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Managing a Laundry using RFID-based Automated Processes

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ABSTRACT

The objective of this paper is to present the use of RFID (Radio Frequency IDentification) technology to automate the laundry process of collecting, cleaning, and returning garments. While RFID has been used for commercial laundry applications for several years now, the process presented here is based on a bank automated teller machine (ATM) style interaction for dropping, and picking up the laundry. The process consists of the following steps: the customer drops the laundry to be cleaned using an ATM style interaction, the laundry gets picked up and cleaned using an automated system requiring minimum human interaction, the cleaned laundry is sent to the pickup location, the customer receives an alert for picking up the laundry, and finally the customer picks up the laundry, again using an ATM style interaction. The use of RFID enables the tracking of the movement of garments through the laundry loop in real-time. The anticipated benefits for the laundry industry include customer convenience, savings in labor, and automated delivery.

INTRODUCTION

The laundry process of receiving garments, cleaning them, and then returning them to the customer is quite labor intensive. Efficiencies and customer convenience can be introduced in the process by automating various steps in the process using RFID technologies. These efficiencies and customer conveniences would be greater especially for standard types of garments, such as uniforms for businesses such as hospitals, police, hotels, etc.

In a typical industrial laundry application, the laundry vendor will pick up all soiled items from a customer site (such as a hotel or a hospital) on scheduled days and deliver them back to the customer based on a service agreement (Morgan, 2007). The customer site then distributes the cleaned garments back to the individual persons to whom the laundry belongs. In this system, the individual user does not have the convenience of picking up and getting the garments at their convenience. Also, they do not know when their garments are ready for pickup. In addition, the customer site is required to keep dedicated personnel just for the task of receiving and giving the laundry, handling misplaced or lost items, etc.

There are several RFID based industrial systems which are used by laundry services (Herb, 2004; Herb, 2005; Tagsys, 2005; Halifax, 2007; Morgan, 2007; Phelps, 2007; Datamars, 2008; Falken, 2008). These RFID based systems provide increases in the automation and efficiency of the cleaning process at the laundry facility (Daugherty, 2008). The process described in this work is focused towards the use of RFID for an automated end-to-end usage – from the customer, to the laundry facility, and back to the customer.

RFID based process for laundry

For this paper, it is assumed that a customer is working for an organization where he/she is required to wear uniforms or other standard garments. Each garment has an RFID tag sewn into the garment – typically in the hem or the inside of a collar, such as the ARIIO 370-HL from Tagsys (2008). It is not necessary for the each business to have large volumes of garments. However, to have a feasible return on investment, it is necessary that the laundry company process a large number of garments a day from various businesses.

In this paper, a detailed process is presented (see Figure 1), to show how RFID technology can be used for a completely automated industrial laundry system -- from customer drop off to customer pick-up -- using an ATM style customer interaction. The process is explained using a hypothetical laundry vendor, say Rapid Laundry (RL). Jack is an employee of RL and his job is to drive the truck to drop-off and pick-up the laundry. Valley Hospital (VH) is a customer company that uses the services of RL to clean the various types of laundry (uniforms, nurse/doctor coats, etc) for its employees. Jill is a nurse, an employee of VH, who wears a four piece uniform and is required to get her uniform washed after each time it is worn.

Figure 1: Overall process diagram.

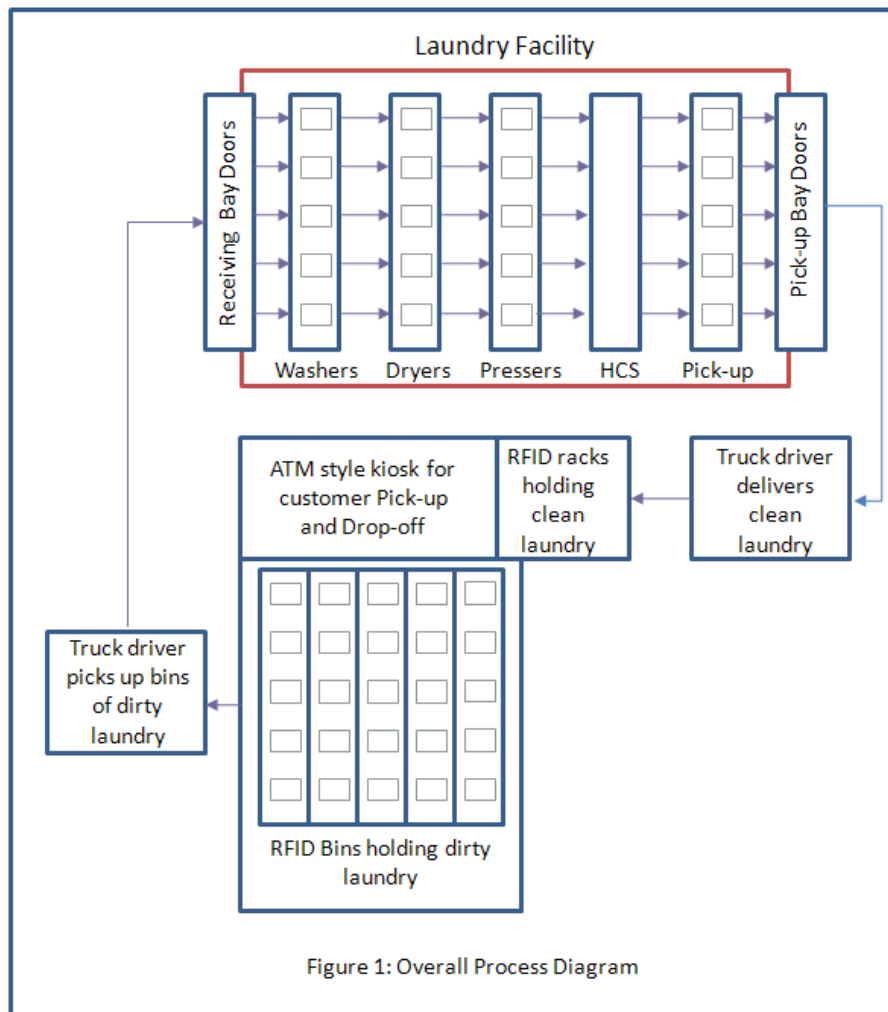


Figure 1: Overall Process Diagram

INITIAL SETUP

RL and VH enter into a contractual setup where RL agrees to clean, press, and deliver the laundry of VH employees at a fixed cost for each garment type. Garments can be from a fixed number of types (five types of garments are used for the discussion in this paper) – light colored cotton, dark colored cotton, light colored blend, dark colored blend, and custom. Custom clothes are washed based on custom settings of the fabric of the garment. While the cost is fixed for all types (except custom), each employee is responsible for the payment of the laundry services. RL uses several types of RFID tags: one type is a RFID Identification Card tags which can be put in a key chain. This tag has higher security features and is used for identifying an employee.

This tag, called the ID-tag, is given to each employee who wants to use the services of RL. Another type of tag is the garment RFID tag, which is affixed to the garment in an inconspicuous location so that the wear-ability of the garment is not affected. RL gives VH a set of RFID key-chain tags as an identification card, to be given to each employee who wants to use the services of RL. It is the responsibility of VH human resources personnel to activate these tags, at the time of issue to the employee. This activation is done using the RL website and the employee's name and other identification information is associated to the ID-tag. After the ID-tag is issued to the employee, she can use the RL website or a toll-free number to provide a credit card number and associate it with the ID-tag. This will enable her to make payment for the laundry without the need of using a separate credit-card at the time of using the system.

Issuing garments to the employee

When Jill, a nurse, begins her employment at the hospital, VH gives her five sets of the four piece uniforms. At that time, she is also given the ID-tag, appropriately activated. Each piece of the uniform may have the RFID garment tag on it. For large volume business customers, RL provides a service, at no cost, to tag all the garments of the business before they are issued to the employee. In cases of business customers that do not have large volumes, the tags will be attached by RL on the first use of the RL laundry services by the business employees.

Dropping off and picking up the laundry

RL has several drop-off and pick-up locations, called kiosks, throughout the city. The locations are designed such that drop-off and pickup can be done using an automated drive-through lane, without getting out of the automobile.

Design of the pick-up and drop-off location kiosk

The kiosk is designed so that Jill can drive up to it, and while seated in her automobile, she can interact with it to drop her clothes or pick them up. The kiosk has a terminal touch-screen through which she interacts, and it looks very much like a bank ATM machine. The kiosk has an RFID Identification card reader at a spot above the terminal screen (much like the Speedpass at a gas station). This reads the ID-tag when it is waved at it. The interaction with the customer is through various options provided on the touch-screen, or by using the buttons next to it. The interface screens are designed such that all options of a screen align with the physical push

buttons on the side of the screen. The user may either touch the touch-screen to select an option, or press the push button next to the option on the screen.

A customer can set several preferences of interaction using the RL website. Examples of such preferences are: credit-card association, additional pin-number security, default pick-up location, default language, etc. The interaction with the customer is done based on these preferences. The kiosk has a credit-card reader for making payments. The kiosk also has a dispenser for dispensing plastic bags (with pre-attached RFID tags) to be used for garments which do not have a tag or for which the tag cannot be read by the kiosk. The kiosk has two wide openings, which are kept closed by an automated door. One opening is marked “in” through which the garments are put in one at a time. The second opening is marked “out” through which garments are returned to the user. By default, to prevent vandalism, all slots such as the credit-card reader, in-out dispenser, etc., remain closed. The openings of these slots open and close automatically based on the transaction being conducted.

Interaction for picking up and dropping garments

To drop-off or pick-up garments, Jill drives in to the drive through kiosk. She waves her ID-tag in front of the reader and the kiosk recognizes her. A welcome message is displayed on the screen. The language is based on the language set by Jill (English or Spanish) in her preferences. If Jill has pin-number security enabled in her preferences, a Pin number is required in addition to the card. The screen will ask for her pin number. A keypad displays on the screen to enter the pin.

The system first checks to see if Jill has any clothes that she has to pick up. A message is displayed on the screen telling her the number of items which are ready for pick up. A details button on the screen, when touched, displays the details of each garment. The system asks for confirmation if she is ready to pick up the garments. When Jill confirms, the “Out” door opens and her garments are dispensed, one garment at a time. As she picks the garments out of the bin, the display reduces the number of garments yet to be picked. After all garments are picked up, a confirmation message asks Jill if she has checked that all garments are received and they all belong to her. If she confirms yes, then the garment pick up process is complete, and the “out” door closes.

Not picking up the garment within some time: A beep sounds when Jill does not pick up the garment from the “out” opening, within 15 seconds. After one minute (4 such beeps) of not picking up the garment, the “out” door closes. The system beeps every 15 seconds and displays a message on the screen to ask if more time is needed. If Jill does not respond again within two minutes, the garment is returned back into the system to be put in the special processing bin, and cannot be retrieved until the next day (because it requires a manual insertion back into the garment delivery system).

Garment does not belong to Jill: If a garment does not belong to Jill, she selects the option of “Garment does not belong to me” which is available on the touch-screen. This option is available until Jill confirms that she has received all garments. On pressing this option, the system does a check and the “in” door opens. Jill is instructed to place the garment in the “in” opening and the system reads the tag and “takes in” that garment. An internal database note is made about the

return and is associated with the garment tag. That garment then goes into the custom / special processing bin, through which such exceptions are handled.

After all garments are picked up, the system sends an email to Jill about when her garments were picked up and from which location. Any exceptions are also noted.

After all the garments are picked up, the system asks Jill if she wants to drop-off any garments. When Jill confirms or if there were no garments to pick-up, the system asks Jill to swipe her credit card (if her account is not associated to a credit card). The system checks to see if her credit card is valid and has transactional balance on it. The “in” door then opens and Jill is instructed to drop in one garment at a time. When Jill drops in the first garment, the system reads the garment and identifies it. Upon successful identification, the garment is “taken-in” (a slot behind the opening is activated which opens the slot from the back, the garment drops and the slot in the rear closes again). The garment in the kiosk is dropped into an appropriate bin for each type of the garment. The system then instructs Jill to drop in the next garment. As each garment is dropped, it goes through the same process. The screen displays a running list of the garments dropped, the cost of cleaning each, and the total cost. When all garments are dropped and identified, Jill selects the option of “Done dropping off”. The system asks Jill to confirm that she is done dropping all garments. When Jill confirms, the “in” door closes. The system then displays the pick-up location (set by Jill in her preferences) and the date and time when they will be ready. Jill has an option to pick them up from a different site. If she selects that option, a list of other pick-up locations are displayed, based on Jill’s preferences. Jill can pick from those preferences (shown on top) or from a list of other locations. After Jill selects a location, and confirms it, the system informs Jill when they will be ready for pick-up. An email confirmation is sent to Jill.

This system processes garments at the speed of five seconds per garment. So a transaction to launder a load of twenty garments can be completed within two minutes.

Garment tag not recognized (or a new garment without a tag): If the garment tag is not recognized, the system will not accept the garment. A message is displayed that the garment is not recognized. An option is given to Jill to use a plastic bag which has a special RFID tag on it. If Jill chooses yes, a plastic bag is dispensed. Jill puts the garment in the bag, clears the “in” opening of any other garments and puts the plastic bag with the garment in the “in” opening. The bag is read and it goes in to the special handling bin. The RFID tag of the bag is associated with Jill’s account and is processed when the special handling bin reaches the laundry site.

If more than one tag is read: If more than one tag is read in the “in” opening, the system will alert Jill about it and will display a message until there is only one garment in the opening.

LAUNDRY PICKUP BY TRUCK DRIVER

A RL truck driver, Jack, picks up and delivers laundry from the kiosks. Pick-up and drop-off may be combined in one trip or done on separate trips. In this paper the pickup and drop off are discussed separately.

At the kiosk location, a customer interacts only with the kiosk touch-screen, whereas the truck driver accesses the facility behind the kiosk. The building facility allows for large laundry bins to be placed under the kiosk. Jack is able to pull up his truck to the level of the bins below the kiosk. Each truck has a RFID tag on it to identify the truck uniquely.

There are five tracks of bins under the kiosk, one track for each type of garment (light colored cotton, dark colored cotton, light colored blend, dark colored blend, and custom /special handling). Each track has several bins (generally four) one behind the other. The track is a conveyor belt which moves when a bin gets filled. As customer's drop-off garments into the kiosk, these garments fall into the respective garment type bin at the head of the respective track. Once a laundry bin gets filled to capacity with the garments, the conveyor belt for that track is activated and the full bin moves forward. The count of the garments in each laundry bin is kept by the kiosk system. When a bin moves, its place is taken by an empty bin behind it. The tracks are long enough to place four empty bins on each track.

Each laundry bin has an RFID tag on it, giving it a unique ID. Each track of the facility has an RFID tag uniquely identifying it for that location. When Jack brings in an empty bin to put in the track, he scans the bin tag using a handheld RFID scanner, then scans the RFID tag of the track, and associates the two. This automatically associates the bin tag to the type of the garments it is going to hold. Based on the bin type (identified from its tag), the system assigns the capacity. Based on this capacity, the conveyor belt will move the bin forward when it gets full. This one scan and enter operation makes it very simple, quick, and efficient for Jack to place an empty bin in the track. While it is possible to have fixed scanners on the tracks to read the bin tags, the handheld scanner is used to keep the set-up cost lower. For popular locations where a track can hold more than four bins, fixed scanners are used to track and move the bins.

In the backend database, with each garment tag, a location ID is encoded. When the garment is with the customer, the location code is the customer ID-tag. When the garment comes into the laundry system for cleaning, the location tag is the tag of the current laundry bin, truck, or any other process location. This enables the system to track a garment at any moment in the life of the garment, once it is tagged and issued to the employee.

As the bin gets filled with garments, the system database associates the garment id's to the bin id. When Jack comes in to pick the laundry bins, he first gets the completely filled bins. He scans the bin and rolls it into the truck. This transaction removes the association of the bin from the kiosk location and assigns it to the truck. He then fills the track with empty bins, scanning each bin and associating it to the track. He then removes the bin at the head of each track, scans them, and rolls them into the truck. For this last operation, Jack has to ensure that no one is at the kiosk, and has to disable the use of the kiosk until this transaction is completed. After all the bins are loaded in the truck, Jack pulls out of the location. Based on the amount of space in his truck, Jack then picks up other bins from other locations and takes them all to the RL Laundry facility for processing.

LAUNDRY PROCESSING AT THE RL LAUNDRY FACILITY

When Jack reaches the RL facility, he pulls in to an empty truck bay. Each bay door has RFID readers on them. Jack first takes his handheld reader and synchronizes it with the main system

using the wireless wi-fi connection near the receiving bay doors. This synchronizes all data from his hand-held scanner with the main system. Jack rolls out the laundry bins from the truck and into the facility, through the readers of the bay doors. The bins get read by these readers, and it informs Jack where to take the laundry bins. This transaction disassociates the bin from the truck and associates it to the RL Laundry facility and back-flushes the location of each garment to the facility. The bin is rolled on to a moving conveyor belt which carries the bin to the washing area. After all bins are emptied from the truck, Jack completes the transaction on his hand-held reader confirming the delivery of all the bins. He then pulls out the truck and parks in into the receiving area where he is then ready to pick up the cleaned garments for delivery, or he may go and pick-up more laundry.

In the facility, the conveyor belt moves the bin to the appropriate washing machine based on the type of the garments in the bin. The washing machines are large enough to hold the washing load of several bins. When the bin reaches the washing machine, it is inverted into a hopper. Garments from the bin fall into the hopper, which has a RFID reader. The hopper reads the garments going in, and the system internally cross checks the database with the bin. The database disassociates the bin tag from the garment tags and associates the garment tag to the hopper tag. Once the washing machine is full, it starts washing the laundry. After completion of the complete wash cycle (wash, rinse etc), the laundry is moved to the drying machine where they are dried. The dried garments are then moved on a conveyor belt, and moved to the pressing area where they are individually pressed.

After each garment is pressed, it is put on a hanger and the hanger is inserted into the Hanger Conveyor System (HCS). The HCS moves garments that are placed on a hanger. This is done by reading the RFID tag of the garment. RFID scanners placed along the path of HCS read the garment tags and based on the pick-up location of the garment, the garment is moved to the appropriate track in the pick-up area. The pick-up area has several tracks, and based on the pick-up locations of the garments that are currently being washed, tracks are assigned in the pickup area. The HCS reads the tag of the garment and moves the garment to the appropriate track in the pick-up area.

At the pick-up area, the garments on hangers are placed automatically on laundry bin rods. Based on the capacity of the bin, it has several bin rods. Each bin rod can carry a specific number of garments on hangers, in specific slots. For example, a bin that can take fifty garments may have five rods which can hold ten garments, one in each slot. Each slot has a RFID tag on it. As each bin rod gets filled up, the RFID tag of the slot is associated with the garment RFID tag. Once the rod is full, it is placed in the bin (without crumbling the garment). The garment tags and rod tags are associated with the bin tag. Several rods are placed until the bin is full. Once the bin is full, the bin track is moved and the next bin in line gets filled up. The filled bins move, on conveyor belts, to the bay door of the pick-up area, where they wait until they are ready to be loaded in the trucks.

Taking care of garments in the custom/special handling bin: Bins carrying custom / special handling garments are moved to a track where the garments are taken individually and examined manually for any special treatment. For garments which are in plastic bags, the RFID tag of the bag is scanned to determine the customer. If the garment is being processed for the first time and does not have an RFID tag, then an appropriate RFID tag is attached to it. The tag is associated to the user account and the garment is sent for washing based on the garment type. If a garment is a custom garment then based on the material quality, the wash cycle is determined, and an

appropriate charge is made to the account. If a garment is returned because it was not taken out of the kiosk in time, then that garment is sent back to the drop-off location again. If a garment is sent back where it does not belong to the customer, then the garment is examined to match with the missing garments list of other customers.

DELIVERING THE LAUNDRY FROM THE RL FACILITY TO THE PICK-UP LOCATION (KIOSK)

Once several such bins are ready for a particular location (or for a few locations), the truck driver (Jack) pulls his truck to the bay. The RFID reader on the bay door reads the tags of the bins of the clean laundry going through the door and associates the bin tag with the truck tag. After all the bins are loaded, Jack uses his hand held scanner to complete the transaction which confirms that all the data is loaded onto his hand held scanner. He is then ready to deliver the clean laundry. Using his handheld, he determines the locations for the delivery and the route he has to use.

Once he reaches a delivery location, he pulls his truck at the bottom of the kiosk. Using his hand-held scanner, he scans the bins that are for this particular site and pulls them out of the truck. He then rolls each bin to the Kiosk Hanger Conveyor System (KHCS) which is used for loading the garments at the kiosk. The KHSC is made up of rods which are the same as the hanger rods used in the bin. The empty KHCS rods can be removed, and replaced with the rods that have the garments on them. Jack first ensures that the kiosk system is put on hold so users are not using it. Then he takes out the empty rods of the KHCS, and fills them up with the rods from the garment bins. He keeps doing this until all the rods from the bins are put in the HCS. This entire operation takes about five minutes. The garment tags are now disassociated from the bin tags.

The KHCS has an RFID reader which can read the RFID tags in the slots of the hanger rods. Once all the garments are loaded, Jack presses a switch which starts moving the KHCS one full circle. The KHSC RFID reader reads the tags of the slots as they move past the reader. Once all the slots have passed through the reader (this operation takes only a couple of minutes), the KHCS knows exactly which garment is on which slot because the garment tag is associated with slot tag. This mechanism of using slot tags on hanger rods simplifies the reading process for the KHCS reader, and virtually eliminates all the error in determining the garment of the user (since garments may be of varying sizes). At this point, an email is sent to the customers that their garments are ready for pickup at the specific location.

For the case where the garments on the KHCS are initially spread out sparsely, so that there are not enough empty hanger rods, KHCS has a mechanism to collect the existing garments and move them into continuous slots.

Jack then picks up the full bins of dirty laundry and places the empty bins (emptied from delivering the clean laundry) into the tracks, as described in section 4. He takes the empty KHCS hanger rods with him to be delivered and used in the pick-up area of the RL Laundry facility, as described in section 5.

When the customer (Jill) comes in to pick her garments, the system determines the tags of the garments and determines which slot the garments are on the KHCS. The KHCS moves the hanger to the kiosk opening and drops the hanger garment into the kiosk “out” opening. It does

this one at a time until all garments of Jill are delivered through the opening. As each garment is dropped, the KHCS slot tag is disassociated from the garment tag.

CONCLUSION

In this paper the use of RFID (Radio Frequency IDentification) technology to automate the laundry process of collecting, cleaning, and returning garments is presented. The process presented here is based on an ATM style interaction for dropping, and picking up the laundry. The process consists of the following steps: the customer drops the laundry to be cleaned using an ATM style interaction, the laundry gets picked up and cleaned using an automated system requiring minimum human interaction, the cleaned laundry is sent to the pickup location, the customer receives an alert for picking up the laundry, and finally the customer picks up the laundry, again using an ATM style interaction. The use of RFID enables the tracking of the movement of garments through the laundry loop in real-time. Many other customizations and enhancements can be easily introduced into the system, such as multiple laundry facilities, urgent processing (at higher cost), slower processing (at lower cost), etc.

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