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Process and arrangement for the automated conveying,
sorting and loading of baggage items

Description

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The invention relates to a process for the automated conveying, sorting and loading of baggage items in facilities which have a baggage-conveying facility which conveys the baggage from a check-in region to a
10 baggage area, from where it is transported for loading into transporting vehicles.

The automated conveying and sorting of baggage items has already been realized in facilities such as a large
15 number of relatively large airports. These facilities serve for transporting baggage items from various charging locations, for example a check-in region, in specific terms relating to flight number and travel class, to corresponding loading stations, in the case
20 of which the baggage items are manually reloaded into suitable loading means, such as carts or containers, for transportation to the aircraft.

The transportation of the package items takes place in
25 this case by conveying equipment such as conveying belts, shell-type transporting systems (endless belt with transporting shells joined to one another) or guided vehicles.

30 For sorting the baggage in such a system, manual or automated baggage-data recognition in accordance with flight destination, airline and travel class takes place, the corresponding data being retained on data carriers, usually bar-coded paper strips, fastened on
35 the respective baggage item.

Furthermore, the individual baggage items are spatially separated from one another within the conveying facility so as to ensure that the baggage item can be

clearly tracked during transportation. In facilities with conveying belts, this takes place by a minimum distance being ensured between the baggage items, and otherwise by assigning the baggage item to a defined element, for example, shell or carriage, of the conveying equipment.

The destination of the baggage items in the facility is a loading station. In this case, these are assigned to certain flights, as appropriate also connecting-flight destinations and/or travel classes.

Within the automating system of the facility, the information regarding baggage item and the whereabouts thereof in the facility are combined with the destination and converted into control commands for the facility. The baggage items are transported to the corresponding loading station and discharged there.

The essential technical embodiments and processes brought in nowadays are set out comprehensively in "Airport Development Reference Manual" and in "Passenger Services Conference Resolutions Manual" from IATA.

However, all the known processes and systems only concern the transportation and sorting of the baggage items. Loading takes place manually and does not form part of the automated transporting process.

Previous attempts to automate this process step as well have failed since it has not been possible to set out suitable solutions, in conjunction with the above-described handling process, for the wide range of baggage items which are to be handled.

The solutions which have already been realized in other industrial applications, for example loading packs onto pallets, cannot be transferred since the solutions

developed there, for example robots with specific gripping tools, can only be used in each case for very limited ranges of shapes, structures, dimensions, etc.

5 A considerable disadvantage of the known arrangements and processes is that the loading of the baggage items onto the transporting means for further transportation to the aircraft takes place manually. On the one hand, this requires a large number of operators and thus high
10 costs during the loading operation and, on the other hand, manual loading is very physically strenuous for those involved. Furthermore, the manual aspect means that there is a considerable risk of incorrect loading and also theft.

15 Replacement of manual loading by an automated station, for example with robots or loading apparatuses, for maintaining the current processes and arrangements for transporting and sorting cannot be realized for
20 practical usage on account of the limitations in handling technology and the large range of baggage items which are to be handled.

Taking this prior art as the departure point, the
25 object of the invention is thus to specify a process of the type mentioned in the introduction, and the technical realization thereof, which allows automation of the transporting, sorting and loading process.

30 This object is achieved according to the invention by the characterizing features of Patent Claim 1.

Accordingly, it is provided that, in a first step, for each baggage item, the flight destination and travel
35 class thereof, as well as the weight, shape, volume and consistency thereof are recorded and registered and that, in a second step, the recorded baggage data are analysed in a computer system (packing computer) which divides the baggage items into predetermined classes

and determines optimum assignment to the loading means in accordance with classification and flight destination as well as a corresponding loading scheme for the individual loading means and that, in a third
5 step, the loading means are fed, in accordance with the loading sequence, to individual loading stations by an automatic transporting system, and that, in a fourth step, the baggage items classified in this way are transported for loading, in a sequence necessary for
10 the loading operation, in accordance with the defined assignment to loading stations.

The essence of the invention is thus the novel configuration of the baggage-handling process for
15 airports which have been equipped, or will be equipped, with an automated baggage-conveying facility. In this case, the sorting of the baggage items and the assignment thereof to the loading stations takes place not, as is the case currently, in accordance with
20 flight destination and, if appropriate, travel class, but additionally in accordance with the baggage type or the handling equipment suitable for the specific baggage item.

25 On the one hand, this makes it possible only for baggage of a certain classification to be fed to the loading stations automated according to the invention. On the other hand, however, this also means that the loading means, such as containers and carts, which are
30 assigned to a certain flight, and assume the task of transportation from the baggage facility to the respective aircraft, have to be loaded with baggage at various loading stations.

35 The process according to the invention for baggage handling and the developments thereof accordingly comprise the following steps:

1. Automated recording of the baggage properties, that is to say, in addition to the associated

passenger, the flight destination and the travel class, also weight, shape, volume, consistency of the baggage item.

5 Transmission of the baggage data to part of the computer system ("packing computer"), which divides the baggage items into predetermined classes and, in accordance with

10 2. Classification and flight destination, determines optimum assignment to the loading means. The optimization takes place here both in relation to the highest possible packing density of the loading means and in relation to a loading sequence which treats the individual baggage items as carefully as possible. Thus, for example, heavy
15 and hard parts are loaded first of all, while flexible and lightweight parts are then stacked thereon.

20 3. Assignment of the baggage items and of the loading means to certain loading stations, in accordance with the baggage classification and the packing and/or stacking planning according to Step 2 and in accordance with the flight destination. In this case, the baggage items assigned to a loading station may have various flight destinations, but
25 always belong to a certain baggage class. The assignment takes place in a further part of the computer system ("sorting computer"), which also assumes the task of transferring data to the automating system of the baggage-conveying
30 facility.

4. Sorting and transporting the baggage items to the respective loading stations.

35 5. Transporting the loading means to the respective loading stations and loading the baggage items within the loading stations assigned to them. Depending on the baggage class, automated, semi-automated or manual loading stations may be used for this purpose.

It is particularly important here that the recording of the volume and of the contour of the baggage items and of the consistency takes place automatically without anyone being involved.

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The data relating to destination of the baggage item and the properties thereof such as weight, volume, shape and consistency are advantageously recorded and stored during check-in of the relevant passenger, it
10 being the case that the recorded data are stored directly in the computer of the baggage-conveying facility or on data carriers which are provided on the baggage items and, during passage through the loading path, are automatically detected by optical or
15 electronic reader units provided for this purpose, in order to control the loading operation.

An expedient development of the invention is that the loading operation of the baggage items is monitored with the aid of optical image-recognition systems by
20 means of which the respective position of the baggage items is detected and corrected, if required, with the aid of mechanical tools, for example gripping tools, it being the case that the respective position of the baggage items is indicated by the image-recognition
25 system if required, in particular with the occurrence of disruptions, and, with the aid of three-dimensional visualization, the use of the mechanical tools, for example gripping tools, is controlled by an operator in order to eliminate the disruptions indicated.

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A further object of the invention is to specify an arrangement for implementing the above-described process, said arrangement being formed by a baggage-conveying facility which is arranged in an
35 airport and is connected to a computer system which controls the movement of the conveying means and control means, the baggage-conveying facility having at least one supply station and at least one collecting station, and having at least one loading station.

In order to achieve this object, provision is made for providing in the region of the supply station means which record automatically determined characteristic variables of the supplied baggage items, such as weight, shape, volume and consistency as well as flight destination and travel class, and make these data available to a computer which controls the baggage-conveying facility and, in accordance with the respective data, controls the transportation of the baggage items to the associated loading station.

Corresponding to a further development of the arrangement according to the invention, automated loading tools, for example robots and/or gripping tools, may be provided for the loading.

According to an advantageous configuration of the above-described arrangement, it is also possible for an automated transporting apparatus to be provided for the transfer of the loading means to the loading stations.

These and further features of the invention form the subject matter of the subclaims and are specified in the following description of an exemplary embodiment.

The invention, preferred configurations of the invention as well as the process sequence according to the invention and further features of the invention will be explained and described in more detail with reference to an exemplary embodiment illustrated in the attached drawing, in which:

Figure 1 shows a flow diagram for the process according to the invention;

Figure 2 shows a schematic overall view of a baggage-conveying facility according to the

invention with island-like loading stations;
and

Figure 3 shows a schematic plan view of an individual
island-like loading station with robots
5 (enlarged detail from Figure 2).

The flow diagram shown in Figure 1 specifies
schematically the process sequence according to the
invention, which is set out in a largely
10 self-explanatory manner and can be understood in
conjunction with what has been explained above and with
what will be explained below.

Figures 2 and 3 show an exemplary embodiment of a
15 baggage-conveying facility by means of which the above-
described process can be realized. In this case, the
drawing shows only that part of the arrangement which
is essential for the automated loading since the
conveying technology otherwise corresponds to the known
20 arrangements from current systems.

In Figure 2, individual loading regions 10, which are
referred to as loading islands and form individual
loading stations, are arranged one beside the other.
25 The loading islands 10 each have handling stations 12,
dynamic intermediate stores 14 for baggage items,
baggage feed means 16 and loading means 18, for example
containers, carriages or carts, which interact with a
transporting system for loading means 20.

30 Figure 3 illustrates an individual loading island 10
which has, by way of example, two loading locations 22
for manual loading and, in the example shown, ten main
loading locations 26 provided with loading robots 24.
35 The rest of the features have already been shown in
Figure 2 and explained in relation to the same.

Accordingly, the facility essentially comprises the following sub-systems with respectively specified individual functions:

- Baggage feeding from the check-in region or transfer baggage charging with conventional technology

- Baggage sorting and baggage transportation:

The mechanical execution takes place in accordance with the prior art. Essential innovations according to the invention relate to additional measures and equipment for baggage identification and baggage classification, such as measuring and computer systems.

The baggage properties may be recorded here via various measuring equipment. For the execution of the process according to the invention, the selection of the measuring means used is irrelevant; all that is necessary is for it to be possible for the essential properties characterizing the baggage item to be reliably recorded and fed to the computer system.

These properties are

Flight destination and travel path,

the recording of which takes place by the data being entered manually or in an automated manner during check-in in accordance the prior art. In this case, the data either may be entered directly into the computer system of the baggage-conveying facility or they are transferred to storage media which are then read out within the baggage-conveying facility. In the current prior art, this takes place by the so-called baggage tags (bar-coded paper strips) which are read out optically. According to the invention, then, it is also possible to use, for this purpose, radio-frequency transponders, in which a relatively large number of data can be registered and to which it is also possible, to some extent, to write subsequently. This technology envisaged for the process according to the invention allows a considerable improvement in data

management, but is not absolutely necessary for realizing the invention.

Weight:

The weight can be recorded both during check-in and by weighing scales integrated in the conveying facility

Volume/contour:

The measuring of the volume and contours of baggage items can take place in two ways, namely by means of optical systems, for example by an arrangement of light emitters and light detectors and/or by evaluation of an image-recognition system, or by means of X-radiation, by the units used for the safety checking of the baggage also being used for detecting the contour and the volume of the baggage items.

Consistency:

For determining the consistency, that is to say essentially checking the surface properties of the baggage items for the following criteria: hard/flexible, smooth/rough, flat/textured, etc., it is envisaged to use a combination of measuring equipment, for example tactile sensors, image-recognition processes and determination of the chemical composition by means of X-ray analysis.

• Loading stations

The loading stations essentially comprise three sub-systems:

Dynamic intermediate store for the transfer of the baggage between the transporting system and the handling equipment.

This sub-system is not absolutely necessary for the process described in the invention, but is expedient if the process is to be used in baggage-conveying facilities in which a high throughput is required. A possible realization of this is set out in the application document with reference number 199 31 756.9.

Handling equipment for loading the baggage into the loading means

Depending on the baggage category, the loading takes place in a fully automated or semi-automated manner. For exceptional cases (outsized or very fragile baggage items) purely manual loading locations also have to be provided. The (semi-) automated handling equipment may be realized, for example, by the use of robots. Depending on the baggage category, these are provided with corresponding gripping tools, for example suction grippers, mechanical grippers, etc. The robots are expediently used with exchangeable grippers with the result that various gripping tools can be used at one station and greater flexibility is thus allowed in the application.

Monitoring and control equipment for the monitoring and correction of the loading operation. For the monitoring and control of the loading operation, it is possible to use, by way of example, optical image-recognition systems. These systems record, for example, the precise position of the supplied baggage item and, accordingly, align the gripping tools and the robot. The stacking operation into the loading means is also monitored by the optical image recognition, in order to detect errors in the unloading of the baggage items and to initiate remedial measures.

Both in the correction of loading errors and for the semi-automatic loading in the case of relatively complex baggage items or in the case of relatively complex stacking operations, it has to be possible for an operator to intervene. This intervention takes place such that no direct access into the loading station is necessary since otherwise, for safety reasons, the station would have to be switched off first of all (time problem). This can be achieved, for example, by a

control system which is based on virtual reality technologies and in the case of which, via an image-recognition system, the loading situation is visualized in 3D and real time and the operator can
5 carry out control and correction operations without direct manual intervention.

Transporting system for the loading means

10 In accordance with the assignment of baggage items and loading means (Step 3 of the process), the loading means are fed to the individual loading stations at the correct times via a transporting system. This transportation may take place, for example, via a
15 conveying belt or a rail-bound transporting vehicle on which the loading means are positioned.

In the exemplary embodiment illustrated in Figures 2 and 3, the various loading stations for the various
20 baggage categories are combined into "loading islands". In such an embodiment, for example 5 flight destinations would be assigned to one loading island. The loading means required for these flights would be introduced into the associated transporting system and
25 then guided past the loading stations. The sorting of the baggage items takes place such that it is only baggage items for the assigned flights which are transported to said loading island. The baggage items are then assigned to the appropriate handling station
30 in accordance with their category, for example hard-shell suitcases or rucksacks.

Within the dynamic intermediate store, the baggage items are first of all stored and then discharged to
35 the handling equipment when the loading means assigned to the flight destination thereof has likewise arrived at the handling station. The handling stations are expediently arranged such that the heavy and hard

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baggage items are loaded first of all in the first stations approached by the loading means.

Patent Claims

1. Process for the automated conveying, sorting and loading of baggage items in airports which have a baggage-conveying facility which conveys the package from a check-in region to a baggage area, from where it is transported for loading into aircraft, characterized in that, in a first step, for each baggage item, the flight destination and travel class thereof as well as weight, shape, volume and consistency thereof are recorded and registered, in that, in a second step, the recorded baggage data are entered into a computer system (packing computer) which divides the baggage items into predetermined classes and determines optimum assignment to the loading means in accordance with classification and flight destination, in that, in a third step, the baggage items handled in this way are transported for loading in accordance with the defined assignment to loading stations, and in that, in a fourth step, the baggage items are loaded into loading means essentially automatically with the aid of robots and gripping tools and/or mechanical loading apparatuses.
2. Process according to Claim 1, characterized in that the loading of the baggage items takes place carefully in accordance with the classification in terms of their weight and their consistency, in that hard and/or heavy baggage items are arranged in the vicinity of the bottom, and that soft and lightweight baggage items are stacked thereon.
3. Process according to either of Claims 1 and 2, characterized in that the loading of the baggage items takes place in accordance with the assignment thereof to baggage classes and flight destinations.





4. Process according to Claim 3, characterized in that the assignment of the baggage items to baggage classes and flight destinations takes place by a computer which controls the baggage-conveying facility and also carries out the data transfer to the baggage-conveying facility.
5. Process according to one of the preceding claims, Claims 1 to 4, characterized in that the data relating to destination of the baggage item and the properties thereof such as weight, volume, shape and consistency are recorded and stored during check-in of the relevant passenger.
6. Process according to one of the preceding claims, Claims 1 to 5, characterized in that the recording of the volume and of the contour of the baggage items and of the consistency takes place automatically without anyone being involved.
7. Process according to Claim 5 or 6, characterized in that the recorded data are stored directly in the computer of the baggage-conveying facility.
8. Process according to Claim 7, characterized in that the recorded data are stored on data carriers which are provided on the baggage items and, during passage through the loading path, are automatically detected by optical or electronic reader units provided for this purpose, in order to control the loading operation.
9. Process according to one of the preceding claims, Claims 1 to 8, characterized in that the loading operation of the baggage items is monitored with the aid of optical image-recognition systems by means of which the respective position of the



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baggage items is detected and corrected, if required, with the aid of mechanical tools, for example gripping tools.

- 5 10. Process according to Claim 9, characterized in
that the respective position of the baggage items
is indicated by the image-recognition system if
required, with the occurrence of disruptions, and
in that, with the aid of three-dimensional
10 visualization, the use of the mechanical tools,
for example gripping tools, is controlled by an
operator in order to eliminate disruptions.
- 15 11. Arrangement for implementing the process according
to one of the preceding claims, having a
baggage-conveying facility which is arranged in an
airport and is connected to a computer system
which controls the movement of the conveying means
and control means, the baggage-conveying facility
20 having at least one supply station and at least
one collecting station, and having at least one
loading station, characterized in that provided in
the region of the supply station are means which
record automatically determined characteristic
25 variables of the supplied baggage items, such as
weight, shape, volume and consistency as well as
flight destination and travel class, and make
these data available to a computer which controls
the baggage-conveying facility and, in accordance
30 with the respective data, controls the
transportation of the baggage items to the
associated loading station.
- 35 12. Arrangement according to Claim 11, characterized
in that automated loading tools, for example
robots and/or gripping tools, are provided for the
loading.

13. Arrangement according to Claim 11 or 12, characterized in that an automated transporting apparatus is provided for the transfer of the loading means to the loading stations.

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