

AN AUTOMATED METHOD AND SYSTEM FOR MANAGING DOCUMENTS FOR COLLECTION

FIELD OF THE INVENTION

[0001] The invention pertains to an automated method and system for managing documents for collection. These documents can be personalized documents like passports and identification cards.

BACKGROUND

[0002] Current automated personalized document (e.g. passport, identification card etc) collection methods involves pre-storing the documents to be collected in compartments of a pre-assigned kiosk. Users are assigned an appointment time and users collect their documents from the pre-assigned kiosk at the appointment time.

[0003] However, such methods suffer from certain limitations. For example, the collection of the documents is inflexible as the documents can only be collected at stipulated appointment times. Further, the collection of the documents can only be done from pre-assigned kiosks. Furthermore, if the kiosk becomes faulty or jammed, the collection of the documents will be comprised. Manual intervention will be required to remove the documents from the faulty kiosk. Even further still, the number of documents capable of being collected by users is limited to the document storage capacity of the kiosk. Current methods are simply not robust to cater to fluctuating demand.

[0004] Thus, instead of pre-storing the documents in the kiosks, what is required is a novel method and system which addresses the above problems by providing an automated method and system for providing the documents to the kiosks only upon request or upon a trigger action (for example, user has arrived at a kiosk). Further, considerations have been contemplated in the invention to transport the documents to the kiosks quickly upon receiving the request or activation of the trigger action. Furthermore, other desirable features and characteristics will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and this background of the disclosure.

SUMMARY OF INVENTION

[0005] According to a first aspect of the invention, an automated document retrieval method is disclosed, the method comprising the steps of receiving a scheduled collection appointment for a document and identifying a central storage location where the document is stored. Prior to the scheduled collection appointment, the method teaches the steps of transferring the document from the central storage location to a shuttle, the shuttle configured to receive the document and travel on a track with the document, and the shuttle and track being positioned on a lower level and the central storage location being positioned on an upper level; and transporting the document to a temporary storage location using the shuttle on the track, the temporary storage location being located closer to a delivery location than the central storage location. In response to a trigger action, the method teaches transferring the document from the temporary storage location to the shuttle, the temporary storage location being positioned on the upper level; and transporting the document to the delivery location using the shuttle on the track. Wherein the upper level is above the lower level such that a trajectory of the shuttle is unhindered by the central storage location and the temporary storage location, and the lower level functions as an exclusive pathway for the shuttle.

[0006] According to a second aspect of the invention, an automated document retrieval method is disclosed, the method comprising the steps of receiving an unscheduled collection request for a document; and identifying a central storage location where the document is stored. The method further comprises the steps of transferring the document from the central storage location to a shuttle, the shuttle configured to receive the document and travel on a track with the document, and the shuttle and track being positioned on a lower level and the central storage location being positioned on an upper level; and transporting the document to a delivery location using the shuttle on the track. Wherein the upper level is above the lower level such that a trajectory of the shuttle is unhindered by the central storage location, and the lower level functions as an exclusive pathway for the shuttle.

[0007] According to a third aspect of the invention, an automated document retrieval system is disclosed, the system comprising a storage location for storing a document, the storage location positioned on an upper level, the upper level comprising a hollowed-out section; and a track positioned on a lower level, the upper level being above the lower level. The system

further comprises a shuttle configured to receive the document and travel on the track, the shuttle positioned on the lower level; and a gantry arm, the gantry arm configured to transfer the document from the storage location on the upper level, to the shuttle on the lower level via the hollowed-out section. Wherein upon transfer of the document to the shuttle, the shuttle travels on the track and transports the document to a delivery location, whereby a trajectory of the shuttle is unhindered by the storage location, and the lower level functions as an exclusive pathway for the shuttle.

[0008] According to a fourth aspect of the invention, a document production system is disclosed, the system comprising a first production equipment and a second production equipment, the first production equipment and the second production equipment positioned on an upper level, the upper level comprising a first hollowed-out section and a second hollowed-out section; and a track positioned on a lower level, the upper level being above the lower level. The system further comprises a shuttle configured to receive a document and travel on the track, the shuttle positioned on the lower level; a first document transfer system, the first document transfer system configured to transfer the document from the first production equipment on the upper level, to the shuttle on the lower level via the first hollowed-out section; and a second document transfer system, the second document system configured to transfer the document from the shuttle on the lower level, to the second production equipment on the upper level via the second hollowed-out section. Wherein upon transfer of the document to the shuttle, the shuttle travels on the track and transports the document to a location where the second document transfer system can transfer the document from the shuttle to the second production equipment, whereby a trajectory of the shuttle is unhindered by the first production equipment and the second production equipment, and the lower level functions as an exclusive pathway for the shuttle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to illustrate various embodiments, by way of example only, and to explain various principles and advantages in accordance with a present embodiment.

[0010] Figure 1 depicts a system for managing documents and preparing them for collection in accordance with certain embodiments.

[0011] Figure 2 depicts a dispatch area in accordance with certain embodiments.

[0012] Figure 3 depicts a transfer of a document from a shuttle in a lower level to a kiosk in an upper level in accordance with certain embodiments.

[0013] Figure 4 depicts a software system for managing documents and preparing them for collection in accordance with certain embodiments.

[0014] Figure 5 depicts a method for scheduled document collection in accordance with certain embodiments.

[0015] Figure 6 depicts a method for unscheduled document collection in accordance with certain embodiments.

[0016] Figure 7 depicts a system for producing documents and storing them in accordance with certain embodiments.

[0017] Figure 8 depicts a pod berthing area in accordance with certain embodiments.

[0018] Figure 9 depicts an automated storage and retrieval unit in accordance with certain embodiments.

[0019] Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been depicted to scale. For example, the dimensions of some of the elements in the block diagrams or steps in the flowcharts may be exaggerated in respect to other elements to help improve understanding of the present embodiment.

DETAILED DESCRIPTION

[0020] The following detailed description is merely exemplary in nature and is not intended to limit the invention or the application and uses of the invention. Furthermore, there is no

intention to be bound by any theory presented in the preceding background of the invention or the following detailed description.

[0021] It is the intent of certain embodiments to disclose an automated document retrieval method and system comprising the steps of receiving a scheduled collection appointment for a document, and identifying a central storage location where the document is stored. Prior to the scheduled collection appointment, the method describes transferring the document from the central storage location to a shuttle, the shuttle configured to receive the document and travel on a track with the document. The shuttle and track are positioned on a lower level while the central storage location is positioned on an upper level. The method then describes transporting the document to a temporary storage location using the shuttle on the track, the temporary storage location being located closer to a delivery location (e.g. kiosk) than the central storage location. In response to a trigger action (e.g. confirmation of the user's arrival at the kiosk), the method describes transferring the document from the temporary storage location to the shuttle. The temporary storage location is positioned on the upper level. The method then describes transporting the document to the delivery location (e.g. kiosk) using the shuttle on the track. The upper level is above the lower level such that a trajectory of the shuttle is unhindered by the central storage location and the temporary storage location, and the lower level functions as an exclusive pathway for the shuttle.

[0022] As the documents are no longer pre-stored in the kiosks, and the documents are transferred to kiosks only at the occurrence of the trigger action (e.g. confirmation of the user's arrival at a kiosk), the user now has the flexibility to approach any of the kiosks, and the document will be transferred to the kiosk which the user had selected. Further, the impact of damaged or faulty kiosks will be mitigated as the system will simply halt document delivery to damaged or faulty kiosks until they are repaired, and deliver documents to other functioning kiosks. The document collection efficiency will also increase as the number of documents collected will no longer be constrained by the number and capacity of the kiosks. Also, all the kiosks can operate around the clock as manual top-up of documents is not required. This allows document collection by users at any convenient time of their choice and without being restricted to operating hours. Even documents produced during operating hours in the day can be collected in the evening of the same day, something not possible in existing solutions.

[0023] A consideration for transferring the documents to the kiosks only at the occurrence of the trigger action is the lead time i.e. time it takes for the documents to be transferred to the kiosks. If the lead time is too long, the advantages gained by not pre-storing the documents in the kiosks will be marginalized. The method and system as described thus provisions for this by having the central storage location and the temporary storage location all positioned on the upper level, while the shuttle and track are positioned on the lower level. The upper level is above the lower level, and thus the lower level functions as a dedicated and exclusive pathway for the shuttles to travel unhindered by obstacles. Thus, the shuttles can travel at fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles. This drastically reduces the lead time and allows the documents to be transferred to the kiosks or delivery locations very quickly. Furthermore, because the documents are stored in temporary storage locations in the dispatch area which are closer to the kiosks or delivery locations, as compared to central storage locations, the lead time is also effectively reduced.

[0024] It is also the intent of certain embodiments to disclose an automated document retrieval method and system comprising the steps of receiving an unscheduled collection request for a document, and identifying a central storage location where the document is stored. The method further comprises the step of transferring the document from the central storage location to a shuttle. The shuttle is configured to receive the document and travel on a track with the document. The shuttle and track are positioned on a lower level while the central storage location is positioned on an upper level. The method then describes transporting the document to the delivery location (e.g. kiosk) using the shuttle on the track. The upper level is above the lower level such that a trajectory of the shuttle is unhindered by the central storage location, and the lower level functions as an exclusive pathway for the shuttle.

[0025] As the documents are no longer pre-stored in the kiosks, and the documents are transferred to kiosks only at the point of receiving the unscheduled collection request, the user now has the flexibility to approach any of the kiosks, and the document will be transferred to the kiosk which the user had selected. Further, the impact of damaged or faulty kiosks will be mitigated as the system will simply halt document collection from damaged or faulty kiosks, and transfer documents to other functioning kiosks. The document collection efficiency will also increase as the number of documents collected will no longer be constrained by the number and capacity of the kiosks. Also, all the kiosks can operate around the clock as manual

top-up of documents is not required. This allows document collection by users at any convenient time of their choice without prior appointment and without being restricted to operating hours. Even documents produced during operating hours in the day can be collected in the evening of the same day, something not possible in existing solutions.

[0026] A consideration for transferring the documents to the kiosks only at the point of receiving the unscheduled collection request is the lead time i.e. time it takes for the documents to be transferred to the kiosks. If the lead time is too long, the advantages gained by not pre-storing the documents in the kiosks will be marginalized. The method and system as described thus provisions for this by having the central storage location positioned on the upper level, while the shuttle and track are positioned on the lower level. The upper level is above the lower level, and thus the lower level functions as a dedicated and exclusive pathway for the shuttles to travel unhindered by obstacles. Thus, the shuttles can travel at fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles. This drastically reduces the lead time and allows the documents to be transferred to the kiosks or delivery locations very quickly.

[0027] Embodiments of the present invention will be described, by way of example only, with reference to the drawings. Like reference numerals and characters in the drawings refer to like elements or equivalents.

[0028] Figure 1 shows system 100 for managing documents and preparing them for collection in accordance with certain embodiments. System 100 comprises automated storage and retrieval unit 101 in central repository area 102. Central repository area 102 comprises two raised levels in relation to the floor, upper level 103 and lower level 104. Automated storage and retrieval unit 101 is configured to store documents. These documents can be personalized documents like passports and identification cards. Automated storage and retrieval unit 101 can have a plurality of shelves 111 (for example, 5 to 8 shelves 111). Each of the shelves 111 can have a plurality of slots for storing documents. For example, each automated storage and retrieval unit 101 can store around 5000 documents.

[0029] Automated storage and retrieval unit 101 is also configured to place documents in shelves 111 in a storage operation, and retrieve documents from shelves 111 in a retrieval operation. Automated storage and retrieval unit 101 can have a dedicated gantry arm (not

shown in figure 1) for each shelf 111 to access any one of its slots and place/retrieve documents. Preferably, the gantry arm is a robotic arm with three degrees of movement and is capable of navigating itself to place/retrieve documents on any slot on any shelf 111 in automated storage and retrieval unit 101. The gantry arm is configured to place documents on shuttle 105 located on track 106. The gantry arm is also configured to retrieve documents from shuttle 105 located on track 106.

[0030] Though only one automated storage and retrieval unit 101 is shown in central repository area 102 in figure 1, the disclosed invention encompasses multiple automated storage and retrieval units 101 in central repository area 102. Certain automated storage and retrieval units 101 could be dedicated to storing a certain type of personalized documents (e.g. one could store passports only while another could store identification cards only).

[0031] Shuttle 105 is configured to carry and transport documents to a destination along track 106. Shuttle 105 can be an autonomous guided vehicle or robot. Shuttle 105 can be sized to transport one or a plurality of documents and as such, can be smaller than an A4 sized document. Shuttle 105 can be designed to be lightweight and aerodynamic. Shuttle 105 can travel at a high speed along track 106. For example, shuttle 105 can travel at 5 meters per second. Shuttle 105 is configured to receive one or a plurality of documents. Shuttle 105 can have a document receiving mechanism. Preferably, the document receiving mechanism is located at the top portion of shuttle 105. Preferably, the document receiving mechanism has a cavity to receive or house the documents. Preferably, the document receiving mechanism has a locking mechanism with a locked configuration to secure the document in the cavity during transport to prevent the document from falling off as shuttle 105 moves at high speeds. The locking mechanism can transition from an unlocked configuration to the locked configuration (and vice versa) in response to sensors on shuttle 105. The locking mechanism can also transition between the unlocked configuration and the locked configuration in response to signals from a remote controller. The lock/unlock status of each shuttle 105 can be monitored continuously by the remote controller.

[0032] Track 106 can have a plurality of lanes. A left lane and a right lane can be configured for bi-directional travel, while a middle lane can be configured for bypass or maintenance. Multiple shuttles 105 can travel in a single lane. The lanes can be defined by optical tapes that

run parallel to one another. In such embodiments, shuttle 105 can have an optical sensor to stay in the lane as defined by the optical tapes.

[0033] As shown in Figure 1, automated storage and retrieval unit 101 is positioned on upper level 103, while shuttle 105 is positioned to move along track 106 located on lower level 104. The height difference between upper level 103 and lower level 104 can be between 2 meters and 2.5 meters. This is to allow sufficient clearance in lower level 104 in the event of a faulty shuttle 105 where a maintenance person has to go into lower level 104 to retrieve any shuttle 105 that has broken down. Alternatively, the height difference between upper level 103 and lower level 104 can be less than 2 meters. Dedicated “rescue” shuttles 105 can be dispatched to the location of any broken-down shuttle 105. These “rescue” shuttles 105 can tow the broken-down shuttle 105 to a maintenance bay using the middle lane without affecting the movement of the other shuttles 105 performing document delivery.

[0034] Upper level 103 can also have hollowed-out sections 110. Hollowed-out sections 110 function as gaps to allow the gantry arm to “reach through” to lower level 104, to either place documents on shuttle 105 or to retrieve documents from shuttle 105. Preferably, hollowed-out sections 110 on upper level 103 are located at one end of each shelf 111 of automated storage and retrieval unit 101 (see figure 1).

[0035] The disclosed invention encompasses multiple shuttles 105 traveling along track 106 in lower level 104. Preferably, each document retrieval task is handled by a dedicated shuttle 105. For a single automated storage and retrieval unit 101, there can be multiple shuttles 105 queuing up along track 106 in lower level 104, waiting to receive the documents from the gantry arms of that automated storage and retrieval unit 101.

[0036] As track 106 is located at a different level to automated storage and retrieval units 101, this advantageously facilitates the movement of shuttle 105 as shuttle 105 can travel on track 106 to its destination unhindered by automated storage and retrieval unit 101. In essence, lower level 104 functions as a dedicated or exclusive pathway for the movement of shuttle 105 on track 106, unhindered by obstacles. Thus, the shuttles can travel at fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles.

[0037] In an exemplary example of a storage operation, the gantry arm of specific shelf 111 navigates towards shuttle 105, shuttle 105 being stationed directly below the specific shelf 111 and its hollowed-out section 110 on upper level 103. Shuttle 105 has a document in its document receiving mechanism and the locking mechanism is in the unlocked configuration. The gantry arm navigates through hollowed-out section 110 and picks the document from shuttle 105. The gantry arm then navigates back through hollowed-out section 110, and to the specific slot on the specific shelf 111 on automated storage and retrieval unit 101, and places the document there.

[0038] In an exemplary example of a retrieval operation, the gantry arm on a specific shelf 111 on automated storage and retrieval unit 101, navigates to a specific slot and picks the document from there. The gantry arm then navigates through hollowed-out section 110 directly below the specific shelf 111 on upper level 103 and towards shuttle 105 stationed directly underneath. The locking mechanism of shuttle 105 is in the unlocked configuration. The gantry arm places the document in the cavity of the document receiving mechanism of shuttle 105. The gantry arm then retracts into automated storage and retrieval unit 101. The locking mechanism of shuttle 105 then transitions to the locked configuration. Shuttle 105 then begins its journey along track 106 towards the delivery location.

[0039] Both the storage and retrieval operations as described above can be performed concurrently in each shelf 111 of any automated storage and retrieval unit 101. This parallelism of the storage and retrieval operations ensures high throughput of each automated storage and retrieval unit 101 and delivers high numbers of hourly storage and retrievals per automated storage and retrieval unit 101.

[0040] The delivery location of shuttle 105 can be kiosk 107 or customer service counter 108 in customer area 109. Users can choose to collect documents from either kiosk 107 or customer service counter 108. Kiosk 107 and customer service counter 108 can be located on upper level 103 and so kiosk 107 and customer service counter 108 will also not impede the movement of shuttle 105 on track 106 on lower level 104, and lower level 104 can function as a dedicated or exclusive pathway for the movement of shuttle 105 on track 106. Shuttle 105 can come to a stop on lower level 104 just below a document transfer system (DTS) of kiosk 107 or a DTS of customer service counter 108. The DTS of kiosk 107 can be located at a rear of kiosk 107, and the DTS of customer service counter 108 can be located at a rear of

customer service counter 108 so that document delivery to kiosk 107 and customer service counter 108 remain out of sight to the user. A DTS can be a robotic arm with three degrees of movement and is capable of navigating itself to transfer documents from shuttle 105 to kiosk 107 or customer service counter 108, and vice versa. A DTS can also be outfitted with a gripper mechanism comprising a rubber material to handle documents without damaging them.

[0041] Once shuttle 105 has reached the delivery location and is stationary, the locking mechanism of shuttle 105 transitions to the unlocked configuration. The DTS can then retrieve the document from shuttle 105 and transfer it to kiosk 107 or customer service counter 108 for dispensation to a user. As shown in Figure 3, kiosk 107 is located on upper level 103. Shuttle 105 comes to a stop on lower level 104 below DTS 310. DTS 310 is located to the rear of kiosk 107. DTS 310 picks up the document from shuttle 105 and feeds the document to kiosk 107. Upon successful user authentication, kiosk 107 dispenses the document to the user. In the event of failure during authentication, the document is returned to shuttle 105 by DTS 310. Shuttle 105 returns the document to the nearest automated storage and retrieval unit 101 and the document storage database is updated accordingly by software system 400.

[0042] Central repository area 102 can be located a fair distance from customer area 109. Therefore, in certain embodiments, automated storage and retrieval units 101 can also be housed in dispatch area 201 as shown in figure 2. Similar to central repository area 102, the automated storage and retrieval units 101 in dispatch area 201 are positioned on upper level 103, while shuttles 105 move along track 106 on lower level 104. Shuttles 105 transport documents by traveling on track 106 located on lower level 104, and lower level 104 functions as a dedicated and exclusive pathway for shuttles 105. Therefore, likewise, shuttles 105 are capable of traveling at high and fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles.

[0043] The automated storage and retrieval units 101 in dispatch area 201 function as temporary storage locations. Dispatch area 201 can be located proximate to the delivery locations like kiosks 107, and can be located closer to the delivery locations than central repository area 102. The advantage of storing documents in automated storage and retrieval units 101 within dispatch area 201 is that due to their closer proximity to the delivery locations (as compared to central repository area 102), the lead time to transport documents to the delivery locations will be effectively reduced. This is especially relevant when users have

made prior appointments to collect documents. Preferably, the night before the appointment, the documents would be transported to these temporary storage locations, for subsequent transfer to kiosk 107 the following day as shown in figure 3.

[0044] Figure 4 shows software system 400 for managing documents and preparing them for collection in accordance with certain embodiments. Software system 400 can comprise inventory management module 401. Inventory management module 401 can be the main module that interfaces with central server 420. Central server 420 can be interfacing with the database server of an immigration authority of the government, which polices and issues passports and identification cards. Inventory management module 401 can have a set of application programming interfaces (APIs) to facilitate the exchange information between system 400 and central server 420. Through these APIs, inventory management module 401 can obtain information on the collection schedule i.e. list of users scheduled to collect their documents and details of the appointments and the user database i.e. the list of users and the documents associated with them. Inventory management module 401 can also interface with kiosks 107 and customer service counters 108 where documents are dispensed or issued.

[0045] Inventory management module 401 can comprise sub-modules material movement control module 402 and user control terminal module 403. Material movement control module 402 can be responsible for the transportation of documents through the entire transportation cycle i.e. from the printers in the production rooms to kiosks 107 and customer service counters 108. Material movement control module 402 can interface with loading and unloading module 404 and fleet management module 405. User control terminal module 403 is for providing the front-end interface to users.

[0046] Loading and unloading module 404 can control all the transfer terminals in the whole system. The transfer terminals can include printers, inspection stations, barcode wrapping machines, pods in production room, pods in berthing area, automated storage and retrieval units 101, kiosks 107 and customer service counters 108. Fleet management module 405 can be responsible for the movement of all documents from production room to pod berthing area, and then to automated storage and retrieval units 101 and finally to kiosks 107 and customer service counters 108. Fleet management module 405 can receive transport orders from material movement control module 402 and assigns these tasks or jobs to shuttles 105. Pod transfer jobs can be assigned to mobile robots 802, and document transfers assigned to shuttles

105 moving along lower level 104. Fleet management module 405 tracks the movement of shuttles 105 and mobile robots 802. Fleet management module 405 also monitors the status of all the shuttles 105 and mobile robots 802 such as “empty”, “loaded” or “in error” and schedules transport and rescue jobs to shuttles 105 and mobile robots 802 based on an optimization algorithm that takes into account the nearest available shuttle 105 or mobile robot 802 for a job and the remaining battery charge level. The charging schedule for shuttles 105 and mobile robots 802 is also determined by the Fleet management module 405 based on the remaining charge level and minimum charge level before recharging needs to be scheduled.

[0047] Software system 400 can also comprise ASRS auto storage module 406. ASRS auto storage module 406 can maintain a database containing information on which documents are currently stored in each of the automated storage and retrieval units 101. ASRS auto storage module 406 can update the database whenever documents are stored in, or retrieved from automated storage and retrieval units 101.

[0048] Inventory management module 401 can obtain information from central server 420 the list of users with appointments to collect documents, scheduled for example, on the next working day. Prior to that working day, inventory management module 401 then sends instructions to fleet management module 405 to transfer the documents scheduled for collection by the users from automated storage and retrieval units 101 in central repository area 102 to automated storage and retrieval units 101 in dispatch area 201. The transfer of these documents is preferably done after working hours on the day prior, when there are less ongoing activities in the system.

[0049] Figure 5 depicts a method for scheduled document collection in accordance with certain embodiments.

[0050] In step 501, software system 400 receives information pertaining to a scheduled collection appointment for a document. This information can comprise a user identification number (which uniquely identifies the user), the document identification number (which uniquely identifies the document), the appointment time (e.g. date and time), and the delivery location.

[0051] In step 502, software system 400 identifies a central storage location where the document is stored. Software system 400 determines that the document is stored in a particular automated storage and retrieval unit 101 in central repository area 102.

[0052] In step 503, software system 400 initiates the transfer of the document from the central storage location (i.e. in an automated storage and retrieval unit 101 in central repository area 102) to shuttle 105. The gantry arm on shelf 111 can navigate to a slot on shelf 111 of the automated storage and retrieval unit 101, and pick the document from there. The gantry arm can then navigate through hollowed-out section 110 and place the document on shuttle 105 stationed directly underneath on track 106 on lower level 104.

[0053] In step 504, software system 400 initiates the transport of the document using shuttle 105 on track 106 to a temporary storage location. The temporary storage location can be in an automated storage and retrieval unit 101 in dispatch area 201. Shuttle 105 travels on track 106 till it reaches a position just under shelf 111 of the automated storage and retrieval unit 101 in dispatch area 201. The gantry arm on shelf 111 navigates towards shuttle 105 and picks the document. The gantry arm then navigates through hollowed-out section 110 and to a specific slot on a specific shelf 111 on automated storage and retrieval unit 101, and places the document there.

[0054] As track 106 is located on lower level 104 while the automated storage and retrieval unit 101 in central repository area 102 is located on upper level 103, upper level 103 being above lower level 104, the trajectory of shuttle 105 is not hindered by the automated storage and retrieval unit 101 in central repository area 102. Dispatch area 201 can be located closer to the delivery location than central repository area 102. The above mentioned steps 503 and 504 to store the document in the temporary storage location are performed prior to the appointment time. For example, steps 503 and 504 can be performed the night before the appointment time, or after working hours, when the number of transactions in the whole system is relatively low.

[0055] In step 505, software system 400 initiates the transfer of the document from the temporary storage location (automated storage and retrieval unit 101 in dispatch area 201) to shuttle 105. The gantry arm on shelf 111 can navigate to the slot on shelf 111 of the automated storage and retrieval unit 101, and pick the document from there. The gantry arm can then

place the document on shuttle 105 stationed directly underneath shelf 111 on track 106 on lower level 104.

[0056] In step 506, software system 400 initiates the transport of the document using shuttle 105 on track 106 to the delivery location. As track 106 is located on lower level 104 while the automated storage and retrieval unit 101 in the dispatch area is located on upper level 103, upper level 103 being above lower level 104, the trajectory of shuttle 105 is not hindered by the automated storage and retrieval unit 101 in dispatch area 201 (please see figures 2 and 3). The above-mentioned steps 505 and 506 to transport the document to the delivery location is performed only in response to a trigger action.

[0057] For example, if the delivery location is kiosk 107, the trigger action could be a confirmation that the user is at kiosk 107. In another example, if the delivery location is customer service counter 108, the trigger action could be a document request made by a customer service officer. In another example, if the delivery location is a delivery area (where the document is subsequently delivered via a courier service or a postal service to the user), the trigger action could be the appointment time. The documents involved in delivery by courier or postal service each day can all be transferred into one or more pods 706 the night before, and the pods 706 are carried by the mobile robots 802 at an appointed time to the area assigned for delivering these documents to concerned personnel.

[0058] The method of steps 501 to 506 describe that the documents are transferred to kiosks 107 or customer service counters 108 only at the occurrence of the trigger action (e.g. confirmation of the user's arrival at kiosk 107). As the documents are not pre-stored in any kiosks 107 or at any customer service counters 108, the user now has the flexibility to approach the kiosk 107 or customer service counter 108 of his choice. Further, the impact of damaged or faulty kiosks 107 will be mitigated as software system 400 will simply halt document collection from damaged or faulty kiosks 107, and assign delivery of documents to other functioning kiosks 107. The document collection efficiency will also increase as the number of documents collected will no longer be constrained by the number and capacity of the kiosks 107.

[0059] Furthermore, the lead time to provide the documents to the delivery locations have been optimized. This because the documents can be transferred across the different locations

(central storage area to temporary storage area, and then temporary storage area to delivery location) very quickly. This fast speed is attributable to the fact that shuttle 105 travels on track 106 on lower level 104, while the automated storage and retrieval units 101 are all located on upper level 103. Lower level 104 thus functions as a dedicated and exclusive pathway for shuttles 105. Therefore, shuttles 105 are capable of traveling at high and fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles. Furthermore, because the documents are stored in temporary storage locations in dispatch area 201 which are closer to the delivery location as compared to central repository area 102, the lead time is effectively reduced.

[0060] The delivery locations i.e. kiosk 107 and customer service counter 108 can also be located on upper level 103, and so kiosk 107 and customer service counter 108 will also not impede the movement of shuttle 105 on track 106 on lower level 104, and lower level 104 can function as a dedicated or exclusive pathway for the movement of shuttle 105 on track 106, unhindered by obstacles.

[0061] Further, software system 400 can perform optimization when storing documents in automated storage and retrieval unit 101. For example, if software system 400 recognizes that there are multiple documents to be collected by the same user, these documents will be stored in the same shelf 111 at adjacent slots in automated storage and retrieval unit 101 in dispatch area 201 to facilitate retrieval of the documents. In another example, documents belonging to family members can be stored in the same shelf 111 at adjacent slots. Further, for efficiency purposes, multiple documents belonging to the same user or family can be placed on the same shuttle 105 during transport from automated storage and retrieval unit 101 to kiosk 107 or customer service counter 108. In some embodiments, if the document has been transferred to kiosk 107, but the document has not been retrieved by the user by a stipulated time, the document will be transferred from kiosk 107 back to the temporary storage location (automated storage and retrieval unit 101 in dispatch area 201).

[0062] As document retrieval from the temporary storage location (steps 505 and 506) begins after the trigger action (confirmation that the user is at kiosk 107), there are times when user authentication (using biometrics like iris scan, fingerprint scan or face recognition and the like) at kiosk 107 fails. In such an event, the document will be placed back in the temporary storage location (automated storage and retrieval unit 101 in dispatch area 201). If user authentication

at kiosk 107 continues to fail, user can request for the document to be sent to customer service counter 108. Software system 400 will then initiate the document to be transported to a designated customer service counter 108 for a customer service officer to personally dispense the document to the user. The counter number of the designated customer service counter 108 can then be displayed on a screen of kiosk 107 directing the user to proceed to the designated customer service counter 108.

[0063] Figure 6 depicts a method for unscheduled document collection in accordance with certain embodiments.

[0064] In step 601, software system 400 receives information pertaining to an unscheduled collection request for a document. This information can comprise a user identification number (which uniquely identifies the user) the document identification number (which uniquely identifies the document) and a delivery location.

[0065] In step 602, software system 400 identifies a central storage location where the document is stored. Software system 400 determines that the document is stored in a particular automated storage and retrieval unit 101 in central repository area 102.

[0066] In step 603, software system 400 initiates the transfer of the document from the central storage location (i.e. in an automated storage and retrieval unit 101 in central repository area 102) to shuttle 105. The gantry arm on shelf 111 can navigate to a slot on shelf 111 of the automated storage and retrieval unit 101, and pick the document from there. The gantry arm can then navigate through hollowed-out section 110 and place the document on shuttle 105 stationed directly underneath shelf 111 on track 106 on lower level 104.

[0067] In step 604, software system 400 initiates the transport of the document using shuttle 105 on track 106 to the delivery location. As track 106 is located on lower level 104 while the automated storage and retrieval unit 101 in the central repository area 102 is located on upper level 103, upper level 103 being above lower level 104, the trajectory of the shuttle is not hindered by the automated storage and retrieval unit 101 in central repository area 102. The delivery location can be kiosk 107 or customer service counter 108.

[0068] The method of steps 601 to 604 describe that the documents are transferred to kiosks 107 or customer service counters 108 only in response to the unscheduled collection request. As the documents are not pre-stored in any kiosks 107 or at any customer service counters 108, the user now has the flexibility to approach the kiosk 107 or customer service counter 108 of his choice. Further, the impact of damaged or faulty kiosks 107 will be mitigated as software system 400 will simply halt assigning document collection from damaged or faulty kiosks 107, and assign document collection to be at other functioning kiosks 107. The document collection efficiency will also increase as the number of documents collected will no longer be constrained by the number and capacity of the kiosks 107.

[0069] Furthermore, the lead time to provide the documents to the delivery locations have been optimized. This because the documents can be transferred from the central storage area to the delivery location very quickly. This fast speed is attributable to the fact that shuttle 105 travels on track 106 on lower level 104, while automated storage and retrieval units 101 are all located on upper level 103. Lower level 104 functions as a dedicated and exclusive pathway for shuttles 105. Therefore, shuttles 105 are capable of traveling at high and fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuverer past obstacles.

[0070] The delivery locations i.e. kiosk 107 and customer service counter 108 can also be located on upper level 103, and so kiosk 107 and customer service counter 108 will also not impede the movement of shuttle 105 on track 106 on lower level 104, and lower level 104 can function as a dedicated or exclusive pathway for the movement of shuttle 105 on track 106, unhindered by obstacles.

[0071] Figure 7 shows system 700 for producing documents and storing them in accordance with certain embodiments. System 700 comprises production equipment 701 in production area 702. Production equipment 701 are configured to produce the documents (e.g. passport, identification card etc). Production equipment 701 can comprise production printer 703, quality control inspection table 704 and barcode printing and wrapping machine 705. Similar to central repository area 102 and dispatch area 201, production area 702 also comprises two raised levels in relation to the floor, upper level 103 and lower level 104. Production equipment 701 are all located on upper level 103 and upper level 103 comprises hollowed-out sections 110. Similar to central repository area 102 and dispatch area 201, shuttles 105

transport documents by traveling on track 106 located on lower level 104, and lower level 104 functions as a dedicated and exclusive pathway for shuttles 105. Therefore, likewise, shuttles 105 are capable of traveling at high and fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles.

[0072] As shown in figure 7, shuttle 105 is configured to carry and transport documents from one production equipment 701 to another. For example, in operation, production printer 703 produces a passport document. Pick and place arm 714 picks the passport document from production printer 703 and places it on first DTS 710. First DTS 710 navigates through hollowed-out section 110 and transfers the passport document from production printer 703 on upper level 103 to shuttle 105 waiting directly under first DTS 710 on lower level 104. Shuttle 105 then moves along track 106 on lower level 104 while transporting the passport document, to a position directly under second DTS 711. Second DTS 711 then navigates through hollowed-out section 110 and transfers the passport document from shuttle 105 on lower level 104 to quality control inspection table 704 on upper level 103 to be inspected by a quality control inspector.

[0073] Upon completion of inspection, the passport document is placed manually on top of third DTS 712 by the quality control inspector after entering details like name and passport or identification number into software system 400. Third DTS 712 then transports the passport document through hollowed-out section 110 to shuttle 105 waiting directly under third DTS 712 on lower level 104. As shown, quality control inspection table 704 can have two dedicated DTSs, one for incoming passport documents (second DTS 711) and one for outgoing passport documents (third DTS 712). This arrangement allows for efficiency in document transfer by allowing independent transfer of documents in and out of quality control inspection table 704. This also avoids the scenario where two documents are present in the DTS at the same time where one document is for inspection and one document has already been inspected.

[0074] Shuttle 105 then moves along track 106 on lower level 104 while transporting the passport document, to a position directly under fourth DTS 713. Fourth DTS 713 then navigates through hollowed-out section 110 and transfers the passport document from shuttle 105 on lower level 104 to barcode printing and wrapping machine 705. Barcode printing and wrapping machine 705 can print two barcodes containing the passport number on two wrapper

strips. A first strip can be wrapped around the top of the passport document and a second strip can be wrapped around the bottom of the passport document. This identifies the passport document at all orientations at every point of transfer using a barcode reader. Further, the barcode serves as universal identifier as the passport document moves from system 700, and on to system 100. Via this barcode reader, each document is tracked and traceable throughout its journey from production area 702, to pod berthing area 801, to central repository area 102, to dispatch area 201, and ultimately to kiosk 107 or customer service counter 108.

[0075] In embodiments, upon completion of wrapping of the passport document, a manipulator arm (not shown in Figure 7) transfers the passport document from barcode printing and wrapping machine 705 to pod 706. Pod 706 is configured to house the passport documents. Pod 706 is gradually filled up as more passport documents are produced and transferred to pod 706. Once pod 706 is full, pod 706 can be electromagnetically locked in response to a signal from a pod beacon, and pod 706 is transported to pod berthing area 801 as shown in figure 8. Pod 706 can be transported from production area 702 to pod berthing area 801 using mobile robot 802. Mobile robot 802 can be an autonomous guided vehicle. Mobile robot 802 can be adapted to transport pod 706 by fitting into the undercarriage of pod 706 as shown in Figure 8. Mobile robot 802 can be larger than shuttle 105 and adapted to transport heavier objects. Bridge 803 can link production area 702 to pod berthing area 801. Pod berthing area 801 can be part of system 700. Mobile robot 802 can transport pod 706 from production area 702 to pod berthing area 801 via bridge 803. Once pods 706 are in pod berthing area 801, the electromagnetic lock of pods 706 can be released in response to a signal from the pod beacon.

[0076] Similar to central repository area 102, dispatch area 201 and production area 702, pod berthing area 801 also comprises two raised levels in relation to the floor, upper level 103 and lower level 104. Pods 706 are all located on upper level 103 and upper level 103 comprises hollowed-out section 110. Pod berthing area 801 can have DTS 810 for transferring the documents from pods 706 to shuttle 105. For example, DTS 810 navigates through hollowed-out section 110 and transfers the passport document from pod 706 on upper level 103 to shuttle 105 waiting directly under DTS 810 on lower level 104. Shuttle 105 then moves along track 106 on lower level 104 while transporting the passport document to a destination. This destination can be lower level 104 of central repository area 102, or kiosk 107 or customer service counter 108.

[0077] All documents produced in production area 702 can be temporally stored in pods 706 at pod berthing area 801 during production hours. After production hours, or during idle time, the documents from each pod 706 are then transported to assigned automated storage and retrieval units 101 in central repository area 102 using shuttles 105 travelling in lower level 104. This activity is preferably completed before the next day's operation. In the event of an urgent request for a document stored in pod 706, instead of first storing in automated storage and retrieval units 101 in central repository area 102, the document is transported directly from pod berthing area 801 to the delivery location (kiosk 107 or customer service counter 108) using shuttles 105 travelling in lower level 104. At any time, the priority for any automated storage and retrieval unit 101 is for retrieval and delivery of documents and storage activity is performed without affecting retrieval and delivery. Empty pods 706 in pod berthing area 801 are returned to production area 702 at regular intervals to facilitate subsequent transfer of documents from production area 702 to pod berthing area 801.

[0078] Though only the production of passport documents has been described, the invention encompasses the production of other personalized documents like identification cards and the like. Further, the movement of shuttles 105 in lower levels 104 is bidirectional. For example, at any time, the passport document can be sent back using the shuttles 105 on lower level 104 to quality control inspection table 704 in production area 702.

[0079] Similar to the previously described embodiments, in pod berthing area 801, shuttles 105 transport documents by traveling on track 106 located on lower level 104, and lower level 104 functions as a dedicated and exclusive pathway for shuttles 105. Therefore, likewise, shuttles 105 are capable of traveling at high and fast speeds (e.g. 5 metres per second) and in substantially straight lines without having the need to maneuver past obstacles.

[0080] The lower levels 104 of production area 702, pod berthing area 801, central repository area 102 and dispatch area 201 can be all linked via a network of lower levels 104. As such, a document can move from the production stage, to the storage stage to the collection stage, and vice versa, through the network of lower levels 104. For example, a document can be produced at production area 702, stored in pod berthing area 801, central repository area 102 and dispatch area 201, and transported to kiosk 107 or customer service counter 108, with shuttle 105 transporting the document through the various stages using the network of lower

levels 104. This full mesh architecture for document flow, as provided by embodiments of the invention, increases the efficiency of producing and managing documents for collection.

[0081] Alternatively, the lower levels 104 of pod berthing area 801, central repository area 102 and dispatch area 201 can be all linked via a network of lower levels 104. As such, a document can move from the pod berthing stage, to the storage stage to the collection stage through the network of lower levels 104. For example, a document can be stored in pod 706 in berthing area 801, central repository area 102 and dispatch area 201, and transported to kiosk 107 or customer service counter 108, with shuttle 105 transporting the document through the various stages using the network of lower levels 104. The transfer of pods 706 between production area 702 and pod berthing area 801 using mobile robots 802 is via upper level 103 as the pods 706 are much heavier and therefore high travel speed is not required.

[0082] Further, the movement of shuttles 105 in lower levels 104 is bidirectional. For example, if the customer service officer at customer service counter 108 detects any defect in the document when issuing the document to a user, the document can be returned back to production area 702 for rework or to be scrapped/discarded. The defective document can be placed at the DTS of customer service counter 108, and the DTS will transfer the defective document to shuttle 105. Shuttle 105 will then transport the defective document back to production area 702 via the network of lower levels 104. Alternatively, shuttle 105 can transport the defective document back to pod berthing area 801 via the network of lower levels 104. The defective document is stored in a dedicated pod 706 for housing rejected or defective documents and this pod 706 will be transported back to production area 702 using mobile robot 802.

[0083] In embodiments, there is no pod berthing area 801. In such embodiments, shuttle 105 in production area 702 transport the document directly from production area 702 to central repository area 102 or dispatch area 201 or delivery area 109 via lower level 104.

[0084] To ensure shortest possible delivery time for documents at kiosk 107 or customer service counter 108, if any gantry arm breaks down in an automated storage and retrieval unit 101, the affected shelf 111 of the automated storage and retrieval unit 101 is manually transferred from this unit to a backup automated storage and retrieval unit 101 within minutes and the database in ASRS auto storage module 406 is automatically updated by software

system 400. If an entire automated storage and retrieval unit 101 breaks down, all the shelves 111 from this unit are transferred to the backup automated storage and retrieval unit 101. Besides being resilient to breakdowns to transport and storage systems, the invention is also scalable upwards and downwards by adding or removing shuttles 105 and automated storage and retrieval units 101. The database in ASRS auto storage module 406 is configured accordingly.

[0085] Preferably, each gantry arm of shelf 111 of automated storage and retrieval unit 101 has a bar code scanner mounted on it. The bar code scanner can be mounted at one end of the gantry arm, preferably at the “gripping” end. The bar code scanner can be configured to scan all the documents placed in the slots of the shelf 111 “on the fly”, or in other words, when the gantry arm is in motion. Therefore, the gantry arm does not need to stop at each slot to scan each document. This advantageously speeds up document location on shelf 111. As the gantry arm scans all document barcodes from top to bottom during a document access, a map of the current physical locations of the documents is generated and compared with that of the database in ASRS auto storage module 406. Any discrepancy between these two data maps is resolved as follows. If there is any document that is physically missing in a slot but is present in the database, this will be flagged as an error. If there is a physical document that is not in the database, this also will be flagged as error for further investigation. If there is a mismatch in locations of a document, the database will be corrected to reflect the physical location. All these errors will be captured in the system data log. During off-peak hours, each automated storage and retrieval unit 101 will conduct a full inventory scan of all documents stored to generate the daily inventory report.

[0086] Figure 9 depicts an automated storage and retrieval unit 101 in accordance with certain embodiments. As shown in figure 9, automated storage and retrieval unit 101 has three shelves 111, two middle gantry arms 901 and two end gantry arms 902. Middle gantry arms 901 can service two adjacent shelves 111. Middle gantry arms 901 can scan with its bar code scanner, documents on the two adjacent shelves 111 as it travels down the shelves 111 and can pick a document from one of the two shelves 111 at a time. End gantry arms 902 on the ends of automated storage and retrieval unit 101 can pick documents from only one shelf 111.

[0087] Unless specifically stated otherwise, and as apparent from the following, it will be appreciated that throughout the present specification, discussions utilizing terms such as “receiving”, “identifying”, “initiating”, “tagging”, “transmitting”, “running”, “incrementing”,

“determining”, “assigning”, “approving”, “selecting”, “sending”, “calculating”, “determining”, “replacing”, “generating”, “initializing”, “outputting”, or the like, refer to the action and processes of a computer system, or similar electronic device, that manipulates and transforms data represented as physical quantities within the computer system into other data similarly represented as physical quantities within the computer system or other information storage, transmission or display devices.

[0088] In the application, unless specified otherwise, the terms "comprising", "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

[0089] It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of the appended claims.

CLAIMS

1. An automated document retrieval method comprising the steps of:-
receiving a scheduled collection appointment for a document;
identifying a central storage location where the document is stored;
prior to the scheduled collection appointment, transferring the document from the central storage location to a shuttle, the shuttle configured to receive the document and travel on a track with the document, and the shuttle and track being positioned on a lower level and the central storage location being positioned on an upper level;
transporting the document to a temporary storage location using the shuttle on the track, the temporary storage location being located closer to a delivery location than the central storage location;
in response to a trigger action, transferring the document from the temporary storage location to the shuttle, the temporary storage location being positioned on the upper level; and
transporting the document to the delivery location using the shuttle on the track;
wherein the upper level is above the lower level such that a trajectory of the shuttle is unhindered by the central storage location and the temporary storage location, and the lower level functions as an exclusive pathway for the shuttle.
2. An automated document retrieval method comprising the steps of:-
receiving an unscheduled collection request for a document;
identifying a central storage location where the document is stored;
transferring the document from the central storage location to a shuttle, the shuttle configured to receive the document and travel on a track with the document, and the shuttle and track being positioned on a lower level and the central storage location being positioned on an upper level; and
transporting the document to a delivery location using the shuttle on the track;
wherein the upper level is above the lower level such that a trajectory of the shuttle is unhindered by the central storage location, and the lower level functions as an exclusive pathway for the shuttle.

3. The automated document retrieval method of any one of the preceding claims wherein a height difference between the lower level and the upper level is between 2 metres and 2.5 meters.
4. The automated document retrieval method of any one of the preceding claims wherein the lower level and the upper level are both raised relative to a floor.
5. The automated document retrieval method of any one of the preceding claims wherein the shuttle is configured to travel at a speed of 5 metres per second.
6. The automated document retrieval method of any one of the preceding claims wherein the delivery location is a kiosk or a customer service counter, and wherein the kiosk or the customer service counter are positioned on the upper level.
7. The automated document retrieval method of any one of the preceding claims wherein the upper level has a hollowed-out section, and the step of transferring the document from the central storage location to a shuttle comprises the steps of : -
 - using a robot arm to pick the document from the central storage location; and
 - navigating the robot arm through the hollowed-out section to place the document on the shuttle.
8. The automated document retrieval method of any one of the preceding claims further comprising the steps of :
 - detecting a defect in the document at the delivery location;
 - transferring the document from the delivery location to the shuttle; and
 - transporting the document to a production area using the shuttle on the track, the document to be re-worked by production equipment in the production area or to be rejected and disposed, wherein the production equipment are positioned on the upper level, such that the trajectory of the shuttle is unhindered by the production equipment in the production area.
9. The automated document retrieval method of any one of the preceding claims wherein the document is a passport document or an identification card.
10. The automated document retrieval method of claim 1 further comprising the steps of :

detecting that the document at the delivery location has not been collected despite a stipulated time period lapsing;

transferring the document from the delivery location to the shuttle; and

transporting the document to the temporary storage location using the shuttle on the track.

11. The automated document retrieval method of claim 1 wherein the trigger action is a confirmation that a user is at a kiosk, or is a document request from a customer service officer.

12. An automated document retrieval system comprising:-

a storage location for storing a document, the storage location positioned on an upper level, the upper level comprising a hollowed-out section;

a track positioned on a lower level, the upper level being above the lower level;

a shuttle configured to receive the document and travel on the track, the shuttle positioned on the lower level;

and a gantry arm, the gantry arm configured to transfer the document from the storage location on the upper level, to the shuttle on the lower level via the hollowed-out section;

wherein upon transfer of the document to the shuttle, the shuttle travels on the track and transports the document to a delivery location, whereby a trajectory of the shuttle is unhindered by the storage location, and the lower level functions as an exclusive pathway for the shuttle.

13. A document production system comprising:-

a first production equipment and a second production equipment, the first production equipment and the second production equipment positioned on an upper level, the upper level comprising a first hollowed-out section and a second hollowed-out section;

a track positioned on a lower level, the upper level being above the lower level;

a shuttle configured to receive a document and travel on the track, the shuttle positioned on the lower level;

a first document transfer system, the first document transfer system configured to transfer the document from the first production equipment on the upper level, to the shuttle on the lower level via the first hollowed-out section; and

a second document transfer system, the second document system configured to transfer the document from the shuttle on the lower level, to the second production equipment on the upper level via the second hollowed-out section;

wherein upon transfer of the document to the shuttle, the shuttle travels on the track and transports the document to a location where the second document transfer system can transfer the document from the shuttle to the second production equipment, whereby a trajectory of the shuttle is unhindered by the first production equipment and the second production equipment, and the lower level functions as an exclusive pathway for the shuttle.

14. The automated document retrieval system or the document production system of any one of claims 12 to 13, wherein a height difference between the lower level and the upper level is between 2 metres and 2.5 meters.

15. The automated document retrieval system or the document production system of any one of claims 12 to 14, wherein the lower level and the upper level are both raised relative to a floor.

16. The automated document retrieval system or the document production system of any one of claims 12 to 15, wherein the shuttle is configured to travel at a speed of 5 metres per second.

17. The automated document retrieval system or the document production system of any one of claims 12 to 16, wherein the document is a passport document or an identification card.

18. The automated document retrieval system of claim 12, wherein the delivery location is a kiosk or a customer service counter, and wherein the kiosk or the customer service counter is positioned on the upper level.

19. A system comprising the automated document retrieval system of claim 12 and the document production system of claim 13, wherein the second production equipment is located in a production area, the storage location is located in a storage area, and the delivery location is located in a delivery area; and wherein the shuttle is configured to transport the document from the production area to the storage area and to the delivery area via the track in the lower level.