METHOD AND SYSTEM FOR THE GEOREFERENCED DETERMINATION OF THE LOCATION OF CONTAINERS IN THE LOADING RANGE OF CONTAINER CRANES

The invention relates to a method for georeferenced determination of the location of containers, especially in the loading area of container cranes according to the preamble of patent claim 1.

When using container cranes and a transport vehicle operating beneath the container crane to unload container ships, it is known to determine the current position of the container crane with a GPS-supported system.

Additionally, it is known also to equip the transport vehicles which are brought with the container outside the loading area or in the loading area of the container crane with a GPS supported determination of location.

However, it has been shown that when such a transport vehicle operates in the reception blackout area of the container crane caused by satellite reception, the crane-side GPS system is screened off from GPS satellite reception, so that no GPS location can be determined for the transport vehicles operating in the reception blackout area of the container crane.

For this reason it is not possible to precisely locate the container situated in the loading area of the container crane.

Previously aid has been rendered in that an operating person radioed instructions to the container crane operator as to which container he must deliver to where, to do a correct positional assignment of the container in the loading area. In other instances, processes were defined with which an assumption regarding the location of the container could be made with high probability.

When unloading containers from ships that are docked, it is known to read out the OCR-scannable information on the container and feed it into a port administration program. In this

way, what container is currently being unloaded, as it matches with its OCR-scannable label, is known in connection with the GPS coordinates of the container crane.

However, as soon as the container is hoisted by the container crane and delivered to the loading or unloading place on the ground, it is no longer possible to detect the current georeferenced position in the loading or unloading area of the container crane, because, in undesired fashion, this area is screened off by the container crane itself from satellite-supported receipt of GPS signals.

In this way, when using container cranes to load and unload containers, mixups result in such a way that the container present in the loading or unloading area can no longer be precisely localized, and therefore the wrong containers are delivered to the wrong locations.

Therefore the task that is the basis of the invention is to further develop a method and a system of the type named initially, so that containers can be precisely located in the loading and unloading area of containers.

To solve the set problem, the invention is characterized by the technical teaching of claim 1.

The essential feature of the invention is that now, instead of GPS localization of the transport vehicle that fails in the reception blackout area of container cranes, the distance of the transport vehicle to determined fixed points of the crane is determined.

Thus a relative location determination (position determination) of the transport vehicle operating in the crane area is generated in relation to the crane.

After the GPS coordinate of the crane are known, it is now possible, through compensation for the relative distance of the transport vehicle to the determined fixing marks of the crane and its GPS coordinates, to determine the absolute position of the transport vehicle, even in the reception blackout area of the crane.

What is meant by the term “reception blackout area” is that the outriggers or gantries or other parts of the container crane cover the transport vehicle operating under the crane so that the GPS system of the transport system can no longer receive and evaluate the signals of the GPS satellites operating with sky support.

It is here that the invention goes into service, making provision instead that the relative distance of the transport vehicle is measured in relation to the known position of the crane, and that these relative coordinates are compensated for in connection with the absolute position coordinates of the container crane so that at any time the exact position of the transport vehicle beneath the crane is determined.

Since the transport vehicle can hoist or lower either a single long container (40 feet) or two short containers (20 feet each), it is now possible to determine the absolute location of the transport vehicle at any time, to determine the position of the long container hoisted by the container crane or the two short containers hoisted by it.

Thus for the first time it is possible to use the port administration program to localize the containers that are situated in the loading or unloading area of the crane, and consequently determine their location precisely with absolute position coordinates.

Thus, errors regarding the location of the container are precluded, and no longer is such a container positioned in the wrong place at the wrong time.

Thus the given technical teaching yields a substantial advantage in that due to a simple measurement of distance of the relative coordinates of the transport vehicle, thus also the container detected by the transport vehicle can be determined in absolute, georeferenced coordinates and thus its absolute position can be determined in X-Y directions, and a Z-direction if necessary, in the setup area.

Instead of the Cartesian coordinates given here as an example, the known geocoordinates can also be used.

In a particularly preferred embodiment of the present invention, provision is made that the distance is measured according to the invention by wireless communication.

For this purpose a transponder is placed on the transport vehicle, which operates with a distance-measuring device operating via wireless communication. In this case, as an example, the distance is measured via a radio beacon and a transponder.

This distance-measuring device uses wireless communication to emit radio impulses at regular intervals, which are detected by receivers on the crane and sent back again. The transmission time of these pulses is determined, and from the transmission time, the exact distance is determined in the both or all three of the spatial planes.

For this it is preferred if at least three radio beacons are present in three different locations on the crane, which send back the received pulses.

Also conceivable is a version in which the distance-measuring device is attached to the transport vehicle and measures its distance to the transponders, which are attached as radio beacons on the legs of the crane, for example.

In another embodiment of the present invention, provision can also be made that, instead of wireless communication for distance measurement, the distance is measured optically, by a laser for example.

In a third embodiment of the invention, provision is made that the distance is measured via ultrasound.

In addition, other measurement principles for measuring distance are viewed as essential to the invention:
Time of Flight Measurement, which is radio measurement
Time difference of arrival

RSSI (Received Signal Strength Indicator)
UWB (Ultra Wide Band technology)
and more of the same.

Naturally the present invention is not limited to the position of the transport vehicle with the container (or double container) suspended on it being measured only in the reception blackout area of the container. In another embodiment of the invention, provision is made that the distance is measured in relation to two container cranes at a distance from each other and possibly operating separately.

Also, the distance can also be measured outside the GPS reception blackout area in the direction of only one crane.

According to one particular feature of the invention, provision is made that the signals of the transport vehicle are further processed via radio-supported technology. This means that one transponder (tag) is situated on the transport vehicle, which operates with a Reader that is preferably locationally fixed. However, the reader does not have to be fixed. And the radio beacon can constitute one device together with the reader.

Likewise, in a further development, provision can be made that also on the container crane, one or more transponders can be placed, which communicate with a positionally fixed reader device. In this case, the distance is measured between the crane and an additional known point, which then serves as a reference point.

The object of the present invention thus derives not merely from the object of the individual patent claims, but also from a combination of the individual patent claims with each other.

All of the data and features disclosed in the documentation, including the abstract, especially the spatial configuration depicted in the drawings, are claimed as essential to the invention, if individually or in combination they exhibit novelty vis-à-vis prior art.

In what follows the invention is explained in greater detail using drawings depicting just one embodiment route. From the drawings and the specification of same, further features and advantages of the invention essential to the invention are derived.

Shown are:

Figure 1: a schematic depiction of a container crane according to the invention, with depiction of the loading and unloading area and a transport vehicle operating there

Figure 2: a schematic depiction of a top-down view of the container crane with its loading and unloading area mostly in the reception blackout area

Figure 3: a block diagram of possible data processing to determine the current absolute position of the container hoisted by the transport vehicle

Figure 4: a variation of an embodiment form according to the invention, in which the distance is measured between two container cranes

Figure 1 generally depicts that a number of containers 1 is unloaded from a ship 2 which is docked in a harbor, by a container crane 5. For this, the container crane 5 exhibits one or more hoisting tools situated on the crane trolley 6, which are situated so as they can be raised and lowered in the directions of the arrows 7, for example.
In the embodiment example shown, the crane trolley 6 is brought into the position 6’, i.e., a container situated on the ship 1 is unloaded by running the crane trolley 6 along the gantry 4 and is to be delivered to a storage area 3.

For this purpose, a container storage area 8 is provided, in which one or more transport vehicles 9 operate.

For determining the absolute position of the crane 5, it has a GPS receiver 20, which picks up a transmission beam 19a, 19b, 19c, 19d from multiple satellites 18a, 18b, 18c, 18d, and based on

the transmission time differences between the various transmission beams 19, determines the absolute position of the container crane 5 in the storage area 3.

However, as soon as the container crane 5 with its gantry 4 moved over the storage area 3, the transport vehicle 9 operating in the reception blackout area 17 is screened off from satellite reception, and is no longer in a position to transmit an exact location using its own GPS receiver to the warehousing administration program.

In a manner known per se, the transport vehicle 9 is comprised of a gripping device 10, which is situated on a hoisting unit 11. It can move freely with wheels and, for example, is just lifting a container 12 which is situated in row 13 of the loading and unloading area. According to figure 2, in the loading and unloading area, two additional rows 14, 15 are situated, at which containers can be lowered or raised. The arrangement of two additional rows 14, 15 is one embodiment of the invention; however, other configurations of the loading and unloading area can be provided.

According to the invention, provision is now made that due to the screening off of transport vehicle 9 in the reception blackout area 17 of the container crane 5, the distance of the transport vehicle to established crane fixed points is measured.

Each crane fixed point is configured as a radio beacon 28, 29, wherein – as figure 2 shows – overall 4 different radio beacons 28a, 28b and 29a, 29b are present. This is to be understood as merely exemplary for a preferred constellation. The more radio beacons present, the more exact the distance measurement is to a distance sensor 26 connected with the transport vehicle, which simultaneously is data-linked with a transponder 23 situated on the transport vehicle or is part of same.

Thus the distance sensor 26 carries out distance measurements of measurement-interval duration to the radio beacons 28, 29 in fixed positions on the crane, and thus very precisely determines the distance of the transport vehicle 9 relative to the container crane 5.

The transponder 23 on the transport vehicle 9 operates with a Reader 24 preferably in a fixed position, which in turn compensates for the received data with the absolute crane position data.

As figure 1 shows, first in the GPS receiver 20 on the crane, the four satellite signals are received in a specific data format 21, and entered via an output 22 to a computer. According to figure 3, the crane coordinates 21 are compensated for via the output 22 with the aid of a computation of the current position of the crane in computing block 31.

This absolute position of the crane is fed to a computer 32 and linked with the data of the distance measuring device 26, by inputting them into a computing block 33, which determines the relative transport vehicle coordinates Xs, Ys, Zs.

Thus from this is derived a so-called Floating Reference Point 34, which means that now the relative coordinates of the transport vehicle 9 are inputted into the computer 32 and compensated for with the absolute location coordinates of the container crane 5. Via an output 35, this computation is passed to a computing block 36 and finally issued in computing block 37 as a result.

The result are the absolute positional coordinates of the container just hoisted or lowered by the transport vehicle or delivered with it.

As figure 2 shows, in a row 13, 14, 15, either a double container 12 or two single containers 12a, 12b can be placed, which however are always raised or lowered jointly or individually by the transport vehicle 9.

If, according to figure 2, transport vehicle 9 is located exactly above the double containers 12a, 12b placed in row 13, the distance is measured and converted in the previously-described procedural method with the absolute location coordinates of the container crane, wherein then the absolute position of the two containers 12a, 12b in row 13 is known, and thus a precise tracking is to be done of to which storage place the transport vehicle 9 takes these two containers.

Also conceivable are variations in which, for example, the position of the transport vehicle 9 is determined shortly beforehand or afterward, and the actual position is determined using an offset.

Thus at any time, the absolute position of the container hoisted or lowered by the transport vehicle is possible, even if the transport vehicle is operating in the GPS reception blackout area of container crane 5.

Figure 4 shows as a further development of the present invention that the distance does not necessarily have to be measured to a single container crane. In the embodiment example shown, two container cranes 5a, 5b are situated adjacent to each other, which operate at a certain interval on the dock. On each container crane 5a, 5b, the radio beacons 28, 29 necessary for distance measurement are placed, and the distance then is measured between the radio beacons both of the one container crane 5a and the other container crane 5b. In this way it is possible to measure the distance of the transport vehicle, even if it is not operating beneath a container crane 5, but rather next to such a container crane.

Likewise the invention is not limited to measuring distance using radio beacons that are situated on two container cranes 5a, 5b that are at an interval from each other.

It also suffices if the transport vehicle 9 measures distance only with the radio beacons 28, 29 of a single container crane 5, even if the transport vehicle 9 moves outside the reception blackout zone 17 of container crane 5.

In the general part of the specification, it has already been pointed out that in fact it is preferred that the distance be measured via an RFID-based system with radio beacons.

However, the invention is not limited to this. Instead of one such with distance measurement operating with wireless communication, measurements can also be made with ultrasonic, optical or laser-supported distance-measuring devices.

Legend for drawings

1	Container	20	GPS receiver
2	Ship	21	Data format
3	Storage area	22	Output
4	Gantry	23	Transponder
5	Container crane	24	Reader
6	Crane trolley	25	Data transmission
7	Arrow direction	26	Distance sensor
8	Container storage area	27	Measurement beam
9	Transport vehicle	28	Radio beacon
10	Gripping device	29	Radio beacon
11	Hoisting unit	30	Crane base
12	Container	31	Computing block
13	Row	32	Computer
14	Row	33	Computing block
15	Row	34	Relative coordinates
16		35	Output
17	Reception blackout area	36	Computing block
18	Satellite	37	Computing block
19	Transmission beam		

Patent Claims

1. Method for georeferenced determination of the location of containers (1, 12), especially in the loading area of container cranes (5), wherein satellite-supported determination is made of the position of the container crane (5) and of the transport vehicle (9) that hoists and lowers the containers (1, 12), **characterized in that** for detection of the absolute position coordinates of the containers (12) situated in the satellite reception blackout area (17), in a first procedural step, the distance is measured between at least one measurement point on the transport vehicle (9) and one or more measurement points on the container crane (5),

that in a second procedural step the position coordinates of the container crane (5) obtained by satellite-supported determination of position are set in regard to the relative coordinates of the transport vehicle (9) obtained through distance measurement

and that in a third procedural step, from the absolute crane coordinates and the relative position coordinates of the transport vehicle (9), the absolute position of the transport vehicle (9) and/or that of the container (12; 12a, 12b) situated beneath the transport vehicle is determined.

2. System according to claim 1, **characterized in that** the distance between the transport vehicle (9) and the container crane (5) is measured by wireless communication.

3. System according to claim 1 or 2, **characterized in that** on the transport vehicle (9), at least one transponder (23)/reader is placed, which determines the measured values regarding the relative position to the container crane (5) and transmits them on to a reader (24)/transponder, which is linked with a data processing unit (computer 32).

4. System according to one or more of the foregoing claims, **characterized in that** the relative position of the transport vehicle (9) is determined to at least two container cranes (5a, 5b) situated at an interval from each other.

5. System for georeferenced determination of the location of containers (1, 12), especially in the loading area of container cranes (5), wherein satellite-supported determination is made of the location of the container crane (5) and of the transport vehicle (9) that hoists and lowers the containers (1, 12), **characterized in that** at least one distance-measuring device for detection the relative position coordinates of the containers (12) situated in the satellite reception blackout area (17) and the container crane (5) is placed on the container crane (5) and/or on the transport vehicle (9),

that the position coordinates of the container crane (5) obtained through satellite-supported determination of the location, in regard to the relative coordinates obtained of the transport vehicle (9) determined through distance measurement, are processed in a data processing unit

and that from that the absolute position of the container (12; 12a; 12b) situated beneath the transport vehicle (9) is determined.

6. System according to claim 5, **characterized in that** on the transport vehicle (9) at least one transponder (23) is placed, which uses wireless communication to communicate with a reader (24), and that the reader (24) is data-linked with the data processing unit (computer 32).

7. System according to claim 5 or 6, **characterized in that** the measurement points on the crane (5) are configured as radio beacons (28, 29) and that the distance-measuring device (26) on the transport vehicle (9) is configured as a transponder (23).

8. Utilization of a system according to one of claims 5 to 7, **characterized in that** it is suitable for implementing the method according to at least one of the procedural claims 1 to 4.