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Transport system for transporting transport pieces

The invention relates to a transport system for the conveying of transport items, which comprises a large number of self-driving vehicles, which are in each case embodied for accommodating at least one transport item.

Large logistics centres with baggage, mail and/or package sorting installations, in which baggage items, letters and/or large letters and/or packages are processed, are operated for example by the company Siemens Postal, Parcel & Airport Logistics GmbH.

In these kinds of logistics centres, baggage items, letters, packages or consignments (referred to as sorting items in the following) are separated from an inventory, for example a stack, at a separating apparatus (material input), transported by a conveying system along a conveying path and are supplied, at multiple sorting outputs, for example realised by sorting diverters or crossbelt sorters or tilting apparatuses, to the respective destination points, such as destination points of a baggage sorting installation in an airport, for example.

During the transport or sorting process, the sorting items are sorted into the destination points. For the sorting process, each destination point is in each case assigned a variable destination code according to the sorting logic or according to the sorting process by means of a sorting/transport controller. The sorting items are also assigned a variable destination code, according to which they are then sorted into a destination point. Multiple destination points may also have the same destination code, for example in the case of destination addresses that are known to have high consignment volumes. This is useful, for example, if there is insufficient capacity at a destination point to receive all sorting items

for this destination code.

In industrial manufacturing plants, there is also a great need to transport structural parts, components and also the end products to previously determined points in the manufacturing plant. In addition to permanently installed assembly lines, since the early 1990s self-driving vehicles have also been used for this purpose, which accommodate the transport item together with information regarding the destination and autonomously move said transport item to the destination intended for it. Reference can be made here, for example, to the manufacturing of washing machines, tumble dryers and dishwashers with the manufacturing plants of AEG Hausgeräte GmbH in Nuremberg, Germany.

To control the self-driving vehicles, on the one hand a monitoring entity or also transport control entity is used, which communicates to the self-driving vehicle, for example, the next destination towards which the self-driving vehicle then autonomously moves. Likewise, data regarding the travel state and/or the vehicle state and the like can also be transferred from the self-driving vehicle. On the other hand, however, it is also possible for an item of destination information for the transport item to be read on the vehicle side, in response to which the self-drive vehicle then autonomously heads for the destination corresponding to said destination information.

The communication between the monitoring entity and the self-driving vehicles generally takes place as part of a wireless data transfer, for example in accordance with the transfer standard according to IEEE 802.11 (WLAN), IEEE 802.15.1 (Bluetooth), IEEE 802.15.4 (ZigBee). If the spatial extent of the travel area of the self-driving vehicles is very large,

however, then the wireless technology may reach its range limits, whereby the data transfer is either made slow or is interrupted or, in the worst-case scenario, is fully terminated.

In order to increase the range of these kinds of wireless technology, it is known to use what are known as repeaters, which are arranged in a stationary manner in the radio range and forward the data communication either wirelessly or also in a cable-supported manner. If the travel region of the self-driving vehicles changes and/or expands, however, the repeaters have to be rearranged, shifted and/or disassembled.

To this end, the German patent application DE 10 2009 043 060 A1 discloses a transport system for the conveying of transport items, wherein the transport items may be structural parts in industrial manufacturing, for example, wherein the transport system comprises the following units:

- a) a large number of self-driving vehicles, which are in each case embodied for accommodating at least one transport item;
- b) a monitoring entity for the self-driving vehicles, wherein the monitoring entity and the self-driving vehicles possess communication means for exchanging data, which enable communication from vehicle to monitoring entity and/or from monitoring entity to vehicle, wherein
- c) the communication means are at least partially embodied as wireless communication means, and wherein
- d) the wireless communication means are at least partially embodied as repeaters for the communication and are in each case arranged on one or more of the large number of self-driving vehicles.

Transport systems similar to this are also disclosed in the PCT unexamined patent application WO 2017/079460 A2 and the

German patent DE 10 2015 015 770 B3.

Starting from this prior art, the object underlying the present invention is thus to specify a transport system with self-driving vehicles, in which the travel region and the density of the self-driving vehicles can be modified as desired, without causing impairments to the communication between the monitoring entity and the self-driving vehicles.

This object is achieved according to the invention by the features of claim 1. Advantageous embodiments of the invention can be found in the further claims 2 to 4.

Particularly for the purpose of ensuring an adequate density of self-driving vehicles equipped with a repeater, the invention now provides that the monitoring entity is embodied such that communication with a self-driving vehicle equipped with a repeater can be carried out to the effect that said vehicle is moved to a predefinable position. To this end, it may already be sufficient if the monitoring entity predefines the information of a destination point for said vehicle and/or transfers an item of position information regarding the destination point to said vehicle. The present invention further provides that the monitoring entity, in the event of a presence of an inhomogeneous distribution of the self-driving vehicles, dispatches at least one self-driving vehicle equipped with a repeater into an area with a high density of self-driving vehicles in a targeted manner. In this manner it is possible for one or more additional data bridges to be created as required, whereby the stability of the communication remains ensured. It is additionally provided according to the invention that the monitoring entity is embodied such that, in the event of a presence of an area to be newly covered by self-driving vehicles, it dispatches at

least one self-driving vehicle equipped with a repeater into said area in a targeted manner. In this manner, one or more data bridges are likewise created for a new area, so that reliable communication is also enabled from the outset in said newly covered area. This makes a permanent installation of repeaters arranged at fixed positions obsolete.

A transport system embodied according to the invention is therefore characterised in that all the self-driving vehicles equipped with a repeater are thus support points for the wireless communication and divide the radio paths to be bridged, up to an access point of the system itself, into many short radio paths from repeater to repeater, whereby range-related problems can be fully eliminated. When adapting the travel region, it is also possible to carry out the radio-related coverage with the self-driving vehicles circulating in these travel regions on an ad hoc basis and to respond to corresponding high vehicle densities in an appropriate manner.

In an advantageous embodiment of the present invention, it is possible for a plurality of, preferably even all, self-driving vehicles to be equipped with a repeater. In this manner, a close-meshed network of repeaters is formed for wireless communication between the monitoring entity and even the self-driving vehicles operating furthest away from the access points, whereby uninterrupted communication can also be ensured over large distances.

In order to increase the signal quality and/or a maximum possible data transfer rate, it may be provided that a data transfer can be carried out in parallel via various repeaters.

In the aforementioned transport system, the transport items are structural parts in industrial manufacturing and/or

sorting items, such as letters, packages, bags, suitcases or the like, in a logistics flow.

Typically, in the transport system, the communication with the self-driving vehicle may comprise data regarding the travel state, such as position, travel direction, speed, for example, and/or regarding the vehicle state, such as maintenance state, battery state, for example, and/or regarding the loading state and/or regarding the destination to be headed for currently and/or next.

The monitoring entity may also ascertain the position of the circulating vehicles and create distribution profiles, as required.

In a further advantageous embodiment of the invention, it may be provided that the repeater of a self-driving vehicle transfers radio signals directly into a cable-bound infrastructure. This may take place during a loading operation, for example, when the self-driving vehicle is also coupled to a data interface during the loading operation.

Advantageous embodiments of the present invention are explained in further detail below with reference to the drawing. In this context the Figure shows a schematic representation of a transport system 2 for baggage items 3 in an airport terminal. To receive and to transport the baggage items 3 to destination points 4a to 4i, 6a to 6g, 8a to 8g and 10a to 10g provided in the further logistics flow, self-driving battery-operated vehicles 12 are provided, which are equipped with corresponding sensors for the navigation within the transport system 2. These sensors may be GPS sensors, for example, or magnetic field and/or e-field sensors, which are oriented towards transmitters and current loops installed in

the transport system 2. The transport system 2 further possesses a monitoring entity 14, which on the one hand takes over the control and/or the destination information supply for the autonomously driving vehicles 12 and on the other hand also controls the logistical process of the sorting of baggage items and thus also communicates, to a vehicle 12 loaded with a baggage item, where said baggage item 3 is to be transported. As an alternative or in addition to this, however, the self-driving vehicles 12 could also possess address capturing systems, such as barcode readers for example, with which they are themselves able to capture the address of a baggage item 3 currently loaded on the vehicle and then autonomously ascertain, if necessary also still in collaboration with the monitoring entity 14, where the baggage item 3 is to be transported. Whether a renewed communication with the monitoring entity 14 is necessary in this context depends significantly upon whether the self-driving vehicle is even actually capable of being able to ascertain the physical position of the destination from the read/captured address information of the baggage item 3. At the destination point itself, the baggage item 3 can then be handed over from the vehicle to the destination point, for example by a conveyor belt that is arranged on the vehicle and can be driven there or by a tilting apparatus or another form of unloading apparatus. It would also be possible to realise a gripping mechanism arranged on the destination point side or the like here.

For communication between the self-driving vehicles 12 and the monitoring entity 14, what are known as access points 16 are provided, which are connected to the monitoring entity 14 either in a cable-supported manner or also in a cable-free manner via an air interface. Although these access points 16 are arranged such that they are distributed somewhat evenly

and according to demand over the transport system 2, particular problems with regard to range and/or signal strength may also always occur here. For this reason, in the present exemplary embodiment, each of the self-driving vehicles 12 is equipped with a wireless repeater 18, which emits the communication received from the surrounding area once again and thus embraces a bridge function for the communication transmission. In this manner, the communication emitted by a self-driving vehicle can be conducted over parallel paths to one or more of the access points 16, which results in a high transfer integrity and transfer rate while the vehicles 12 are communicating with the monitoring entity 14.

As each self-driving vehicle also has an ID of the vehicle, which for example is a permanent constituent part in the headers of data frames emitted by the vehicle 12, the monitoring entity 14 is able to track the movement of the vehicles 12 and carry out particular further expedient evaluations, such as the density distribution of the vehicles and the like. To this end, the communication with a self-driving vehicle may comprise data regarding the travel state, such as position, travel direction, speed, for example, and/or regarding the vehicle state, such as maintenance state, battery state, for example, and/or regarding the loading state and/or regarding the destination to be headed for currently and/or next.

For this reason, the monitoring entity 14 here in the present case may also have the ability to communicate with a particular self-driving vehicle 12 in a very targeted manner and to transfer an item of information to said vehicle 12 which makes it possible for the self-driving vehicle 12 to move to a predefinable position within the transport system 2.

The monitoring entity 14, due to the communication with the self-driving vehicles 12, may further also be embodied such that, in the event of a presence of an inhomogeneous distribution of the self-driving vehicles, it dispatches at least one self-driving vehicle 12 equipped with a wireless repeater 18 into an area with a high density of self-driving vehicles 12 in a targeted manner. In this manner it is possible for one or more additional data bridges to be created as required, whereby the stability of the communication remains ensured.

The Figure furthermore also shows the case in which the monitoring entity 14, in the presence of an area 20 to be newly covered by self-driving vehicles 12, dispatches at least one self-driving vehicle 12a, 12b, 12c equipped with a wireless repeater 18 into said area 20 in a targeted manner, without said vehicles 12a, 12b, 12c themselves already having to be carrying a baggage item 3. In this manner, one or more data bridges are likewise created for the new area 20, so that reliable communication is also enabled from the outset in said newly covered area 20.

P a t e n t k r a v

1. Transportsystem (2) til transport af transportemner (3), hvor transportemnerne (3) er emner i en industriel produktion og/eller sorteringsemner, såsom breve, pakker, tasker, kufferter eller lignende, i en logistikstrøm, omfattende:

a) en flerhed af selvkørende køretøjer (12), som hver især er udformet til optagelse af mindst et transportemne (3);

b) en kontrolinstans (14) for de selvkørende køretøjer (12), hvor kontrolinstansen (14) og de selvkørende køretøjer (12) råder over kommunikationsmidler til dataudveksling, som muliggør en kommunikation fra køretøj (12) til kontrolinstans (14) og/eller fra kontrolinstans (14) til køretøj (12), hvor

c) kommunikationsmidlerne i det mindste delvist er udformet som trådløse kommunikationsmidler, og hvor

d) de trådløse kommunikationsmidler i det mindste delvist er udformet som repeatere (18) for kommunikationen og hver især er anbragt på et eller flere af flerheden af selvkørende køretøjer (12),

kendetegnet ved, at

kontrolinstansen (14) er udformet således, at

i) en kommunikation med et selvkørende køretøj (12), der er udstyret med en repeater (18), i hvert tilfælde kan udføres i det omfang, at dette køretøj (12) bevæger sig til en på forhånd angivet position; og

ii) kontrolinstansen (14) er udformet på basis af kommunikationen med de selvkørende køretøjer (12) således, at den, i tilfælde af, at der foreligger en ikke ensartet fordeling af de selvkørende køretøjer (12), målrettet sender mindst et selvkørende køretøj (12), der er udstyret med en repeater (18), afsted ind i et område med en høj tæthed af selvkørende køretøjer (12); og

iii) kontrolinstansen (14) er udformet således, at den, i tilfælde af, at der foreligger et nyt område (20), der er tilgængeligt for selvkørende køretøjer (12), målrettet sender mindst et selvkørende køretøj (12), der er udstyret med en repeater (18), afsted ind i dette område.

2. Transportsystem (2) ifølge krav 1,

kendetegnet ved, at flere, fortrinsvis alle, selvkørende køretøjer (12) er udstyret med en repeater (18).

3. Transportsystem (2) ifølge krav 1 eller 2,

kendetegnet ved, at

der kan udføres en datatransmission parallelt via forskellige repeatere (18).

5 4. Transportsystem (2) ifølge et af de foregående krav,

kendetegnet ved, at

kommunikationen med et selvkørende køretøj (12) omfatter data vedrørende kørselstilstanden, såsom f.eks. position, kørselsretning, hastighed, og/eller vedrørende køretøjstilstanden, såsom f.eks. vedligeholdelsestilstanden, batteriladningstilstanden, og/eller vedrørende læssetilstanden og/eller vedrørende den destination, som der skal styres mod aktuelt eller som den næste.

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