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Knight et al.

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(54) **ASYNCHRONOUS AUTOMATED CORRECTION HANDLING IN CONCIERGE SYSTEM OF INCORRECTLY SORTED ITEMS USING POINT-OF-SALE DATA**

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(Continued)

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G06Q 10/087	(2023.01)
G06Q 20/40	(2012.01)

(52) **U.S. Cl.**
CPC ***G06Q 10/0833*** (2013.01); ***G06Q 10/087*** (2013.01); ***G06Q 20/4015*** (2020.05)

(58) **Field of Classification Search**
CPC G06Q 10/0833; G06Q 20/40
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,832,517 A * 11/1998 Knutsen, II G06F 11/1471
7,385,499 B2 6/2008 Horton et al.
(Continued)

FOREIGN PATENT DOCUMENTS

KR 2010/0041156 A 4/2010
WO WO-2022020870 A1 * 2/2022 ..... B65G 43/08

OTHER PUBLICATIONS

"Different Picking System in a Warehouse," by iThink Logistics, Aug. 1, 2020 (Year: 2020).*
(Continued)

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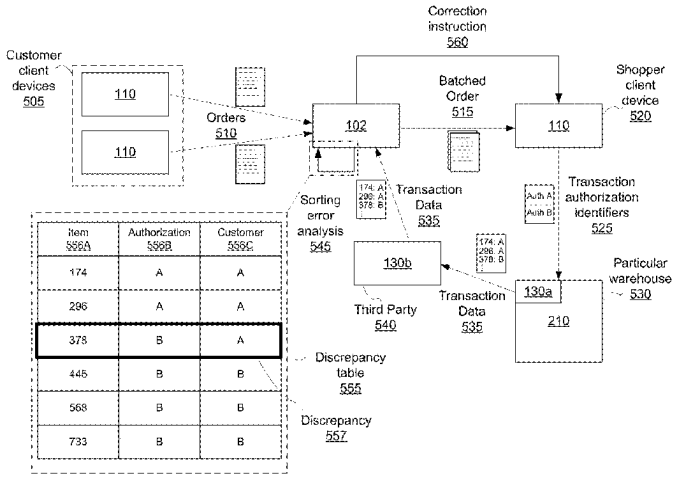
(57) **ABSTRACT**

An online concierge system performs asynchronous automated correction handling of incorrectly sorted items using point-of-sale data. The online concierge system receives orders from customer client devices and determines a batched order based on the received orders. The online concierge system sends the batched order to a shopper client device for fulfillment. The online concierge system receives transaction data associated with the batched order from a third party system. The online concierge system determines whether a sorting error occurred based on the transaction data and the batched order. In response to determining that
(Continued)



a sorting error occurred, the online concierge system sends an instruction to correct the sorting error to the shopper client device.

20 Claims, 6 Drawing Sheets

Related U.S. Application Data

(60) Provisional application No. 63/319,359, filed on Mar. 13, 2022.

(58) **Field of Classification Search**
USPC 705/333
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,693,758	B1 *	4/2010	Bacco	G06Q 20/203 705/28
9,120,621	B1 *	9/2015	Curlander	G06V 20/52
9,489,655	B1 *	11/2016	Lecky	G06Q 10/0875
9,699,606	B1 *	7/2017	Bhatia	G06Q 10/083
10,040,631	B2 *	8/2018	Shakes	G06Q 10/087
10,909,563	B1 *	2/2021	Aaron	G06Q 30/0214
10,929,799	B2 *	2/2021	Nandury	G06F 15/177
11,126,952	B1	9/2021	Son et al.	
11,257,049	B1	2/2022	Durazo Almeida et al.	
11,468,443	B2 *	10/2022	Jones	G06Q 20/3224
2005/0144089	A1 *	6/2005	Kamiyama	G06Q 10/083 705/330
2005/0149391	A1 *	7/2005	O'Shea	G06Q 30/0633 705/14.38
2012/0303498	A1	11/2012	Cova et al.	
2013/0314233	A1	11/2013	Stevens	
2016/0101936	A1	4/2016	Chamberlin	
2016/0337308	A1 *	11/2016	Dong	G06Q 10/10
2018/0217835	A1 *	8/2018	Vadapandeshwara	G06F 9/44505
2019/0236542	A1 *	8/2019	Cantrell	H04L 9/0866
2020/0151665	A1 *	5/2020	Fitzgerald	G06Q 10/08
2021/0027360	A1 *	1/2021	Shmueli	G06F 1/163
2021/0192596	A1	6/2021	Archak et al.	
2021/0406632	A1 *	12/2021	Hill	G06K 19/0723
2021/0406816	A1	12/2021	Dearing et al.	
2023/0156158	A1 *	5/2023	Moyne	H04N 23/60 348/159
2023/0245512	A1 *	8/2023	Mohr	G06K 7/10099 340/5.61

OTHER PUBLICATIONS

Benefits of a barcode driven inventory system, Jan. 29, 2022 (Year: 2022).*

"How to reduce picking and packing errors in grocery stores," by Sofia Spagnuolo, Jul. 15, 2021 (Year: 2021).*

PCT International Search Report and Written Opinion, PCT Application No. PCT/US22/48876, Feb. 1, 2023, 13 pages.

United States Office Action, U.S. Appl. No. 17/752,772, filed Jan. 4, 2024, 24 pages.

United States Office Action, U.S. Appl. No. 17/752,772, filed Aug. 17, 2023, 40 pages.

* cited by examiner

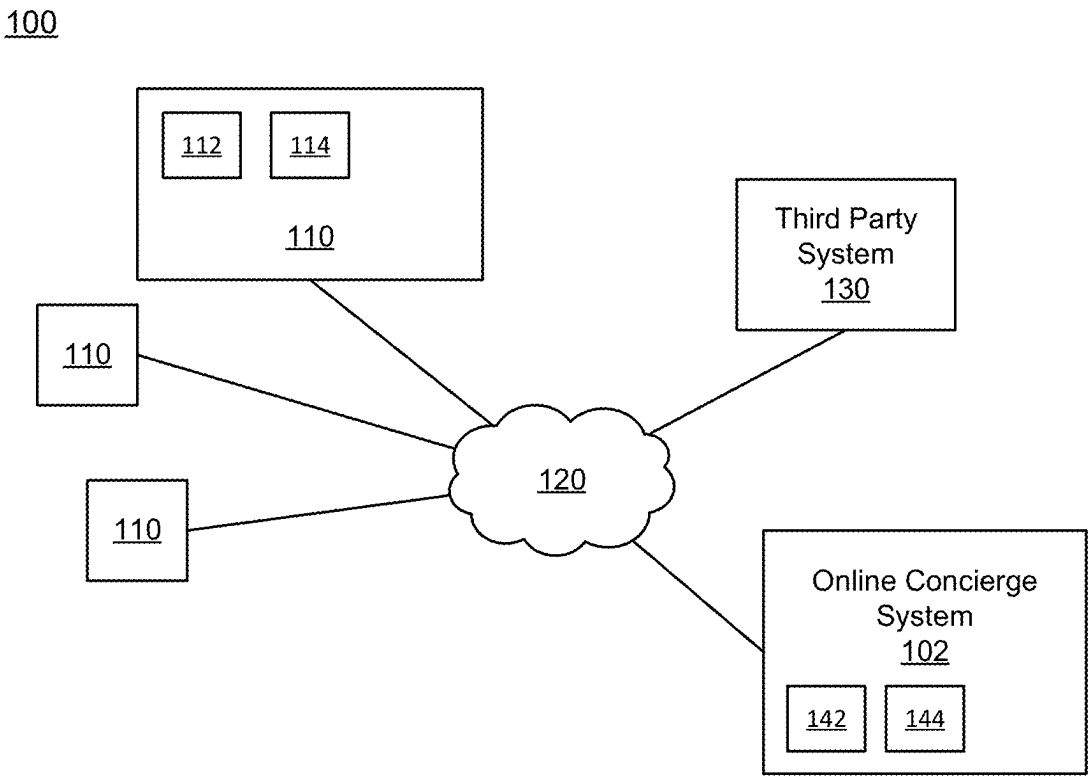

100
112
114
110
110
110
120
Third Party System 130
Online Concierge System 102
142
144

FIG. 1

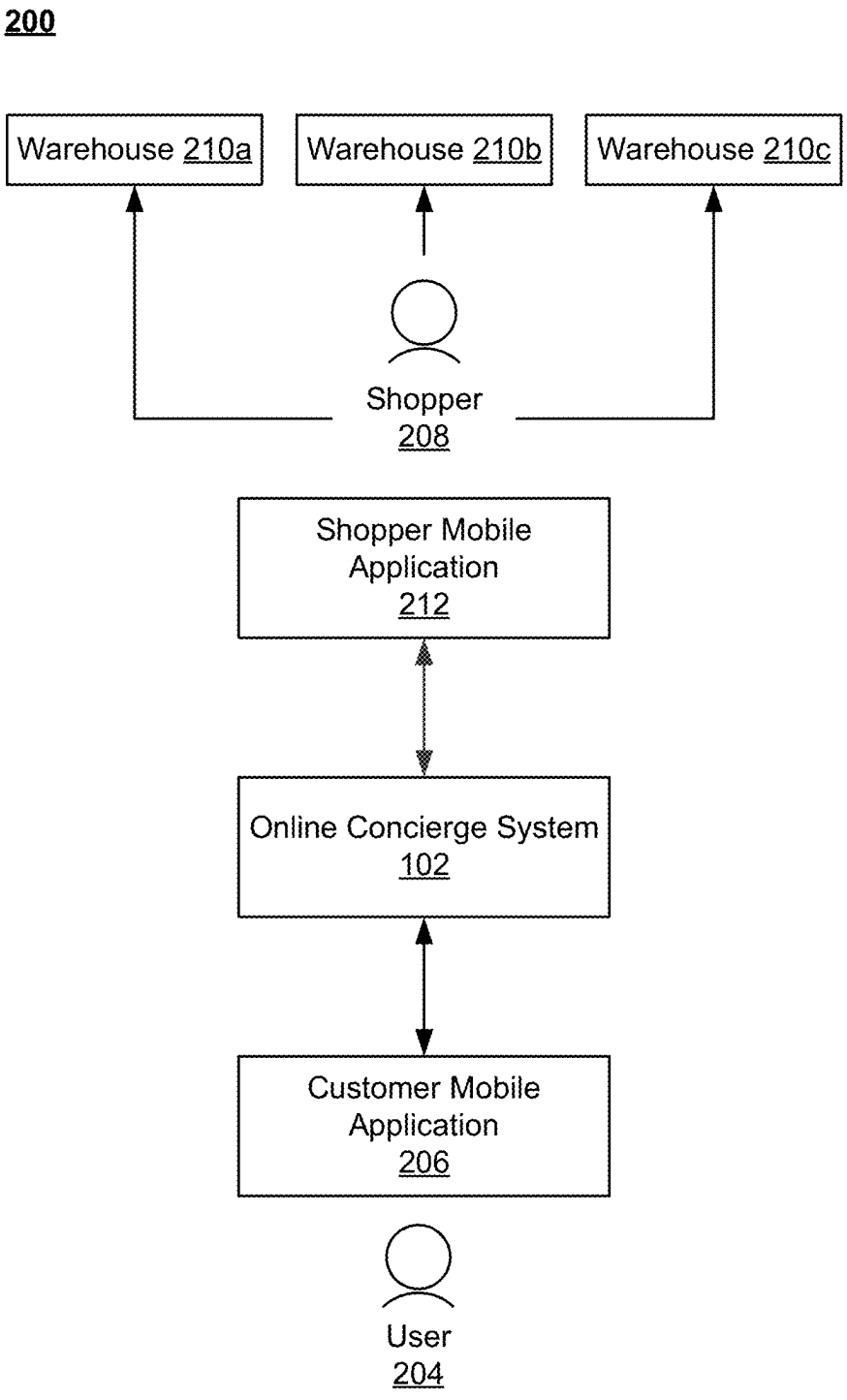

200
Warehouse 210a
Warehouse 210b
Warehouse 210c
Shopper
208
Shopper Mobile Application
212
Online Concierge System
102
Customer Mobile Application
206
User
204

FIG. 2

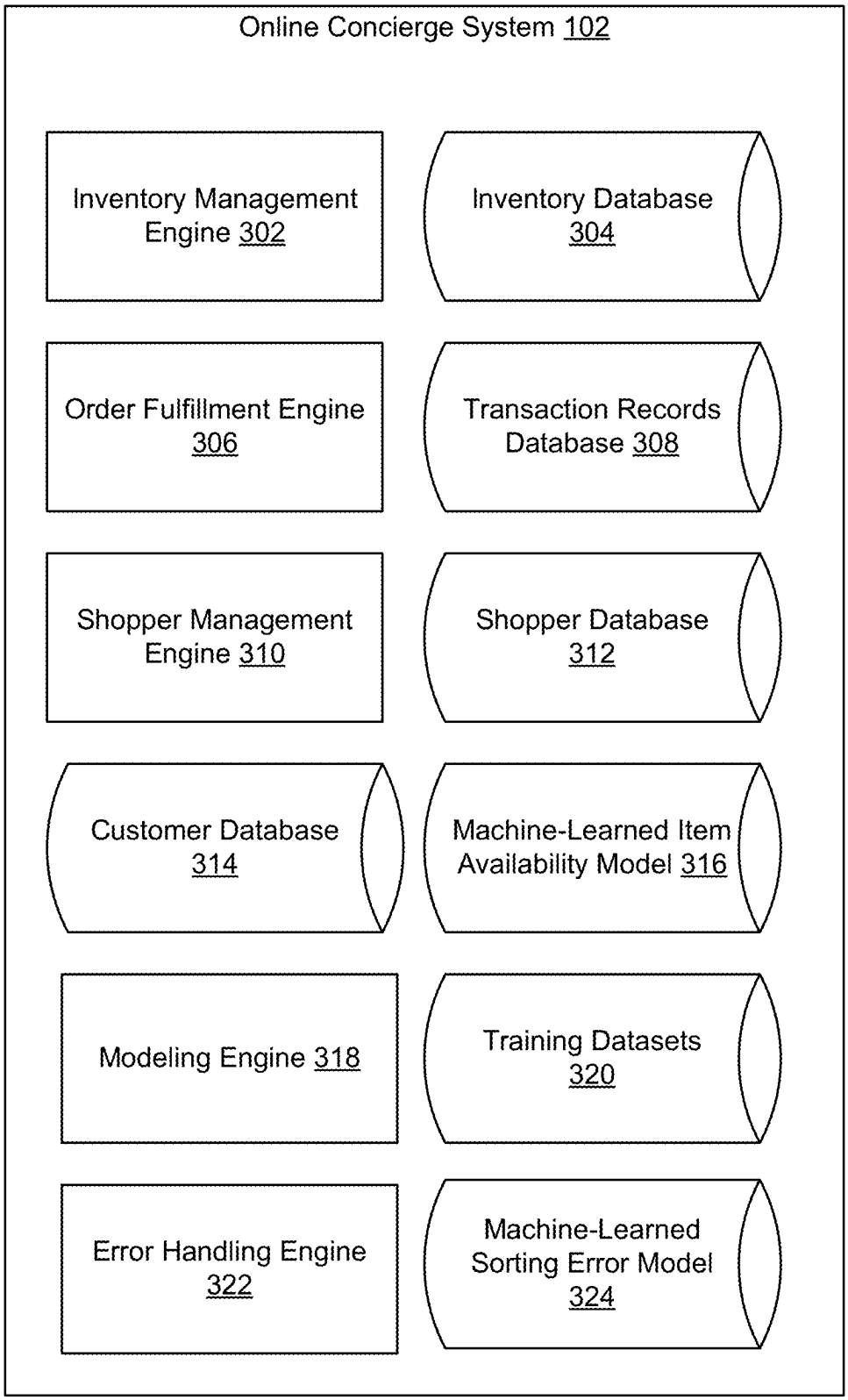

Online Concierge System 102
Inventory Management Engine 302
Inventory Database 304
Order Fulfillment Engine 306
Transaction Records Database 308
Shopper Management Engine 310
Shopper Database 312
Customer Database 314
Machine-Learned Item Availability Model 316
Modeling Engine 318
Training Datasets 320
Error Handling Engine 322
Machine-Learned Sorting Error Model 324

FIG. 3

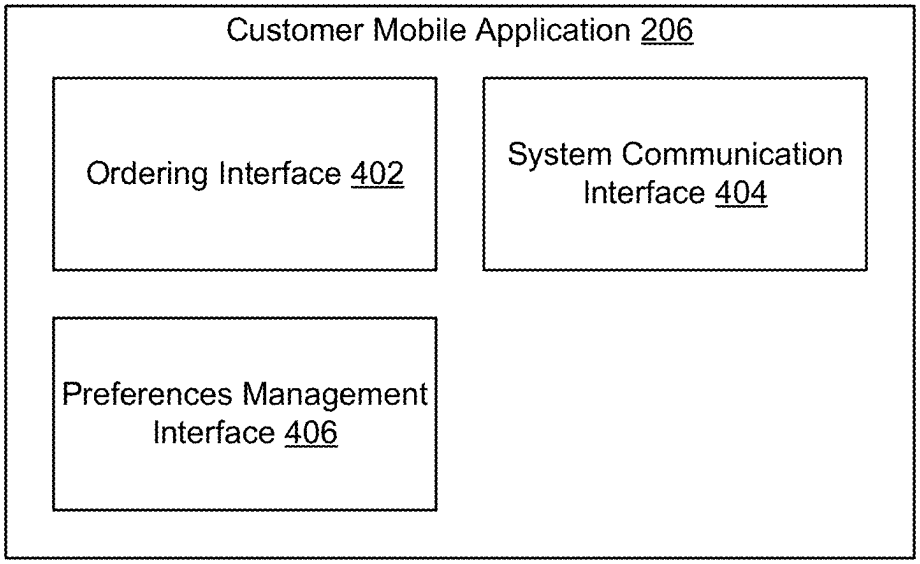

Customer Mobile Application 206
Ordering Interface 402
System Communication Interface 404
Preferences Management Interface 406

FIG. 4A

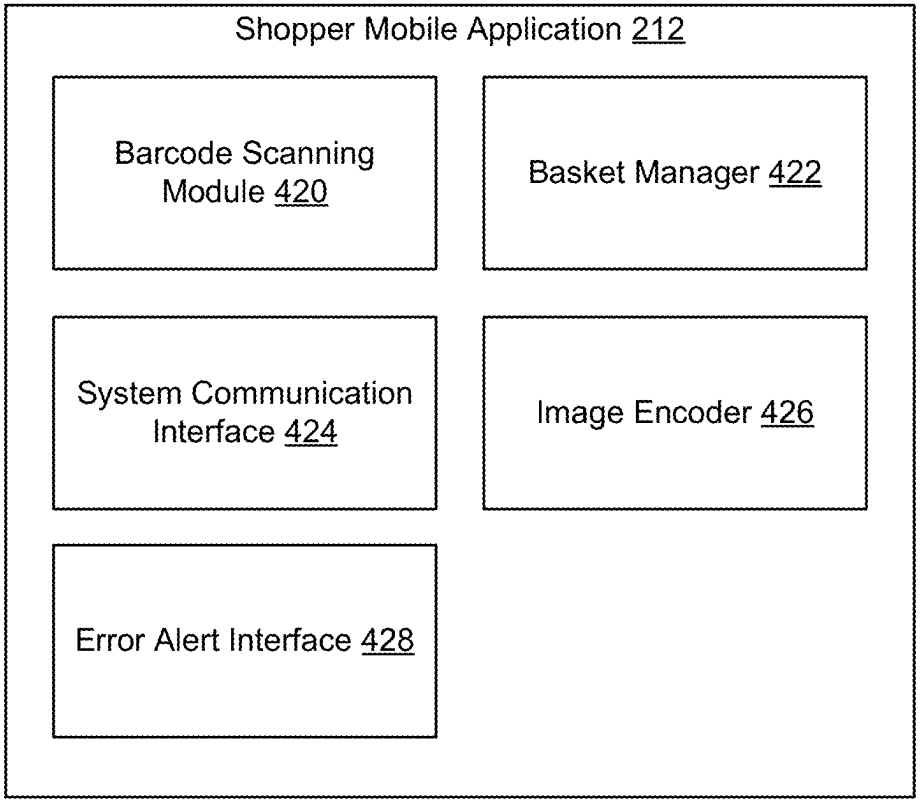

Shopper Mobile Application 212
Barcode Scanning Module 420
Basket Manager 422
System Communication Interface 424
Image Encoder 426
Error Alert Interface 428

FIG. 4B

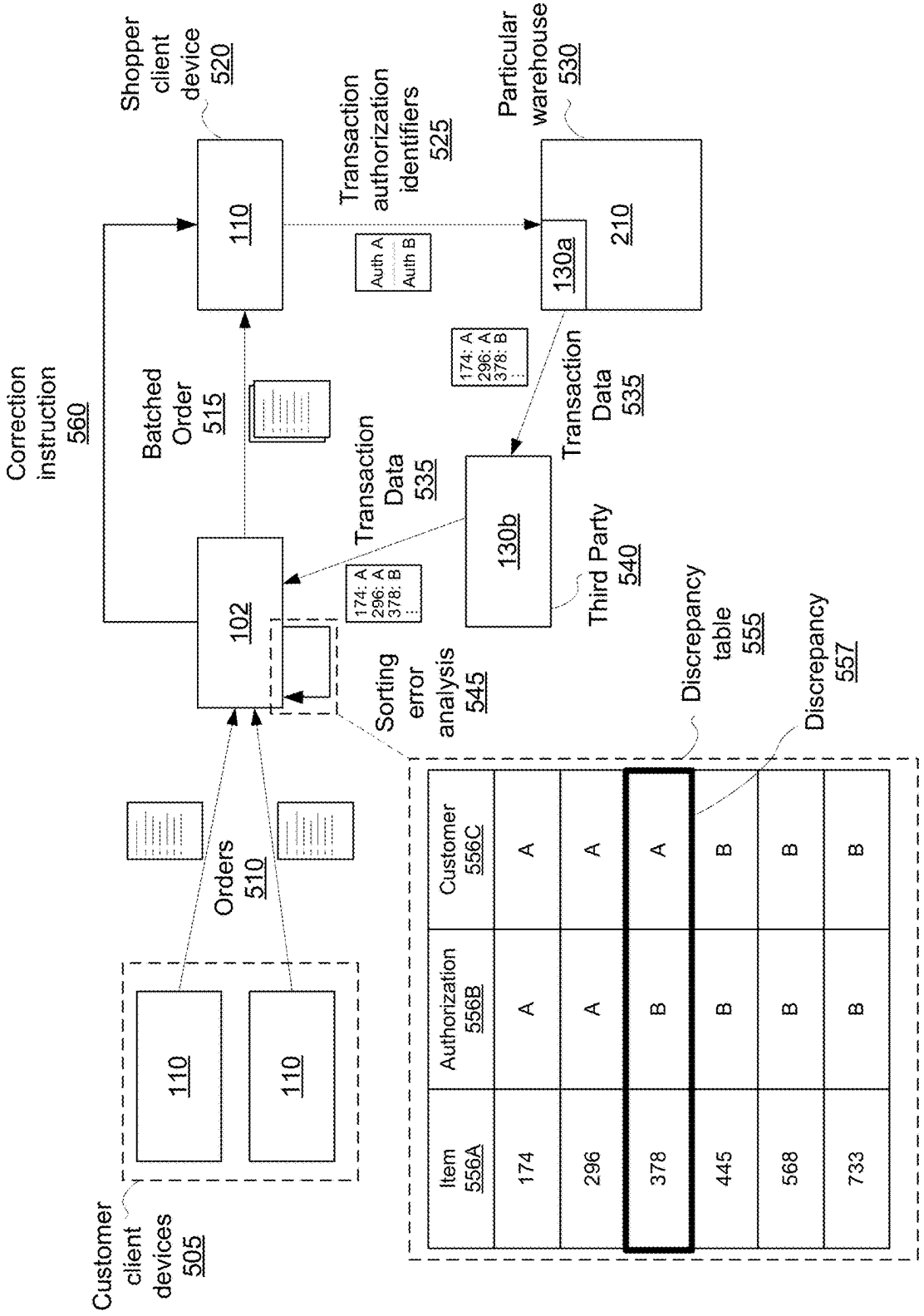

Customer client devices 505
110
110
Orders 510
102
Correction instruction 560
Batched Order 515
Shopper client device 520
110
Transaction authorization identifiers 525
Auth A
Auth B
Particular warehouse 530
130a
210
174: A
296: A
378: B
Transaction Data 535
Transaction Data 535
174: A
296: A
378: B
130b
Third Party 540
Sorting error analysis 545
Discrepancy table 555
Discrepancy 557
Item 556A
Authorization 556B
Customer 556C
174 A A
296 A A
378 B A
445 B B
568 B B
733 B B

FIG. 5

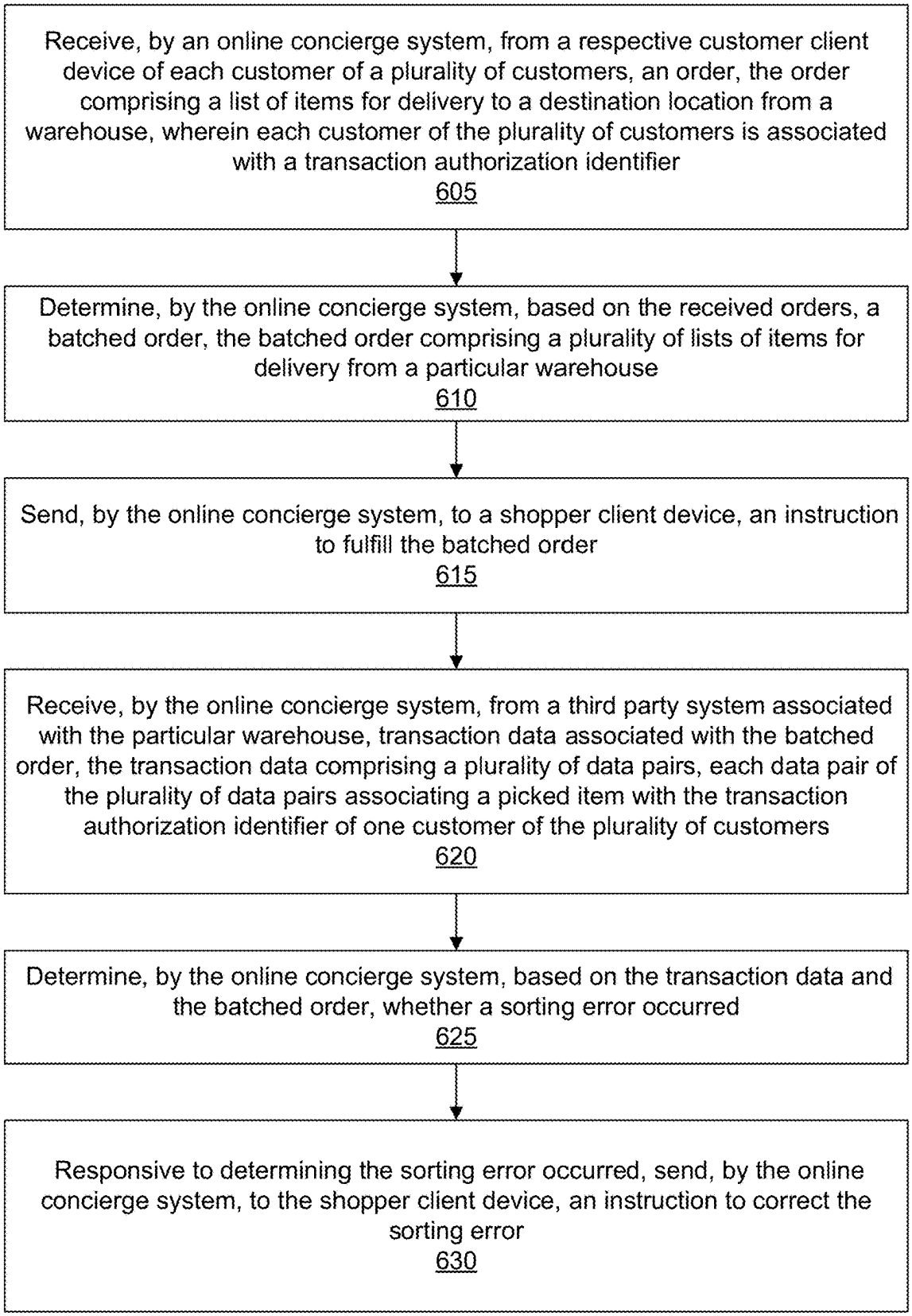

Receive, by an online concierge system, from a respective customer client device of each customer of a plurality of customers, an order, the order comprising a list of items for delivery to a destination location from a warehouse, wherein each customer of the plurality of customers is associated with a transaction authorization identifier
605
Determine, by the online concierge system, based on the received orders, a batched order, the batched order comprising a plurality of lists of items for delivery from a particular warehouse
610
Send, by the online concierge system, to a shopper client device, an instruction to fulfill the batched order
615
Receive, by the online concierge system, from a third party system associated with the particular warehouse, transaction data associated with the batched order, the transaction data comprising a plurality of data pairs, each data pair of the plurality of data pairs associating a picked item with the transaction authorization identifier of one customer of the plurality of customers
620
Determine, by the online concierge system, based on the transaction data and the batched order, whether a sorting error occurred
625
Responsive to determining the sorting error occurred, send, by the online concierge system, to the shopper client device, an instruction to correct the sorting error
630

FIG. 6

ASYNCHRONOUS AUTOMATED CORRECTION HANDLING IN CONCIERGE SYSTEM OF INCORRECTLY SORTED ITEMS USING POINT-OF-SALE DATA

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of U.S. patent application Ser. No. 17/752,772, filed May 24, 2022, which claims the benefit of U.S. Provisional Application No. 63/319,359, filed Mar. 13, 2022, which are incorporated by reference.

BACKGROUND

This disclosure relates generally to automated quality control and more specifically to asynchronous automated correction handling of incorrectly sorted items.

In current delivery fulfillment systems, pickers fulfill orders at a physical warehouse on behalf of customers as part of an online concierge service. A physical warehouse may be, for example, a grocery store. An online concierge system assigns lists of items to shoppers, who collect the items in the warehouse. The items are then delivered to the customers by the shopper or by a separate delivery driver.

Increased efficiency can be achieved by batching lists of items assigned to shoppers, such as multiple lists of items from different customers that correspond to items in the same warehouse, which can be serviced by one shopper in one pass through the warehouse. However, batching lists of items in this manner results in their collection together, which can lead to the incorrect sorting of those items (e.g., per customer) after their collection. It can be difficult to identify and correct sorting errors among items collected together. Ideally these sorting errors would be caught in real time, but significant latencies created by involved computing systems prevent real-time sorting error identification, and therefore prevent real-time sorting error resolution. Sorting errors can lead to logistical problems due to incorrectly delivered items and financial losses due to customer appeasement in response to uncaught sorting errors.

SUMMARY

In accordance with one or more aspects of the disclosure, an online concierge system receives orders from customers. Each order includes a list of items for delivery to a destination location from a warehouse. Each customer is associated with a transaction authorization identifier. The online concierge system determines a batched order based on the received orders. The batched order includes lists of items for delivery from the same warehouse. The online concierge system sends an instruction to fulfill the batched order to a client device of a shopper.

The online concierge system receives transaction data associated with the batched order from a third party system. The transaction data includes a plurality of data pairs, each data pair of the plurality of data pairs associating an item with the transaction authorization identifier of a customer. The online concierge system determines, based on the transaction data and the batched order, whether a sorting error occurred. If the online concierge system determines that a sorting error occurred, the online concierge system sends an instruction to correct the sorting error to the client device of the shopper.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system environment in which an online system, such an online concierge system, operates, according to one or more embodiments.

FIG. **2** illustrates an environment of an online shopping concierge service, according to one or more embodiments.

FIG. **3** is a diagram of an online shopping concierge system, according to one or more embodiments.

FIG. **4**A is a diagram of a customer mobile application (CMA), according to one or more embodiments.

FIG. **4**B is a diagram of a shopper mobile application (SMA), according to one or more embodiments.

FIG. **5** is a data flow diagram illustrating a process for asynchronous automated correction handling of incorrectly sorted items, according to one or more embodiments.

FIG. **6** is a flowchart illustrating a process for asynchronous automated correction handling of incorrectly sorted items, according to one or more embodiments.

The figures depict embodiments of the present disclosure for purposes of illustration only. Alternative embodiments of the structures and methods illustrated herein may be employed without departing from the principles, or benefits touted, of the disclosure described herein.

DETAILED DESCRIPTION

System Architecture

FIG. **1** is a block diagram of a system environment **100** in which an online system, such as an online concierge system **102** as further described below in conjunction with FIGS. **2** and **3**, operates. The system environment **100** shown by FIG. **1** comprises one or more client devices **110**, a network **120**, one or more third-party systems **130**, and the online concierge system **102**. In alternative configurations, different and/or additional components may be included in the system environment **100**. Additionally, in other embodiments, the online concierge system **102** may be replaced by an online system configured to retrieve content for display to users and to transmit the content to one or more client devices **110** for display.

The client devices **110** are one or more computing devices capable of receiving user input as well as transmitting and/or receiving data via the network **120**. In one embodiment, a client device **110** is a computer system, such as a desktop or a laptop computer. Alternatively, a client device **110** may be a device having computer functionality, such as a personal digital assistant (PDA), a mobile telephone, a smartphone, or another suitable device. A client device **110** is configured to communicate via the network **120**. In one embodiment, a client device **110** executes an application allowing a user of the client device **110** to interact with the online concierge system **102**. For example, the client device **110** executes a customer mobile application **206** or a shopper mobile application **212**, as further described below in conjunction with FIGS. **4**A and **4**B, respectively, to enable interaction between the client device **110** and the online concierge system **102**. As another example, a client device **110** executes a browser application to enable interaction between the client device **110** and the online concierge system **102** via the network **120**. In another embodiment, a client device **110** interacts with the online concierge system **102** through an application programming interface (API) running on a native operating system of the client device **110**, such as IOS® or ANDROID™.

A client device **110** includes one or more processors **112** configured to control operation of the client device **110** by

performing functions. In various embodiments, a client device **110** includes a memory **114** comprising a non-transitory storage medium on which instructions are encoded. The memory **114** may have instructions encoded thereon that, when executed by the processor **112**, cause the processor to perform functions to execute the customer mobile application **206** or the shopper mobile application **212** to provide the functions further described above in conjunction with FIGS. **4**A and **4**B, respectively.

The client devices **110** are configured to communicate via the network **120**, which may comprise any combination of local area and/or wide area networks, using both wired and/or wireless communication systems. In one embodiment, the network **120** uses standard communications technologies and/or protocols. For example, the network **120** includes communication links using technologies such as Ethernet, 802.11, worldwide interoperability for microwave access (WiMAX), 3G, 4G, 5G, code division multiple access (CDMA), digital subscriber line (DSL), etc. Examples of networking protocols used for communicating via the network **120** include multiprotocol label switching (MPLS), transmission control protocol/Internet protocol (TCP/IP), hypertext transport protocol (HTTP), simple mail transfer protocol (SMTP), and file transfer protocol (FTP). Data exchanged over the network **120** may be represented using any suitable format, such as hypertext markup language (HTML) or extensible markup language (XML). In some embodiments, all or some of the communication links of the network **120** may be encrypted using any suitable technique or techniques.

One or more third party systems **130** may be coupled to the network **120** for communicating with the online concierge system **102** or with the one or more client devices **110**. In one embodiment, a third party system **130** is an application provider communicating information describing applications for execution by a client device **110** or communicating data to client devices **110** for use by an application executing on the client device. In other embodiments, a third party system **130** provides content or other information for presentation via a client device **110**. For example, the third party system **130** stores one or more web pages and transmits the web pages to a client device **110** or to the online concierge system **102**. The third party system **130** may also communicate information to the online concierge system **102**, such as advertisements, content, or information about an application provided by the third party system **130**.

In accordance with one or more aspects of the disclosure, the third party system **130** is a transaction server corresponding to a Point-of-Sale (POS) device at a warehouse, such as a grocery store. The transaction server receives transaction data (e.g., data from the POS device) from the warehouse and sends the transaction data to the online concierge system **102**. As described in greater detail below, the transaction data can include a set of data pairs, each data pair including a warehouse item and a respective transaction identifier. The transaction identifier identifies the customer and/or order associated with the transaction authorization used to acquire the item from the warehouse.

Generally, there is significant delay from the time a transaction occurs at a PoS device until its corresponding transaction data is sent by the transaction server to the online concierge system **102**, such as ten minutes. This delay can impact the timing of sorting error correction, e.g., preventing resolution of a sorting error upon its occurrence at the POS device.

Generally, payment for an order is received by the online concierge system **102** from a client device **110** upon placement of the order by the client device **110**. When the shopper **208** uses a PoS device, payment for picked items comes from the online concierge system **102**. As such, if a sorting error occurs, one customer is not charged a greater amount and another customer is not charged less, because their payments were already recorded at the online concierge system **102**. To the online concierge system **102**, which has already pooled the payments from multiple customers, payment for a picked item is the same whether it is on behalf of one customer or another, as the payment amount is the same either way. As such, upon detection of the sorting error, the online concierge system **102** adjusts the association in the transaction data of the picked item from the incorrect user to a correct user, without necessitating an alteration to the transaction itself.

The online concierge system **102** includes one or more processors **142** configured to control operation of the online concierge system **102** by performing functions. In various embodiments, the online concierge system **102** includes a memory **144** comprising a non-transitory storage medium on which instructions are encoded. The memory **144** may have instructions encoded thereon corresponding to the modules further below in conjunction with FIG. **3** that, when executed by the processor **142**, cause the processor to perform the functionality further described above in conjunction with FIGS. **2-6**. For example, the memory **144** has instructions encoded thereon that, when executed by the processor **142**, cause the processor **142** to automatically handle sorting errors. Additionally, the online concierge system **102** includes a communication interface configured to connect the online concierge system **102** to one or more networks, such as network **120**, or to otherwise communicate with devices (e.g., client devices **110**) connected to the one or more networks.

One or more of a client device, a third party system **130**, or the online concierge system **102** may be special purpose computing devices configured to perform specific functions, as further described below in conjunction with FIGS. **2-6** and may include specific computing components such as processors, memories, communication interfaces, and/or the like.

System Overview

FIG. **2** illustrates an environment **200** of an online platform, such as an online concierge system **102**, according to one embodiment. The figures use like reference numerals to identify like elements. A letter after a reference numeral, such as "**210***a*," indicates that the text refers specifically to the element having that particular reference numeral. A reference numeral in the text without a following letter, such as "**210**," refers to any or all of the elements in the figures bearing that reference numeral. For example, "**210**" in the text refers to reference numerals "**210***a*" or "**210***b*" in the figures.

The environment **200** includes an online concierge system **102**. The online concierge system **102** is configured to receive orders from one or more users **204** (only one is shown for the sake of simplicity). An order specifies a list of goods (items or products) to be delivered to the user **204**. The order also specifies the location to which the goods are to be delivered, and a time window during which the goods should be delivered. In some embodiments, the order specifies one or more retailers from which the selected items should be purchased. The user may use a customer mobile application (CMA) **206** to place the order; the CMA **206** is configured to communicate with the online concierge system **102**.

The online concierge system **102** is configured to transmit orders received from users **204** to one or more shoppers **208**. A shopper **208** may be a contractor, employee, other person (or entity), robot, or other autonomous device enabled to fulfill orders received by the online concierge system **202**. The shopper **208** travels between a warehouse and a delivery location (e.g., the user's home or office). A shopper **208** may travel by car, truck, bicycle, scooter, foot, or other mode of transportation. In some embodiments, the delivery may be partially or fully automated, e.g., using a self-driving car. The environment **200** also includes three warehouses **210***a*, **210***b*, and **210***c* (only three are shown for the sake of simplicity; the environment could include hundreds of warehouses). The warehouses **210** may be physical retailers, such as grocery stores, discount stores, department stores, etc., or non-public warehouses storing items that can be collected and delivered to users. Each shopper **208** fulfills an order received from the online concierge system **102** at one or more warehouses **210**, delivers the order to the user **204**, or performs both fulfillment and delivery. In one embodiment, shoppers **208** make use of a shopper mobile application **212** which is configured to interact with the online concierge system **102**.

FIG. **3** is a diagram of an online concierge system **102**, according to one embodiment. In various embodiments, the online concierge system **102** may include different or additional modules than those described in conjunction with FIG. **3**. Further, in some embodiments, the online concierge system **102** includes fewer modules than those described in conjunction with FIG. **3**.

The online concierge system **102** includes an inventory management engine **302**, which interacts with inventory systems associated with each warehouse **210**. In one embodiment, the inventory management engine **302** requests and receives inventory information maintained by the warehouse **210**. The inventory of each warehouse **210** is unique and may change over time. The inventory management engine **302** monitors changes in inventory for each participating warehouse **210**. The inventory management engine **302** is also configured to store inventory records in an inventory database **304**. The inventory database **304** may store information in separate records-one for each participating warehouse **210**—or may consolidate or combine inventory information into a unified record. Inventory information includes attributes of items that include both qualitative and qualitative information about items, including size, color, weight, SKU, serial number, and so on. In one embodiment, the inventory database **304** also stores purchasing rules associated with each item if they exist. For example, age-restricted items such as alcohol and tobacco are flagged accordingly in the inventory database **304**. Additional inventory information useful for predicting the availability of items may also be stored in the inventory database **304**. For example, for each item-warehouse combination (a particular item at a particular warehouse), the inventory database **304** may store a time that the item was last found, a time that the item was last not found (a shopper looked for the item but could not find it), the rate at which the item is found, and the popularity of the item.

For each item, the inventory database **304** identifies one or more attributes of the item and corresponding values for each attribute of an item. For example, the inventory database **304** includes an entry for each item offered by a warehouse **210**, with an entry for an item including an item identifier that uniquely identifies the item. The entry includes different fields, with each field corresponding to an attribute of the item. A field of an entry includes a value for the attribute corresponding to the attribute for the field, allowing the inventory database **304** to maintain values of different categories for various items.

In various embodiments, the inventory management engine **302** maintains a taxonomy of items offered for purchase by one or more warehouses **210**. For example, the inventory management engine **302** receives an item catalog from a warehouse **210** identifying items offered for purchase by the warehouse **210**. From the item catalog, the inventory management engine **202** determines a taxonomy of items offered by the warehouse **210**. different levels in the taxonomy providing different levels of specificity about items included in the levels. In various embodiments, the taxonomy identifies a category and associates one or more specific items with the category. For example, a category identifies "milk," and the taxonomy associates identifiers of different milk items (e.g., milk offered by different brands, milk having one or more different attributes, etc.), with the category. Thus, the taxonomy maintains associations between a category and specific items offered by the warehouse **210** matching the category. In some embodiments, different levels in the taxonomy identify items with differing levels of specificity based on any suitable attribute or combination of attributes of the items. For example, different levels of the taxonomy specify different combinations of attributes for items, so items in lower levels of the hierarchical taxonomy have a greater number of attributes, corresponding to greater specificity in a category, while items in higher levels of the hierarchical taxonomy have a fewer number of attributes, corresponding to less specificity in a category. In various embodiments, higher levels in the taxonomy include less detail about items, so greater numbers of items are included in higher levels (e.g., higher levels include a greater number of items satisfying a broader category). Similarly, lower levels in the taxonomy include greater detail about items, so fewer numbers of items are included in the lower levels (e.g., higher levels include a fewer number of items satisfying a more specific category). The taxonomy may be received from a warehouse **210** in various embodiments. In other embodiments, the inventory management engine **302** applies a trained classification module to an item catalog received from a warehouse **210** to include different items in levels of the taxonomy, so application of the trained classification model associates specific items with categories corresponding to levels within the taxonomy.

Inventory information provided by the inventory management engine **302** may supplement the training datasets **320**. Inventory information provided by the inventory management engine **302** may not necessarily include information about the outcome of picking a delivery order associated with the item, whereas the data within the training datasets **320** is structured to include an outcome of picking a delivery order (e.g., if the item in an order was picked or not picked).

The online concierge system **102** also includes an order fulfillment engine **306** which is configured to synthesize and display an ordering interface to each user **204** (for example, via the customer mobile application **206**). The order fulfillment engine **306** is also configured to access the inventory database **304** in order to determine which products are available at which warehouse **210**. The order fulfillment engine **306** may supplement the product availability information from the inventory database **234** with an item availability predicted by the machine-learned item availability model **316**. The order fulfillment engine **306** determines a sale price for each item ordered by a user **204**. Prices set by the order fulfillment engine **306** may or may not be

identical to in-store prices determined by retailers (which is the price that users **204** and shoppers **208** would pay at the retail warehouses). The order fulfillment engine **306** also facilitates transactions associated with each order. In one embodiment, the order fulfillment engine **306** charges a payment instrument associated with a user **204** when he/she places an order. The order fulfillment engine **306** may transmit payment information to an external payment gateway or payment processor, such as the third party system **130** in one or more embodiments. The order fulfillment engine **306** stores payment and transactional information associated with each order in a transaction records database **308**.

In various embodiments, the order fulfillment engine **306** generates and transmits a search interface to a client device of a user for display via the customer mobile application **106**. The order fulfillment engine **306** receives a query comprising one or more terms from a user and retrieves items satisfying the query, such as items having descriptive information matching at least a portion of the query. In various embodiments, the order fulfillment engine **306** leverages item embeddings for items to retrieve items based on a received query. For example, the order fulfillment engine **306** generates an embedding for a query and determines measures of similarity between the embedding for the query and item embeddings for various items included in the inventory database **304**.

In some embodiments, the order fulfillment engine **306** also shares order details with warehouses **210**. For example, after successful fulfillment of an order, the order fulfillment engine **306** may transmit a summary of the order to the appropriate warehouses **210**. The summary may indicate the items purchased, the total value of the items, and in some cases, an identity of the shopper **208** and user **204** associated with the transaction. In one embodiment, the order fulfillment engine **306** pushes transaction and/or order details asynchronously to retailer systems. This may be accomplished via use of webhooks, which enable programmatic or system-driven transmission of information between web applications. In another embodiment, retailer systems may be configured to periodically poll the order fulfillment engine **306**, which provides detail of all orders which have been processed since the last request.

The order fulfillment engine **306** may interact with a shopper management engine **310**, which manages communication with and utilization of shoppers **208**. In one embodiment, the shopper management engine **310** receives a new order from the order fulfillment engine **306**. The shopper management engine **310** identifies the appropriate warehouse **210** to fulfill the order based on one or more parameters, such as a probability of item availability determined by a machine-learned item availability model **316**, the contents of the order, the inventory of the warehouses, and the proximity to the delivery location. The shopper management engine **310** then identifies one or more appropriate shoppers **208** to fulfill the order based on one or more parameters, such as the shoppers' proximity to the appropriate warehouse **210** (and/or to the user **204**), his/her familiarity level with that particular warehouse **210**, and so on. Additionally, the shopper management engine **310** accesses a shopper database **312** which stores information describing each shopper **208**, such as his/her name, gender, rating, previous shopping history, and so on.

As part of fulfilling an order, the order fulfillment engine **306** and/or shopper management engine **310** may access a user database **314** which stores information describing each user. This information could include each user's name, address, gender, shopping preferences, favorite items, stored payment instruments, and so on.

In various embodiments, the order fulfillment engine **306** determines whether to delay display of a received order to shoppers for fulfillment by a time interval. In response to determining to delay the received order by a time interval, the order fulfilment engine **306** evaluates orders received after the received order and during the time interval for inclusion in one or more batches that also include the received order. After the time interval, the order fulfillment engine **306** displays the order to one or more shoppers via the shopper mobile application **212**; if the order fulfillment engine **306** generated one or more batches including the received order and one or more orders received after the received order and during the time interval, the one or more batches are also displayed to one or more shoppers via the shopper mobile application **212**. A batched order is a batch that includes multiple orders to be fulfilled together by a shopper **208** at the same warehouse **210**. For example, a batched order may include three orders, each from a different user **204**, for items from one particular warehouse **210**, e.g., a particular grocery store.

The online concierge system **102** also includes an error handling engine **322**. The error handling engine **322** reviews batched orders to check for sorting errors. This is an asynchronous process, often occurring minutes after a shopper **208** picked items at a warehouse **210** to fulfill a batched order. The online concierge system **102** waits to receive transaction data from the third party system **130**, which contributes to the delay. In one embodiment, the transaction data includes payment information and/or transaction information associated with each order in the batched order, which the error handling engine **322** receives from a third party system **130**, e.g., a transaction server associated with a PoS device at the warehouse **210** that was used by the shopper **208** to log the acquisition of (e.g., purchase) the picked items. Depending upon the embodiment, the transaction data may alternatively or additionally include receipt data received from a client device **110** of a shopper **208**, such as one or more photos of one or more receipts received by the shopper **208** from a PoS device at the warehouse **210**.

Due to the asynchronicity of the technique, the picked items are likely no longer at the warehouse **210** upon its performance. In the intervening time between the picking of the items and the performance of the technique, the shopper **208** has likely departed to deliver the picked items to the customers at one or more destination locations, and/or has given the picked items to a second shopper **208** for delivery. In an embodiment, the error handling engine **322** tracks whether the shopper **208** that picked the items to fulfill the batched order is the shopper **208** that delivers the picked items to the customers at one or more respective destination locations, or if the delivery is handled by a second shopper **208**. As described below, upon detecting a sorting error, the error handling engine **322** sends a correction instruction to the shopper **208** delivering the picked items to correct a sorting error associated with the batched order. Depending upon the embodiment, the correction instruction may be sent as soon as the error handling engine **322** determines a sorting error, upon confirmation by a shopper **208** of delivery of an order in the batched order to a customer at a destination location, and/or upon entry by the client device **110** of the shopper **208** into a geofence around a destination location or a current location of a client device **110** of a customer (e.g., as determined by a global positioning system (GPS) trace provided by the client device **110**).

The error handling engine **322** checks for sorting errors in a batched order using the transaction data received from the POS device and/or the shopper **208** (e.g., a shopper mobile application on the client device **110** of the shopper **208**). In one embodiment, the error handling engine **322** compares the transaction data to stored batched order data to determine whether one or more picked items were incorrectly sorted by the shopper **208**. As an example of a sorting error, a shopper **208** fulfilling a batched order including an order from a customer named Annie and an order from a customer named Brian places a loaf of bread ordered by Annie into Brian's bag, and uses the POS device to charge the bread to Brian.

In some embodiments, the transaction data includes receipt data. The error handling engine **322** applies a machine-learned sorting error model **324** to the receipt data to extract text from the receipt data. The error handling engine **322** analyzes the extracted text to determine which items were charged to which customers of a batched order. The error handling engine **322** identifies a sorting error based on the analysis.

In some instances, sorting errors can include a picked item being associated (e.g., by the shopper **208**) with the wrong customer (e.g., charged to the wrong customer, bagged in the wrong customer bag). These sorting errors occur in batched orders. Other sorting errors can include a number of picked items of the same type being greater or fewer than specified by the order, and/or a picked item not being the item specified by the order (e.g., an order specifies dog food but the shopper **208** picks cat food). These latter types of sorting errors can occur when shoppers **208** fulfill single orders rather than batched orders, or when shoppers **208** fulfill batched orders. As such, various techniques described herein with reference to a batched order can equally apply to single orders, such as techniques involving the analysis of receipt data to identify a sorting error.

In an embodiment, the error handling engine **322** determines a sorting error confidence value for each potential sorting error. For example, the confidence value may be one of low confidence, medium confidence, or high confidence. Alternative embodiments may employ alternative confidence value options, such as only low confidence and high confidence, which may be represented by a binary value, such as "1" for high confidence and "0" for low confidence. If an item in a batched order is missing from the set of picked items, the error handling engine **322** may assign the sorting error a high confidence. If an item in a batched order is determined by the error handling engine **322** to have been charged to the wrong customer, the error handling engine **322** may assign the sorting error a medium confidence. If the sorting error involves an incorrect quantity of an item in an order, the error handling engine **322** may identify the sorting error as low confidence. This may be if the difference between the ordered quantity of the item and the quantity of the item that was picked is less than an item quantity threshold, such as two. In some embodiments, the error handling engine **322** only sends correction instructions to shoppers **208** for sorting errors that are not low confidence.

Machine Learning Models

The online concierge system **102** further includes a machine-learned item availability model **316**, a modeling engine **318**, training datasets **320**, and a machine-learned sorting error model **324**. The modeling engine **318** uses the training datasets **320** to generate the machine-learned item availability model **316** and/or the machine-learned sorting error model **324**. The machine-learned item availability model **316** can learn from the training datasets **320**, rather than follow only explicitly programmed instructions. Similarly, the machine-learned sorting error model **324** can learn from the training datasets **320**, rather than follow only explicitly programmed instructions. The machine-learned item availability model **316** and the machine-learned sorting error model **324** may use different subsets of the training datasets **320**, depending upon the embodiment. The inventory management engine **302**, order fulfillment engine **306**, and/or shopper management engine **310** can use the machine-learned item availability model **316** to determine a probability that an item is available at a warehouse **210**. The machine-learned item availability model **316** may be used to predict item availability for items being displayed to or selected by a user or included in received delivery orders. A single machine-learned item availability model **316** is used to predict the availability of any number of items. The error handling engine **322** can use the machine-learned sorting error model **324** to perform optical character recognition upon receipt data to identify a sorting error for a batched order.

The machine-learned item availability model **316** can be configured to receive as inputs information about an item, the warehouse for picking the item, and the time for picking the item. The machine-learned item availability model **316** may be adapted to receive any information that the modeling engine **318** identifies as indicators of item availability. At minimum, the machine-learned item availability model **316** receives information about an item-warehouse pair, such as an item in a delivery order and a warehouse at which the order could be fulfilled. Items stored in the inventory database **304** may be identified by item identifiers. As described above, various characteristics, some of which are specific to the warehouse (e.g., a time that the item was last found in the warehouse, a time that the item was last not found in the warehouse, the rate at which the item is found, the popularity of the item) may be stored for each item in the inventory database **304**. Similarly, each warehouse may be identified by a warehouse identifier and stored in a warehouse database along with information about the warehouse. A particular item at a particular warehouse may be identified using an item identifier and a warehouse identifier. In other embodiments, the item identifier refers to a particular item at a particular warehouse, so that the same item at two different warehouses is associated with two different identifiers. For convenience, both of these options to identify an item at a warehouse are referred to herein as an "item-warehouse pair." Based on the identifier(s), the online concierge system **102** can extract information about the item and/or warehouse from the inventory database **304** and/or warehouse database and provide this extracted information as inputs to the item availability model **316**.

The machine-learned sorting error model **324** can be configured to receive as input receipt data, such as image data (e.g., photos) of receipts. For example, the shopper **208** may take photos of the receipts printed by a PoS device upon completion of a transaction with the POS device by the shopper **208** as part of fulfilling the batched order. The machine-learned sorting error model **324** may be adapted to receive any information that the modeling engine **318** identifies as indicators of a sorting error. At minimum, the machine-learned sorting error model **324** receives a photo as input. Receipt data may be stored in the transaction records database **308**.

The machine-learned item availability model **316** contains a set of functions generated by the modeling engine **318** from the training datasets **320** that relate the item, warehouse, and timing information, and/or any other relevant inputs, to the probability that the item is available at

a warehouse. Thus, for a given item-warehouse pair, the machine-learned item availability model **316** outputs a probability that the item is available at the warehouse. The machine-learned item availability model **316** constructs the relationship between the input item-warehouse pair, timing, and/or any other inputs and the availability probability (also referred to as "availability") that is generic enough to apply to any number of different item-warehouse pairs. In some embodiments, the probability output by the machine-learned item availability model **316** includes a confidence score. The confidence score may be the error or uncertainty score of the output availability probability and may be calculated using any standard statistical error measurement. In some examples, the confidence score is based in part on whether the item-warehouse pair availability prediction was accurate for previous delivery orders (e.g., if the item was predicted to be available at the warehouse and not found by the shopper or predicted to be unavailable but found by the shopper). In some examples, the confidence score is based in part on the age of the data for the item, e.g., if availability information has been received within the past hour, or the past day. The set of functions of the item availability model **316** may be updated and adapted following retraining with new training datasets **320**. The machine-learned item availability model **316** may be any machine learning model, such as a neural network, boosted tree, gradient boosted tree or random forest model. In some examples, the machine-learned item availability model **316** is generated from XGBoost algorithm.

The machine-learned sorting error model **324** contains a set of functions generated by the modeling engine **318** from the training datasets **320** that relate receipt data and/or any other relevant inputs to textual output (e.g., a sequence of one or more letters and/or numbers). Thus, for given receipt data (e.g., a photo of a receipt), the machine-learned sorting error model **324** outputs a text sequence of characters predicted by the machine-learned sorting error model **324** as being in the receipt data. The machine-learned sorting error model **324** constructs a relationship between receipt data and/or any other inputs and the text sequence output that is generic enough to apply to any number of different receipt data instances. In some embodiments, the text sequence output includes a confidence score generated by the machine-learned sorting error model **324**. The confidence score may be the error or uncertainty score of the output text sequence, e.g., the likelihood that the text sequence accurately reflects text present in the receipt data. The output may include one or more confidence scores, e.g., for each detected letter, each detected word, each detected sentence, and/or so on. The set of functions in the sorting error model **324** may be updated and adapted following retraining with new training datasets **320**. The machine-learned sorting error model **324** may be any machine learning model.

The item probability generated by the machine-learned item availability model **316** may be used to determine instructions delivered to the user **204** and/or shopper **208**, as described in further detail below. The text sequence generated by the machine-learned sorting error model **324** may be used to determine one or more sorting errors for a batched order. For example, the online concierge system **102** may check the text sequence for a customer identifier, e.g., a name or transaction authorization identifier, as well as one or more item identifiers, e.g., item names and quantities.

The confidence score generated by the machine-learned sorting error model **324** may be used to inform the sorting error confidence value of a respective identified sorting error. For example, a low confidence score from the model (e.g., less than a machine-learned confidence threshold value, such as 70%), may cause the error handling engine **322** to assign the respective sorting error a low confidence.

The training datasets **320** relate a variety of different factors to known item availabilities from the outcomes of previous delivery orders (e.g., if an item was previously found or previously unavailable) and, in some embodiments, to receipt data with known respective text sequences. The training datasets **320** include the items included in previous delivery orders, whether the items in the previous delivery orders were picked, warehouses associated with the previous delivery orders, and a variety of characteristics associated with each of the items (which may be obtained from the inventory database **204**). Each piece of data in the training datasets **320** includes the outcome of a previous delivery order (e.g., if the item was picked or not). The item characteristics may be determined by the machine-learned item availability model **316** to be statistically significant factors predictive of the item's availability. For different items, the item characteristics that are predictors of availability may be different. For example, an item type factor might be the best predictor of availability for dairy items, whereas a time of day may be the best predictive factor of availability for vegetables. For each item, the machine-learned item availability model **316** may weight these factors differently, where the weights are a result of a "learning" or training process on the training datasets **320**. The training datasets **320** may include various receipt data included in previous orders that has been labeled with respective text sequences, which may include a mapping of locations within the receipt data (e.g., particular pixels of a photo) to particular characters or sequences of characters. The training datasets **320** may alternatively or additionally include mock receipt data, e.g., photos of fake receipts generated by an administrator of the online concierge system **102**, and respective text sequences.

The training datasets **320** are very large datasets taken across a wide cross section of warehouses, shoppers, items, warehouses, delivery orders, times, and item characteristics. The training datasets **320** are large enough to provide a mapping from an item in an order to a probability that the item is available at a warehouse. In addition to previous delivery orders, the training datasets **320** may be supplemented by inventory information provided by the inventory management engine **302**. In some examples, the training datasets **320** are historic delivery order information used to train the machine-learned item availability model **316**, whereas the inventory information stored in the inventory database **304** includes factors input into the machine-learned item availability model **316** to determine an item availability for an item in a newly received delivery order. In some examples, the modeling engine **318** may evaluate the training datasets **320** to compare a single item's availability across multiple warehouses to determine if an item is chronically unavailable. This may indicate that an item is no longer manufactured. The modeling engine **318** may query a warehouse **210** through the inventory management engine **302** for updated item information on these identified items.

Machine Learning Factors

The training datasets **320** include a time associated with previous delivery orders. In some embodiments, the training datasets **320** include a time of day at which each previous delivery order was placed. Time of day may impact item availability, since during high-volume shopping times, items may become unavailable that are otherwise regularly stocked by warehouses. In addition, availability may be affected by restocking schedules, e.g., if a warehouse mainly

restocks at night, item availability at the warehouse will tend to decrease over the course of the day. Additionally, or alternatively, the training datasets **320** include a day of the week previous delivery orders were placed. The day of the week may impact item availability since popular shopping days may have reduced inventory of items or restocking shipments may be received on particular days. In some embodiments, training datasets **320** include a time interval since an item was previously picked in a previously delivery order. If an item has recently been picked at a warehouse, this may increase the probability that it is still available. If there has been a long time interval since an item has been picked, this may indicate that the probability that it is available for subsequent orders is low or uncertain. In some embodiments, training datasets **320** include a time interval since an item was not found in a previous delivery order. If there has been a short time interval since an item was not found, this may indicate that there is a low probability that the item is available in subsequent delivery orders. And conversely, if there is has been a long time interval since an item was not found, this may indicate that the item may have been restocked and is available for subsequent delivery orders. In some examples, training datasets **320** may also include a rate at which an item is typically found by a shopper at a warehouse, a number of days since inventory information about the item was last received from the inventory management engine **302**, a number of times an item was not found in a previous week, or any number of additional rate or time information. The relationships between this time information and item availability are determined by the modeling engine **318** training a machine learning model with the training datasets **320**, producing the machine-learned item availability model **316**.

The training datasets **320** include item characteristics. In some examples, the item characteristics include a department associated with the item. For example, if the item is yogurt, it is associated with the dairy department. The department may be the bakery, beverage, nonfood, and pharmacy, produce and floral, deli, prepared foods, meat, seafood, dairy, the meat department, or dairy department, or any other categorization of items used by the warehouse. The department associated with an item may affect item availability, since different departments have different item turnover rates and inventory levels. In some examples, the item characteristics include an aisle of the warehouse associated with the item. The aisle of the warehouse may affect item availability since different aisles of a warehouse may be more frequently re-stocked than others. Additionally, or alternatively, the item characteristics include an item popularity score. The item popularity score for an item may be proportional to the number of delivery orders received that include the item. An alternative or additional item popularity score may be provided by a retailer through the inventory management engine **302**. In some examples, the item characteristics include a product type associated with the item. For example, if the item is a particular brand of a product, then the product type will be a generic description of the product type, such as "milk" or "eggs." The product type may affect the item availability, since certain product types may have a higher turnover and re-stocking rate than others or may have larger inventories in the warehouses. In some examples, the item characteristics may include a number of times a shopper was instructed to keep looking for the item after he or she was initially unable to find the item, a total number of delivery orders received for the item, whether or not the product is organic, vegan, gluten free, or any other characteristics associated with an item. The relationships between item characteristics and item availability are determined by the modeling engine **318** training a machine learning model with the training datasets **320**, producing the machine-learned item availability model **316**.

The training datasets **320** may include additional item characteristics that affect the item availability and can therefore be used to build the machine-learned item availability model **316** relating the delivery order for an item to its predicted availability. The training datasets **320** may be periodically updated with recent previous delivery orders. The training datasets **320** may be updated with item availability information provided directly from shoppers **208**. Following updating of the training datasets **320**, a modeling engine **318** may retrain a model with the updated training datasets **320** and produce a new machine-learned item availability model **316**.

Customer Mobile Application

FIG. **4**A is a diagram of the customer mobile application (CMA) **206**, according to one embodiment. The CMA **206** includes an ordering interface **402**, which provides an interactive interface with which the user **104** can browse through and select products and place an order. The CMA **206** also includes a system communication interface **404** which, among other functions, receives inventory information from the online shopping concierge system **102** and transmits order information to the system **202**. The CMA **206** also includes a preferences management interface **406** which allows the user **104** to manage basic information associated with his/her account, such as his/her home address and payment instruments. In an embodiment, the preferences management interface **406** specifies transaction authorization data (e.g., payment information of the payment instrument, such as details of a credit card account) used to pay for orders. This transaction authorization data may be associated with a transaction authorization identifier. In an embodiment, the transaction authorization identifier is an identifier of the user **104**, such as a customer identifier assigned by the online concierge system **102**. The preferences management interface **406** may also allow the user to manage other details such as his/her favorite or preferred warehouses **210**, preferred delivery times, special instructions for delivery, and so on.

Shopper Mobile Application

FIG. **4**B is a diagram of the shopper mobile application (SMA) **212**, according to one embodiment. The SMA **212** includes a barcode scanning module **420** which allows a shopper **208** to scan an item at a warehouse **210** (such as a can of soup on the shelf at a grocery store). The barcode scanning module **420** may also include an interface which allows the shopper **108** to manually enter information describing an item (such as its serial number, SKU, quantity and/or weight) if a barcode is not available to be scanned. SMA **212** also includes a basket manager **422** which maintains a running record of items collected by the shopper **208** for purchase at a warehouse **210**. This running record of items is commonly known as a "basket." In one embodiment, the barcode scanning module **420** transmits information describing each item (such as its cost, quantity, weight, etc.) to the basket manager **422**, which updates its basket accordingly. The SMA **212** also includes a system communication interface **424** which interacts with the online shopping concierge system **102**. For example, the system communication interface **424** receives an order from the online concierge system **102** and transmits the contents of a basket of items to the online concierge system **102**. The SMA **212** also includes an image encoder **426** which encodes the contents of a basket into an image. For example, the image

encoder **426** may encode a basket of goods (with an identification of each item) into a QR code which can then be scanned by an employee of the warehouse **210** at check-out.

The SMA **212** also includes an error alert interface **428**. In an embodiment, the error alert interface **428** is a component of the system communication interface **424**. The error alert interface **428** presents error alerts using graphical elements, textual elements, and/or audial elements. The SMA **212** presents an error alert using a client device **110** of a shopper **208** based on receipt by the SMA **212** of a correction instruction from the online concierge system **102**. An error alert indicates that a sorting error has likely occurred and that the shopper **208** is to correct the sorting error, e.g., take a picked item from the bag of a first customer and place it into the bag of a second customer.

The SMA **212** may present the error alert at a particular time, depending upon the embodiment. The particular time may depend upon the received correction instruction. For example, if the correction instruction includes an instruction for the SMA **212** to present the error alert upon entry by the client device **110** of the shopper **208** into a geofence around a destination location, then the SMA **212** will present the error alert upon detecting the client device **110** of the shopper **208** has entered the geofence (e.g., based on a GPS trace retrieved from a GPS receiver in the client device **110** of the shopper **208**).

Asynchronous Automated Correction Handling

FIG. **5** is a data flow diagram illustrating a process for asynchronous automated correction handling of incorrectly sorted items, according to one or more embodiments. Customer client devices **505**, which are client devices **110** used by customers (e.g., client devices **110** that include a customer mobile application **206**), send orders **510** to the online concierge system **102**. The online concierge system **102** generates a batched order **515** from the orders **510** and sends the batched order **515** to a shopper client device **520**, which is a client device **110** used by a shopper (e.g., a client device **110** that includes a shopper mobile application **212**).

The shopper goes to the particular warehouse **530** associated with the batched order **515** and picks the items listed in the batched order **515**. The shopper uses transaction authorization identifiers **525** at a PoS device **130***a* to purchase or otherwise acquire the picked items from the particular warehouse **530**. For example, the shopper uses an account of the online concierge system **102** to purchase the picked items for each customer associated with an order **510** in the batched order **515**. This may be done one at a time, e.g., the shopper purchases all picked items for one customer's order, then all picked items for a second customer's order, and so on, switching the transaction authorization identifier **525** associated with each purchase according to the customer whose items are being purchased. The shopper's use of the POS device **130***a* generates transaction data **535**.

The POS device **130***a* sends the transaction data **535** to a third party **540**, e.g., a third party system **130***b* of a provider of the POS device **130***a*. As a specific example, the third party system **130***b* may be a transaction server. The third party **540** sends the transaction data **535** to the online concierge system **102**. In an embodiment, the third party **540** formats the transaction data **535**, e.g., converts it from a first data format (e.g., a data format of the transaction data as received from the POS device **130***a*) into a second data format (e.g., data pairs), before sending the transaction data **535** to the online concierge system **102**.

The online concierge system **102** performs sorting error analysis **545** to determine whether the transaction data is indicative of one or more sorting errors by the shopper. The online concierge system **102** constructs a discrepancy table **555**, which includes as records items **556**A picked by the shopper for the batched order. For each record, the discrepancy table **555** includes an attribute **556**B indicating a transaction authorization identifier **525** used by the shopper when purchasing the item, as well as an attribute **556**C indicating an intended customer for the item, e.g., the customer to whose order **510** in the batched order **515** the item corresponds. In an embodiment, the online concierge system **102** uses each transaction authorization identifier **525** to determine a corresponding customer, who is indicated at the attribute **55**B instead of, or in addition to, the transaction authorization identifier.

The online concierge system **102** may determine the intended customer for each item based on the batched order. The online concierge system **102** matches each picked item, as indicated in the transaction data, to a customer by identifying an order in the batched order that includes the picked item, then identifying the customer to whom the identified order corresponds.

Discrepancy table **555** includes a discrepancy **557**, where item "378" was listed by the order for customer "A" but was purchased using the transaction authorization identifier of customer "B." As such, the online concierge system **102** identifies the discrepancy **557** as a sorting error. The online concierge system **102** sends a correction instruction **560** to the shopper client device **520** to correct the sorting error, e.g., ensure that item **378** is in customer A's bag.

FIG. **6** is a flowchart illustrating a process for asynchronous automated correction handling of incorrectly sorted items, according to one or more embodiments. In various embodiments, the method includes different or additional steps than those described in conjunction with FIG. **6**. Further, in some embodiments, the steps of the method may be performed in different orders than the order described in conjunction with FIG. **6**. The method described in conjunction with FIG. **6** may be carried out by the online concierge system **102** in various embodiments, while in other embodiments, the steps of the method are performed by other systems.

The online concierge system **102** receives **605**, from a respective customer client device **110** of each customer of a plurality of customers, an order. Each order includes a list of items for delivery to a destination location (e.g., a location of the customer client device **110** or a preset location specified by the customer, such as through input to the preferences management interface **406**) from a warehouse **210**. Also, each customer of the plurality of customers is associated with a transaction authorization identifier. The transaction authorization identifier may be specified in the order, or may be associated with the customer by the online concierge system **102** and retrieved on demand (e.g., from the transaction records database **308**).

The online concierge system **102** determines **610**, based on the received orders, a batched order. The batched order includes a plurality of lists of items for delivery from a particular warehouse **210** (e.g., warehouse **210***a*). The online concierge system **102** may determine **610** the batched order as a subset of a total number of orders, e.g., open orders, or orders received within a certain time period, such as within a past half hour. The online concierge system **102** may determine **610** the batched order from the total number of orders based on the warehouse **210** specified by each order, and depending upon the embodiment, the respective destination location of each order. For example, the online concierge system **102** may identify a first subset of orders from the total number of orders that are from the same

warehouse **210**, then determine a second subset of orders from the first subset of orders that includes orders associated with destination locations that are within a proximity threshold of one another. The proximity threshold may specify, for example, that destination locations in a batched order must be within a certain number of driving minutes (e.g., ten minutes of driving) from one another, and/or within a certain number of miles (e.g., five miles of one another), and so on. The online concierge system **102** may limit the number of orders added to a batched order based on a maximum batched order size, which may be specified by an administrator of the online concierge system **102**. For example, the maximum batched order size may be five orders.

The online concierge system **102** sends **615**, to a shopper client device **110**, an instruction to fulfill the batched order. The instruction to fulfill the batched order may include each list of items from the orders in the batched order, and may also include an address of the warehouse **210** and/or navigation instructions from a current location of the shopper client device **110** to the particular warehouse **210**.

The online concierge system **102** receives **620**, from a third party system associated with the particular warehouse **210**, transaction data associated with the batched order. The transaction data includes a plurality of data pairs, where each data pair of the plurality of data pairs associates a picked item with the transaction authorization identifier of one customer of the plurality of customers. For example, the transaction authorization identifier may be a customer identifier, and a data pair may associate a box of cereal with the customer identifier. Alternatively or additionally, the transaction authorization identifier can include a partial credit card number.

The third party system **130** associated with the particular warehouse **210** may be a server associated with an organization that provisions a PoS device at the warehouse **210** (e.g., the PoS device used by the shopper to purchase the picked items). In an embodiment, the POS device directly communicates the transaction data to the online concierge system **102** and the technique does not involve a third party system **130** beyond the POS device. In some embodiments, there is neither a third party system **130** or a PoS device, but rather the online concierge system **130** receives **620** receipt data from the shopper client device **110** (e.g., a photo of a receipt).

The online concierge system **102** determines **625**, based on the transaction data and the batched order, whether a sorting error occurred. Depending upon the embodiment, the online concierge system **102** may construct a table associating each picked item as a record with an intended customer a one column and a transaction authorization identifier as a second column. The online concierge system **102** determines whether one or more rows of the table identifies a different customer between the one column and the second column. If so, the online concierge system **102** determines **625** the picked item recorded at that row to have a sorting error. In some embodiments, the online concierge system **102** alternatively or additionally applies the transaction data (e.g., receipt data) to the machine-learned sorting error model **324** to determine whether one or more sorting errors have occurred.

The online concierge system **102** sends **630** to the shopper client device **110**, an instruction to correct the sorting error. In some embodiments the online concierge system **102** does not send **630** the instruction to correct the sorting error, e.g., when the online concierge system **102** does not identify at least one sorting error. In an embodiment, the online concierge system **102** sends **630** the instruction to correct the sorting error responsive to determining the sorting error occurred. Sending **630** the instruction to correct the sorting error may include the online concierge system **102** determining whether the shopper client device **110** has entered a geofence around a destination location and/or whether the online concierge system **102** has received a delivery confirmation from the shopper client device **110**, at which point the online concierge system **102** releases the instruction to correct the sorting error to the shopper client device **110**.

In an embodiment, the online concierge system **102** receives a confirmation from the shopper client device **110** that the sorting error has been corrected, or an acknowledgement from the shopper client device **110** that the sorting error did not result in the mis-bagging of the respective picked item. The online concierge system **102** may track whether the online concierge system **102** has received confirmations and/or acknowledgements from shopper client devices **110**. This tracked data may be used, for example, to supplement the training datasets **320**.

The techniques described herein provide for asynchronous automated correction handling of incorrectly sorted items using point-of-sale data. This reduces logistical errors such as item delivery to incorrect locations, lessening supply chain strain and improving logistical system reliability. The described techniques overcome technical challenges including the time delays involved in moving point of sale data from a PoS device to the online concierge system **102**, as well as how to properly time the presentation of error alerts, without requiring human input to identify the sorting errors or send out correction instructions.

Additional Considerations

The foregoing description of the embodiments of the invention has been presented for the purpose of illustration; it is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Persons skilled in the relevant art can appreciate that many modifications and variations are possible in light of the above disclosure.

Some portions of this description describe the embodiments of the invention in terms of algorithms and symbolic representations of operations on information. These algorithmic descriptions and representations are commonly used by those skilled in the data processing arts to convey the substance of their work effectively to others skilled in the art. These operations, while described functionally, computationally, or logically, are understood to be implemented by computer programs or equivalent electrical circuits, microcode, or the like. Furthermore, it has also proven convenient at times, to refer to these arrangements of operations as modules, without loss of generality. The described operations and their associated modules may be embodied in software, firmware, hardware, or any combinations thereof.

Any of the steps, operations, or processes described herein may be performed or implemented with one or more hardware or software modules, alone or in combination with other devices. In one embodiment, a software module is implemented with a computer program product comprising a computer-readable medium containing computer program code, which can be executed by a computer processor for performing any or all of the steps, operations, or processes described.

Embodiments of the invention may also relate to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes, and/or it may comprise a computing device selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a tangible computer readable storage medium, which include

any type of tangible media suitable for storing electronic instructions and coupled to a computer system bus. Furthermore, any computing systems referred to in the specification may include a single processor or may be architectures employing multiple processor designs for increased computing capability.

Embodiments of the invention may also relate to a computer data signal embodied in a carrier wave, where the computer data signal includes any embodiment of a computer program product or other data combination described herein. The computer data signal is a product that is presented in a tangible medium or carrier wave and modulated or otherwise encoded in the carrier wave, which is tangible, and transmitted according to any suitable transmission method.

Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based hereon. Accordingly, the disclosure of the embodiments of the invention is intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

The invention claimed is:

1. A method comprising:

receiving, by an online system, a plurality of orders, each order in the plurality of orders received from a user client device of a user of a plurality of users and comprising a list of items for delivery to a destination location from a warehouse, wherein each user of the plurality of users is associated with an authorization identifier;

determining, by the online system, based on the received orders, a first batched order, the first batched order comprising a plurality of lists of items for delivery from a particular warehouse, wherein the plurality of lists of items corresponds to a subset of the plurality of orders;

sending, by the online system, to a shopper client device, an instruction to fulfill the first batched order;

receiving, by the online system, from a third party system associated with the particular warehouse, logged data associated with the first batched order, the logged data comprising a plurality of data pairs, each data pair of the plurality of data pairs associating a picked item with the authorization identifier of one user of the plurality of users;

determining, by the online system, based on the logged data and the first batched order, that a sorting error occurred, wherein the sorting error comprises a picked item being incorrectly associated with a first user of the plurality of users;

tracking, by the online system, a location of the shopper client device over a time period after determining that the sorting error occurred, by receiving location data from a location sensor of the shopper client device;

detecting, by the online system, that the shopper client device has entered a geofence around a destination location of an order of the subset of the plurality of orders; and

responsive to detecting that the shopper client device has entered the geofence, sending, by the online system to the shopper client device, an alert to correct the sorting error, wherein sending the alert causes the shopper client device to display the alert associated with the sorting error by displaying a message to associate the picked item with a second user of the plurality of users.

2. The method of claim **1**, wherein determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprises:

determining, by the online system, for each picked item, based on the first batched order, an intended user;

generating, by the online system, a discrepancy table, wherein the discrepancy table comprises rows, wherein each row corresponds to a data pair in the logged data and the intended user corresponding to the picked item in the data pair; and

determining, by the online system, whether a row in the discrepancy table indicates the first user based on the corresponding authorization identifier at a first column and the second user based on the corresponding intended user at a second column.

3. The method of claim **1**, wherein determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprises:

applying, by the online system, at least part of the logged data to a machine-learned sorting error model, to generate a text sequence output, wherein the logged data comprises receipt data;

determining, by the online system, a user identified in the text sequence output;

determining, by the online system, a picked item identified in the text sequence output;

determining, by the online system, an intended user for the picked item, based on the first batched order; and

determining, by the online system, whether the intended user matches the user identified in the text sequence output.

4. The method of claim **1**, further comprising:

determining, by the online system, for the sorting error, a sorting error confidence value;

wherein sending, by the online system, to the shopper client device, the instruction to correct the sorting error, is responsive to the sorting error confidence value being greater than a predetermined confidence threshold value.

5. The method of claim **1**, further comprising:

receiving, from the shopper client device, a confirmation of delivery to the destination location;

wherein sending, by the online system, to the shopper client device, the instruction to correct the sorting error, is responsive to receiving the confirmation of delivery.

6. The method of claim **1**, wherein determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprises:

generating, by the online system, a discrepancy table; and

applying, by the online system, to a machine-learned sorting error model to the logged data.

7. The method of claim **1**, wherein detecting, by the online system, that the shopper client device has entered the geofence around the destination location of the order of the subset of the plurality of orders, comprises:

receiving location data from a location sensor of the shopper client device.

8. The method of claim **1**, wherein the destination location is a fixed geographic location.

9. A non-transitory computer-readable storage medium having instructions encoded thereon that, when executed by a processor, cause the processor to:

receive, by an online system, a plurality of orders, each order in the plurality of orders received from a respective customer client device of each customer of a

plurality of customers and comprising a list of items for delivery to a destination location from a warehouse, wherein each customer of the plurality of customers is associated with a authorization identifier;

determine, by the online system, based on the received orders, a first batched order, the first batched order comprising a plurality of lists of items for delivery from a particular warehouse, wherein the plurality of lists of items corresponds to a subset of the plurality of orders;

send, by the online system, to a shopper client device, an instruction to fulfill the first batched order;

receive, by the online system, from a third party system associated with the particular warehouse, logged data associated with the first batched order, the logged data comprising a plurality of data pairs, each data pair of the plurality of data pairs associating a picked item with the authorization identifier of one customer of the plurality of customers;

determine, by the online system, based on the logged data and the first batched order, that a sorting error occurred, wherein the sorting error comprises a picked item being incorrectly associated with a first user of the plurality of users;

track, by the online system, a location of the shopper client device over a time period after determining that the sorting error occurred, by receiving location data from a location sensor of the shopper client device;

detect, by the online system, that the shopper client device has entered a geofence around a destination location of an order of the subset of the plurality of orders; and

responsive to detecting that the shopper client device has entered the geofence, send, by the online system to the shopper client device, an alert to correct the sorting error, wherein sending the alert causes the shopper client device to display the alert associated with the sorting error by displaying a message to associate the picked item with a second user of the plurality of users.

10. The computer-readable medium of claim **9**, wherein the instructions for determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred comprise instructions that, when executed by the processor, cause the processor to:

determine, by the online system, for each picked item, based on the first batched order, an intended user;

generate, by the online system, a discrepancy table, wherein the discrepancy table comprises rows, wherein each row corresponds to a data pair in the logged data and the intended user corresponding to the picked item in the data pair; and

determine, by the online system, whether a row in the discrepancy table indicates the first user based on the corresponding authorization identifier at a first column and the second user based on the corresponding intended user at a second column.

11. The computer-readable medium of claim **9**, wherein the instructions for determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprise instructions that, when executed by the processor, cause the processor to:

apply, by the online system, at least part of the logged data to a machine-learned sorting error model, to generate a text sequence output, wherein the logged data comprises receipt data;

determine, by the online system, a user identified in the text sequence output;

determine, by the online system, a picked item identified in the text sequence output;

determine, by the online system, an intended user for the picked item, based on the first batched order; and

determine, by the online system, whether the intended user matches the user identified in the text sequence output.

12. The computer-readable medium of claim **9**, the instructions further comprising instructions that, when executed by the processor, cause the processor to:

determine, by the online system, for the sorting error, a sorting error confidence value;

wherein sending, by the online system, to the shopper client device, the instruction to correct the sorting error, is responsive to the sorting error confidence value being greater than a predetermined confidence threshold value.

13. The computer-readable medium of claim **9**, the instructions further comprising instructions that, when executed by the processor, cause the processor to:

receive, from the shopper client device, a confirmation of delivery to the destination location;

wherein sending, by the online system, to the shopper client device, the instruction to correct the sorting error, is responsive to receiving the confirmation of delivery.

14. The computer-readable medium of claim **9**, wherein the instructions for determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprises instructions that, when executed by the processor, cause the processor to:

generate, by the online system, a discrepancy table; and

apply, by the online system, to a machine-learned sorting error model to the logged data.

15. The computer-readable medium of claim **9**, wherein the instructions for detecting, by the online system, that the shopper client device has entered the geofence around the destination location of the order of the subset of the plurality of orders, comprises instructions that, when executed by the processor, cause the processor to:

receive location data from a location sensor of the shopper client device.

16. The computer-readable medium of claim **9**, wherein the destination location is a fixed geographic location.

17. A system comprising:

a processor; and

a non-transitory computer readable medium storing instructions that, when executed by the processor, cause the processor to perform operations comprising:

receiving, by an online system, a plurality of orders, each order in the plurality of orders received from a user client device of a user of a plurality of users and comprising a list of items for delivery to a destination location from a warehouse, wherein each user of the plurality of users is associated with an authorization identifier;

determining, by the online system, based on the received orders, a first batched order, the first batched order comprising a plurality of lists of items for delivery from a particular warehouse, wherein the plurality of lists of items corresponds to a subset of the plurality of orders;

sending, by the online system, to a shopper client device, an instruction to fulfill the first batched order;

receiving, by the online system, from a third party system associated with the particular warehouse, logged data associated with the first batched order, the logged data comprising a plurality of data pairs, each data pair of the plurality of data pairs associ-

ating a picked item with the authorization identifier of one user of the plurality of users;

determining, by the online system, based on the logged data and the first batched order, that a sorting error occurred, wherein the sorting error comprises a picked item being incorrectly associated with a first user of the plurality of users;

tracking, by the online system, a location of the shopper client device over a time period after determining that the sorting error occurred, by receiving location data from a location sensor of the shopper client device;

detecting, by the online system, that the shopper client device has entered a geofence around a destination location of an order of the subset of the plurality of orders; and

responsive to detecting that the shopper client device has entered the geofence, sending, by the online system to the shopper client device, an alert to correct the sorting error, wherein sending the alert causes the shopper client device to display the alert associated with the sorting error by displaying a message to associate the picked item with a second user of the plurality of users.

18. The system of claim **17**, wherein determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprises:

determining, by the online system, for each picked item, based on the first batched order, an intended user;

generating, by the online system, a discrepancy table, wherein the discrepancy table comprises rows, wherein each row corresponds to a data pair in the logged data and an intended user corresponding to the picked item in the data pair; and

determining, by the online system, whether a row in the discrepancy table indicates a first user based on the corresponding authorization identifier at a first column and a second user based on the corresponding intended user at a second column.

19. The system of claim **17**, wherein determining, by the online system, based on the logged data and the first batched order, whether a sorting error occurred, comprises:

applying, by the online system, at least part of the logged data to a machine-learned sorting error model, to generate a text sequence output, wherein the logged data comprises receipt data;

determining, by the online system, a user identified in the text sequence output;

determining, by the online system, a picked item identified in the text sequence output;

determining, by the online system, an intended user for the picked item, based on the first batched order; and

determining, by the online system, whether the intended user matches the user identified in the text sequence output.

20. The system of claim **17**, further comprising:

determining, by the online system, for the sorting error, a sorting error confidence value;

wherein sending, by the online system, to the shopper client device, the instruction to correct the sorting error, is responsive to the sorting error confidence value being greater than a predetermined confidence threshold value.

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