool. The pallet 50C has a placement surface for placing a picking target object or the like, and a gap 90 (also referred to as a fork pocket) for inserting a claw (fork) of a forklift is provided below the placement surface. In the pallet 50C, for example, four markers 60G to 60J are provided at four corners of the placement surface. Even with such a pallet 50C, as in the first and second embodiments, a relative positional relationship between the pallet 50C and a picking robot is specified based on how the markers 60G to 60J appear, a two-dimensional matrix code as the marker appearing on captured image data is read to acquire control support information, a control content of an operation of the picking robot is determined using information regarding the relative positional relationship between the pallet 50C and the picking robot and the control support information, and control of the picking robot is performed based on the determined control content, whereby the same effects as those of the first and second embodiments can be obtained.

[0042]

The basket-shaped object 50A opened only on the top surface and the basket-shaped object 50B which is a basket cart illustrated in the first and second embodiments, and the pallet 50C illustrated in the third embodiment are examples of the conveyance tool used to convey the picking

target object, and even a conveyance tool other than the illustrated conveyance tools can be handled in the same manner as in the first to third embodiments as long as the conveyance tool is used to convey the picking target object and the marker 60 can be provided.

[0043]

[Fourth Embodiment]

In the first and second embodiments, the description has been given assuming that the captured image data is acquired using the two-dimensional camera 20 and the operation control of the picking robot 10 is performed based on the two-dimensional captured image data, but the present invention is not limited thereto. For example, even in a configuration in which captured image data is acquired using a two-dimensional camera 20 as in the first or second embodiment, and three-dimensional point cloud information based on a three-dimensional camera or a stereo camera is acquired and used, it is possible to improve accuracy of a picking operation of a picking robot by further acquiring control support information from a marker 60 as a two-dimensional matrix code and using the control support information for determination of a control content.

[0044]

In the first to fourth embodiments, the picking robot 10 that performs the picking work after being conveyed to

an arbitrary work place by the AGV or the AMR has been described, but the present invention is not limited thereto, and includes any means for conveying the picking robot 10 to an arbitrary work place. In addition, the first to fourth embodiments can be applied even in a case where it is assumed that a worker places the conveyance tool on which the picking target object 70 is placed in a work range of the picking robot 10 that is arranged at a fixed place and performs work. That is, in an environment where a relative positional relationship between the picking robot 10 and the conveyance tool on which the picking target object 70 is placed is not stable, it is possible to obtain the same effect by adopting the same configuration as in the first to fourth embodiments.

[0045]

In the first to fourth embodiments, the description has been given assuming that the two-dimensional matrix code is used as means for recording the control support information in the marker 60, but the present invention is not limited thereto. Any means may be used as long as the control support information can be directly recorded in the means or the means enable an access to the control support information stored in a server or a storage unit of a computer. For example, the marker 60 including a barcode, a unique figure that can be distinguished from others, a

character string as an identification code, and the like can be considered. That is, means for accessing the control support information may be the marker 60 including a predetermined identification symbol such as a two-dimensional matrix code, a barcode, a unique figure, or a character string.

Reference Signs List

[0046]

100	Picking control system
10	Picking robot
20	Two-dimensional camera
30	Hand unit
40	Automatic guided vehicle
50, 50A, 50B	Basket-shaped object
50C	Pallet
60, 60A to 60J	Marker
70	Picking target object
80	Control device
81	Photographing unit
82	Positional relationship specifying unit
83	Control support information acquisition unit
84	Control content determination unit
85	Control execution unit
90	Gap

CLAIMS

Claim 1. A picking control system comprising:

a picking robot that includes a two-dimensional camera for two-dimensionally photographing a picking target object and a hand unit that picks the picking target object, and performs picking work at an arbitrary work place;

a control device that controls a picking operation of the picking robot; and

a conveyance tool that is a transfer source of the picking target object or a transfer destination of the picking target object and includes a portion for accommodating the picking target object, wherein

the conveyance tool includes markers including predetermined identification symbols at a plurality of positions, and is configured to acquire control support information usable for controlling an operation of the picking robot based on the identification symbols of the respective markers, and

the control device includes:

photographing means that acquires captured image data obtained by photographing the conveyance tool by the two-dimensional camera;

positional relationship specifying means that specifies the marker included in the captured image data,

specifies a position and a photographing angle of the two-dimensional camera based on how the marker appears, and further specifies a relative positional relationship between the conveyance tool and the picking robot;

control support information acquisition means that acquires the control support information by reading the identification symbol as the marker appearing on the captured image data;

control content determination means that determines a control content of the operation of the picking robot by using information regarding the relative positional relationship between the conveyance tool and the picking robot and the control support information; and

control execution means that performs control of the picking robot based on the determined control content.

Claim 2. A picking control system comprising:

a picking robot that includes a two-dimensional camera for two-dimensionally photographing a picking target object and a hand unit that picks the picking target object, and performs picking work after being conveyed to an arbitrary work place by an automatic guided vehicle (AGV) or an autonomous mobile robot (AMR);

a control device that controls a picking operation of the picking robot; and

a conveyance tool that is a transfer source of the

picking target object or a transfer destination of the picking target object and includes a portion for accommodating the picking target object, wherein

the conveyance tool includes markers including predetermined identification symbols at a plurality of positions, and is configured to acquire control support information including at least coordinate position information of the plurality of markers as information usable for controlling an operation of the picking robot based on the identification symbols of the respective markers, and

the control device includes:

photographing means that acquires captured image data obtained by photographing the conveyance tool by the two-dimensional camera;

control support information acquisition means that acquires the control support information by reading the identification symbol as the marker appearing on the captured image data;

positional relationship specifying means that specifies the marker included in the captured image data, specifies a coordinate position of each marker in the captured image data, specifies a coordinate position and a photographing angle of the two-dimensional camera by solving a perspective n-point (PnP) problem based on the

coordinate position information of the plurality of markers acquired as the control support information and coordinate position information of the plurality of markers on the captured image data, and further specifies a relative positional relationship between the conveyance tool and the picking robot;

control content determination means that determines a control content of the operation of the picking robot by using information regarding the relative positional relationship between the conveyance tool and the picking robot and the control support information; and

control execution means that performs control of the picking robot based on the determined control content.

Claim 3. The picking control system according to claim 1 or 2, wherein the conveyance tool records, as the control support information acquirable based on the identification symbol, information regarding an outer shape including a dimension of the conveyance tool and/or information regarding an installation position of the marker with respect to the conveyance tool as the control support information.

Claim 4. The picking control system according to claim 3, wherein the control content determination means estimates an approach distance to the accommodated picking target object based on the information regarding the outer

shape including the dimension of the conveyance tool acquired as the control support information, and uses the approach distance for determining control amounts of the picking operation of the picking robot and a placement operation in a picking state.

Claim 5. The picking control system according to claim 1 or 2, wherein the conveyance tool records, as the control support information acquirable based on the identification symbol, information indicating an outer shape of the picking target object accommodated in the conveyance tool as the control support information.

Claim 6. The picking control system according to claim 5, wherein the control content determination means estimates a posture of the picking target object appearing on the captured image data based on the information indicating the outer shape of the picking target object acquired as the control support information, determines an optimum picking position in the estimated posture of the picking target object, and determines a control amount of the picking operation of the picking robot.