Baggage Delivery Notification System and Method Prototype

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Customers: Airline companies, frequent fliers, special service flight passengers

Patent:
http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=%2Fnetahtml%2FPTO%2Fsrchnum.html&r=1&f=G&l=50&s1=%2220140210623%22.PGNR.&OS=DN/20140210623&RS=DN/20140210623

Description

Airport terminals are typically crowded on baggage claim areas and lack a certain ease of use as the passengers stand around anxiously awaiting their luggage to come out to claim. Our project would help alleviate that burden by scanning tags to identify a person's bags and send them a notification via text message that they are ready for pick-up. A monitor next to the baggage carousels will also be used to show a real-time table of luggage about to come out to the baggage claim area, as well as luggage which can already be found in the baggage claim area. This would result in a more orderly luggage retrieval process, compared to the current chaotic process. The goal of the system is to read data from RFID chips located on tags attached to luggage bags to communicate with the airline and identify who the luggage belongs to. The system should be robust enough to handle communication with different airlines in the accurate identification of luggage. The structural integrity of the mounted scanner should be able to fit any baggage carousel and be easy to attach.

Requirement Specifications

Goals and Objectives

1) System must be able to scan and decode rfid chips accurately.
2) System must perform with minimal delay.
3) System must run on a continuous power supply.
4) Must comply with all health and safety regulations.
5) Must comply with all environmental regulations.
6) Must comply with all legislature and US laws and regulations as of 2015.
7) Product should be operational out of the box with some assembly required.
8) Must be able to operate 24/7 in an airport environment
9) Cost of product must be reasonable
10) Able to allow free passage of all objects through the scanning area.
11) Operate with correct procedures for the access and use of personal information

Constraints

Limitation in reader and transmission range, Tag Housing stability and ruggedness will also put a constraint on maintaining the tag with the luggage to be scanned. Communication protocols with airline database will need to match for proper gathering of a person's name and number for contact. Limitation of mount brackets for carousel/conveyor types.

Functionality

Must scan RFID chip, transmit RFID chip data via query to airline database. Receive airline database phone number, and send out a text message notification to acquired phone number. This system should process information continuously, and show real-time data of recent scanned tag to a display.

Usability

Unit will be easy to assemble and get operational out of the box. The antennas will need to be mounted in the appropriate location based on the model of conveyer system, and may be the only major installation required. Once the antennas are in place, they will be connected via wire to the receiving unit that will house the receiver, microcontroller, and wifi unit.

Unit has sd card holding wifi connection information that can be sideloaded to get the system up and running with local internet?

With active internet connection system would run as indicated

College Course Specified Requirements

A custom-made microcontroller will be used for the processing of passenger data instead of an already existing computer system of some sort, due to the design requirements and academic goals specified by the Senior Design Course.

Planned Implementation

RFID Chips

The RFID Chips will be located in a baggage tag attached to the luggage. We are currently planning on using UHF RFID Chips to allow for the best possible coverage area during receiving. Whether we are using read-only or read/write RFID chips for our presentation will be determined by whether or not we can access a RFID writer (See: RFID Chip Writer).
Each RFID chip will contain only two bits of information:

1. The airline's 2 digit IATA code
2. Identification data for the passenger. The data provided for identification can be determined by the host airline.

Microcontroller Hardware

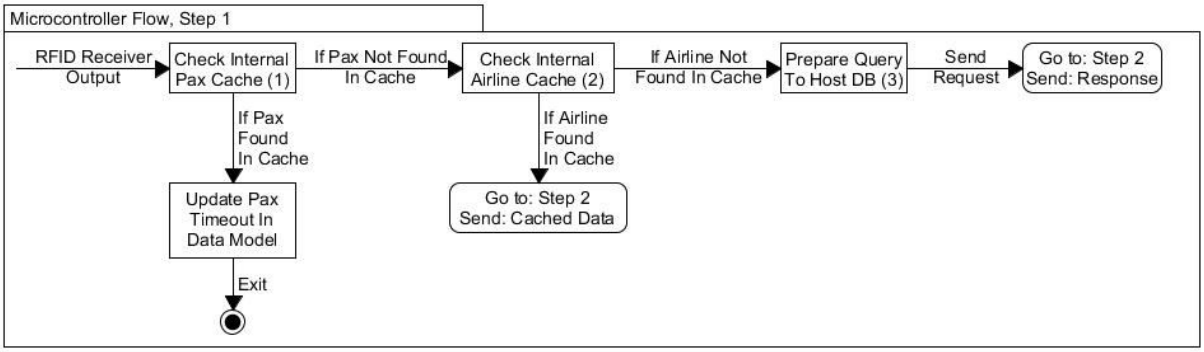
The system will comprise of microcontroller with wireless capabilities for communication needs with the airline. At this time the Texas Instruments CC3200 simplelink chip will be used for controlling data flow and communication with the RFID receiver. The Thingmagic RFID receiver

board will be connected through serial communication to the microcontroller to receive tag information. Power of the microcontroller will be provided by a rechargeable battery operating at 5v and 1 ampure to provide the board with its needed 3.2volts and the receivers 5v requirements.

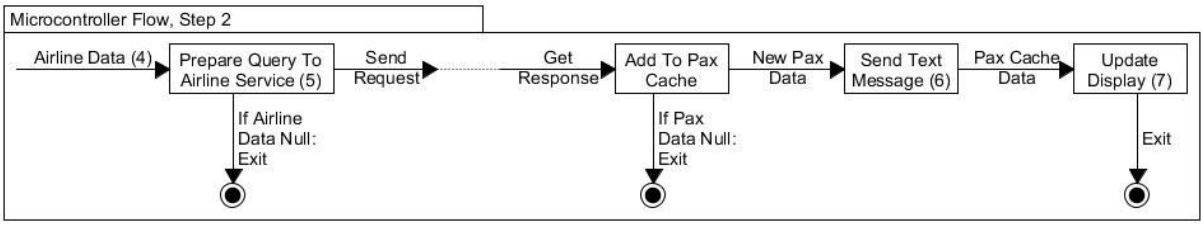
Microcontroller Software

We are currently investigating the use of Java ME Embedded 8.1 with CLDC runtime. We are currently unsure of the limitations, practicality, and exact deployment instructions for this runtime environment, so we are still doing further research on the topic. If the Java ME Embedded solution is unsuccessful, we plan on trying to implement an Android OS on the microcontroller. If the Android OS solution is unsuccessful, we will most likely settle with an implementation in C.

The microcontroller software will be in charge of managing the passenger data for the specific carousel the microcontroller is attached to. The program flow can be found below.



(1) The Microcontroller will contain an internal cache of passenger data for the carousel. This cache will exist to prevent passenger lookup during rescanning (See: RFID Receiver), and this cache will be used to build the public display (See: Public TV Display).
(2) The Microcontroller will contain an internal cache of airline data. The airline data cached will be a mapping of the airline to its web service endpoints for retrieving passenger information. This cache will exist to prevent unnecessary requerying of airline endpoints. It is currently not guaranteed that this cache will exist on the microcontroller (See: Alternative Implementation Ideas).
(3) The Host DB will be used to determine how to contact the airline associated to the RFID chip (See Above: RFID Chips) so the passenger data can be queried.



(4) The Airline Data here will either be the response from the Host DB, or the data found in the Airline Cache (See Above: 2, 3). This data contains the web service endpoint for the airline (See: Airline Web Service Endpoints).
(5) The Airline Service will be queried to perform a passenger data retrieval, based on the data found on the RFID chip (See Above: RFID Chips). The passenger data returned from the airline service will be determined by how the airline implements the web service (See: Airline Web Service Endpoints).
(6) A text message will be sent to passengers who provided their phone number during check-in (See: Text Message Alerts).
(7) The public TV displays will be sent updated passenger data, containing the data of the newly scanned baggage (See: Public TV Display).

RFID Receiver

The RFID Receivers will be attached to the individual baggage carousels in the baggage claim area of airports. The Receivers serve two purposes:

1. Scan the RFID chips on newly loaded luggage to be processed by the microcontroller. The passenger who owns the new luggage will be notified that their bag is about to come out.
2. Rescan the RFID chips on already existing luggage which looped the entire length of the baggage carousel and has not yet been picked up. Each bag has a timeout value associated to them, most likely set to be 1.5x or 2x the length of the carousel. If a bag is not rescanned before the timeout is reached, it is assumed the bag has been picked up by the passenger.

We have identified two types of baggage carousels:

1. The baggage carousel is a single, large loop where the baggage handlers load the luggage directly onto the carousel from a back room. The luggage occasionally returns to the back room if it has not been picked up while it continues its trip around the carousel. An example of this type of carousel can be found at the Orlando International Airport. Another example of this type of carousel can be seen here: http://upload.wikimedia.org/wikipedia/commons/4/49/Baggage_reclaim_hahn_airport.jpg
2. The baggage carousel consists of a loading belt and a looping belt. Luggage is loaded onto the loading belt by the baggage handlers in a back room either above or below the baggage claim area and the loading belt deposits the luggage onto the looping belt in the baggage claim area. In this situation, the looping belt never returns to a back room and all the luggage on the belt will be readily accessible to passengers at all times. An example of this type of carousel can be found at the Oakland International Airport. Another example of this type of carousel can be seen here: http://www.airport-technology.com/projects/oakland/images/2-oak.jpg

These two different types of baggage carousels need to be managed in two different ways.

For Type 1 baggage carousels, we only need a single Receiver, located in the back room where they load the luggage onto the baggage carousels. Since the bags will inevitably pass back

under this scanner if it has not been picked up, this scanner scan serve both purposes mentioned above.

For Type 2 baggage carousels, we will need two Receivers. The first Receiver would be attached to the loading belt in the back room where they load the luggage onto the loading belt, and it would only be able to serve the first purpose mentioned above. Since the bags will never pass under this scanner a second time (due to the bags being deposited on the looping belt), a second Receiver is needed. The second Receiver would be attached to looping belt in the baggage claim area, and it would serve the second purpose mentioned above. Due to the second Receiver being located in a high-traffic public area, it would be in danger of being damaged, so additional precautions would have to be made.

Antenna Mounting

Mounting of the receiving unit's antenna to the conveyer is depending on the conveyer system used. Most antenna come in a square structure with a circular radiating coil providing a cone shaped radiation pattern onto the track, this circular pattern will allow for excitation in the tags in any orientation they may be attached to the baggage. This square type antenna can be mounted pointing at a section of the track, and is hardy enough to not be damage from use. Another antenna to use would be a long thin structure that can be mounted along the edge of the conveyer system, the transmitting unit can transmit away from the passenger towards the center of the system, with the receiving unit placed in any location as needed, this is assuming a bistatic setup. Another antenna system would include a thin antenna that can be placed under the conveyor, scanning each object as they pass over the scanning pad. Due to transmitting regulations, antenna placement is best in a location of the circular system with the least amount of interaction when used in a public area.

Specifically the M5e thingmagic device with bistatic mode would allow for the transmission along one antenna and receiving from another. This would allow for the placement of the transmitting device to be located in a safe location while the receiving antenna can be place in an optimal location. Specific antenna used would be dependent on conveyor system and final design.

Text Message Alerts

We are currently investigating possible solutions for sending text messages to passengers. Current avenues of research include:

1. Connecting to a free SMS site service via wifi
2. Send via email
3. Send via GSM Module attached to the microcontroller

Public TV Display

The details for how we want to implement this are still not determined, and we are very open to suggestion.

If we want to implement this with a hardwired connection from the microcontroller, we will need to attach a video output bus to the microcontroller and the microcontroller will need to include a graphics card of some sort. Video output cables will have to be ran from the microcontroller to each tv.

If we want to implement this with a wireless connection, we will need to transmit a signal from the microcontroller. Each TV will have to have a device on it to receive the signal from the microcontroller and generate the display images. Each TV will also need to be able to be able to determine if the signal it is receiving is from the correct microcontroller, and not a signal from a microcontroller on a different carousel.

RFID Chip Writer (Based on Availability)

The ability to write the RFID chips for the prototype will be dependent on whether or not we are able to affordably access an RFID writer. In a real-world setting, the RFID chips will need to be written during passenger check-in, so the airline can provide the chip the correct passenger data for lookup during baggage claim.

Alternative Implementation Ideas

Airline Data Cache

We have not yet decided if we want to cache this data on the microcontroller or on the server which contains our Host DB and its web service endpoints. Due to our current plans for our presentation to have extremely limited server infrastructure, we will not be able to implement a server-side data cache for the database, so any caching of the airline data would have to occur on the microcontroller. The implementation mentioned in the *Planned Implementation* section might even be the best implementation, since it will not require the Host DB to be queried for every new bag that gets scanned.

Presentation-Specific Implementation

Hardware

Any treadmill can be set up with the arms/control panel removed to provide a surface a test bag can be placed on. This will let us move an object past a transmitting/receiving antenna for demonstration.

Host DB (Software)

The Host DB and its web service endpoint will be mocked for the sake of the presentation. In the absence of a readily available networked database, we plan on using http://www.freemysqlhosting.net as our database host for our fake airline data. For the web service endpoint, we currently plan on piggy-backing on a domain owned by a group member's (Adrian McGrath's) LLC. Since the webservice will only be temporarily piggy-backing for presentation purposes, advanced server infrastructure will not be implemented. The web service endpoint will just be implemented using a basic php script.

Airline Web Service Endpoints (Software)

Since the airlines specify the passenger identification data on the RFID chips (See Above: RFID Chips), the airlines will have control over how they want to implement their web service endpoint. We do not care how the airlines plan on performing a passenger lookup with the passenger identification data they provided, since we simply send them the exact data they put on the RFID chip. It is the airline's responsibility to be able to interpret the data and respond correctly.

The Airlines for the presentation will be mocked. We are planning on creating at most 5 mocked airlines to work with during our presentation. The passenger data for these airlines will be located on a database provided by http://www.freemysqlhosting.net, and the web service endpoints for the mocked airlines will be piggy-backing on a domain owned by a group member's (Adrian McGrath's) LLC. Since the webservice will be only piggy-backing, advanced server infrastructure will not be implemented. The webservices will just be implemented using a basic php script.