SOFTWARE REQUIREMENTS SPECIFICATION

JUST WALK OUT

VERSION 1.0

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CONTENTS

1. Introduction

    1.1 Purpose

    1.2 Scope

    1.3 Definitions, acronyms, and abbreviations

    1.4 References

    1.5 Overview

2. Overall description

    2.1 Product perspective

    2.2 Product functions

    2.3 User characteristics

    2.4 Constraints

    2.5 Assumptions and dependencies

    2.6 Apportioning of requirements

3. Specific requirements

    3.1.1 User interfaces

    3.1.2 Hardware interfaces

    3.1.3 Software interfaces

    3.1.4 Communications interfaces

3.2 Functional requirements

    3.2.1 User Class 1 - The User

3.2.2 User Class 2 – The Store

3.3 Performance requirements

3.4 Design constraints

3.5 Software system attributes

1. Introduction

This section gives a scope description and overview of everything included in this SRS document. Also, the purpose for this document is described and a list of abbreviations and definitions is provided.

1.1 Purpose

The purpose of this indicator is to give a detailed description of the requirements for the “Just Walk Out” software. It will illustrate the purpose and complete declaration for the development of system. It will also explain system constraints, interface and interactions with other external applications. This document is primarily intended to be proposed to a customer for its approval and a reference for developing the first version of the system for the development team.

1.2 Scope

The “Just Walk Out” is a machine-learning based mobile e- commerce application which helps people to shop from their closest store without standing in the tradition of queues. It uses computer vision to allow customers to make purchases without a cashier. This mobile application also makes use a deep learning algorithms and sensor fusion. This technology incorporates many of the same concepts found in self-driving cars.

Customers will use this mobile application to enter the store and then cart/pick the required items off the shelves. Anything a customer takes off a shelf is added to a virtual shopping cart called e-cart. Items returned to the shelves automatically are removed. When they're finished shopping, customers just exit. Their purchases automatically are scanned and charged to their accounts, and receipts are sent to their smart phones. This SRS project is inspired from the upcoming technology by Amazon.

Furthermore, the software needs Internet connection to fetch and display results. All system information is maintained in a database, which is located on a web-server. The software also interacts with the GPS-Navigator software which is required to be an already installed application on the user’s mobile phone. The application also has the capability of representing both summary and detailed information about the stores.

1.3 Definitions, acronyms, and abbreviations

TERM	DEFINITION
1. GPS	Global positioning system.
2. GPS-Navigator	An installed software on mobile phone which could provide GPS connection and data, show locations on map and find paths from current position to defined destination.
3. User	Someone who interacts with the mobile phone application.
4. Admin/Administrator System	administrator who is given specific permission for managing and controlling the system.
5. Web-Portal	A web application which present special facilities for the store.
6. RFID	Radio frequency identification
7. QR code	Quick response

1.4 References

www.google.com
www.wikipedia.com
www.youtube.com
www.ieee.com
www.amazongo.com
www.usatoday.com
www.kantify.com

1.5 Overview

The remainder of this document includes the overall description, the external interface requirements, system features and other non functional requirements for the SRS. It also provides overview of the system functionality and system interaction with other systems. It also mentions the system constraints and assumptions about the product. It provides the requirements specification in detailed terms and a description of the different system interfaces.

2. Overall description

This section will give an overview of the whole system.

2.1 Product perspective

When the customer goes to the shop, (s) he just picks the items they want and walk out of the store. No standing in queues. No checkouts. No fumbling for cash or cards!

This technology works with a combination of artificial intelligence, deep learning, computer vision, RFID tags, QR code, Image recognition, Facial recognition and sensor fusion. This allows customers to be charged only for the items they picked up.

Requirements to shop using Just walk out:

i. To be able to shop using Just Walk Out app, shoppers need to download and register to the Just Walk Out app.
ii. This includes linking your bank account with this app.
iii. Shop must be a registered member of Just walk out.
iv. Sign in using this app that generates qr code specific to the customer's account that logs the customer to the network and connects to the customers Just Walk Out account.

Lot of cameras and lasers (in the form of LIDAR sensors) are placed inside the store which tracks what people do in the store, what items are picked up and from where they get picked up, and what the user is carrying with them.

Also the sensors are trained to tell the difference between a cupcake package and a sandwich, over and over and over again, so as to avoid billing wrong item which the customer probably didn't pick up. This is implemented using deep learning algorithms.

This advance technology completely eliminates lines and checkout. Upon leaving the stores, users will be charged on account and get a receipt.

It transcends the boundaries of computer vision and machine learning to create a seamless "Grab and Go" shopping lines with no annoying queues at checkout.

2.2 Product Functions

2.2.1 Intelligent Recommendations

This app can locate nearby stores which are registered with just walk out based on your purchase history and also gives suggestions like which store you must try. The mobile application will need to communicate to a GPS application within the mobile phone, which in turn communicates with a physical GPS device to find the location of the user. The GPS will provide the mobile application with locations of both the user and the stores and the distance between them, but it will also provide maps to navigate and reach the desired store. The functionality provided by the GPS will be embedded into the application in order for the user to be able to use the functions in the application in a seamlessly manner.

2.2.2 In-store experience

Sign in using the mobile app "Just Walk Out" that generates QR code specific to your account and scan the code near the sensor to enter the store. The surveillance identifies the customer and keeps track of the person and in information related to him like images of the user, details about the user like height and weight, user biometrics, a username and password, even user purchase history. Store surveillance system then identify each unique user and can track them as they shop through the store. Cameras pick up images when customer stops in front product shelves, when they picked up any

item, whether the item is placed again in the shelf or in customers basket. When users hand is removed from inventory location, multiple images are captured of the users hand, then with deep learning algorithms it is determined whether item is purchased or placed back. The tech is similar to what's used to allow self-driving cars to navigate the world.

For an example, let's presume multiple cameras are covering a single shelf; some cameras are positioned closer, some farther. A few cameras think the customer picked up the cheap soda, one thinks the user grabbed the fancy artisanal stuff, one saw nothing at all, and another thinks the customer was just picking their nose. Now what? Was the camera that picked up the fancy soda closer and had a better view? Did the nose picker camera get blocked by the user?

Given the rate of error for each camera based on its location and point of view, Bayes' Rule tells exactly how to combine all of the inputs to know just how likely it was that the user has the cheap soda. Bayes' rule combines inputs from different sensor types entirely.

These are implemented using different algorithms like image recognition, facial recognition and also voice recognition if the customer makes any sound. Anything they take from the store's shelves is automatically added to their virtual shopping cart. If they put an item back, it is removed from their cart in the same fashion. Infrared, pressure and load sensors on the shelves note when the items are picked up and whether they are put up. These sensors also feed into the store's sense of where everything and everyone in it are at any moment. When the customer passes through the exit (transition area) of the retail location, the items picked by the user may be automatically transitioned from the materials handling facility to the user and the user may be charged a fee for the items. For example, if the user is purchasing items from a retail location, rather than the user having to stop and 'check out' with a cashier, teller or automated check station, because the picked items are already known and identified on an item identifier list associated with the user, the user

may simply exit the retail location with the items. The exit of the user will be detected and, as the user passes through the exit (transition area), the user, without having to stop or otherwise be delayed, will automatically be charged a fee for the items (the items are transitioned to the user).The store's system triggers a receipt that is sent to the shopper indicating the items sold and the purchase price and automatically bills their accounts and sends a receipt to the app as well to their email. Throughout the shopping process, the system is constantly tracking and logging product information, leading up to the moment the consumer exits the store through the "transition area." In the transition area, the system then senses that the consumer is leaving and automatically counts every item chosen and automatically does payment and sends a receipt to the app as well as email.

If the customer tries to purchase items and the total amount increases the balance in his/her account, he will immediately get a notification stating that "Low balance. Keep back item(s)". It will also suggest him about which item to replace or remove from cart.

2.3 User classes and characteristics

a) Customer
b) Store administrator
c) Administrator of Just Walk Out

Each of these three types of users has different use of the system requirements.

a) The mobile application users, customers can only use the application to search for a store, choose a store and then navigate to it. They require the app to enter the store by scanning qr code. And finally, the customer will receive the bill in the app.
b) The store administrators: they will manage the information about the store, items sold, and adding items to the virtual cart correctly.The administrators they manage the overall system.

c) The administrator of the app manages the information of each store. Maintain customer profile and store profile. Maintain customers purchase history.

2.4 Operating System

This app works with latest versions of android, iOS operating systems.

2.5 Design and implementation constraints

Technologies and tools used in store:

2.5.1 Sensor fusion

It is essentially an amalgamation of sensor data from a number of inputs, such as weight and motion sensors. Sensors are the devices that could detect any type of changes in the electrical or physical or other quantities in their surroundings, depending on their sensing nature and alerts about it. Sensor technology is now being used to make a machine depicting a Human Being by combining different sensors together. This technology that allows this to happen is Sensor Fusion, which leverages a microcontroller (a "brain") to fuse the individual data collected from multiple sensors to get a more accurate and reliable view of the data than one would get by using the data from each discrete sensor on its own. Sensor fusion is software that intelligently combines data derived from disparate sources for the purpose of improving application or system performance. Combining data from multiple sensors corrects for the deficiencies of the individual sensors to calculate accurate position and orientation information.

It'll involve a lot of tracking and Artificial Intelligence. The system will involve usage of sensors throughout the (physical) stores and AI to figure out which direction you are looking at, even in a crowd. The sensors would also be able to identify partially blocked labels.When paired with Computer Vision, Sensor Fusion helps to determine when

someone has reached for an item, removed it, or placed it back on the shelf.

2.5.2 Computer vision

Computers to acquire and process visual information and generate appropriate algorithms based on the data that is gathered. Multiple cameras are used to recognize customers as well as their placement or proximity to departments, shelves, items, and so on.

Computer vision is the technology which studies the 3D scene and reconstruct, interrupt and understand the objects in that 3D scene from its 2D images in terms of the properties of the structure present in scene. Computer Vision is concerned with the theory and technology for building artificial systems that obtain information from images or multi-dimensional data.

The cameras would even know the customer's skin tone, to determine if it was indeed the hand of the person the system thinks it is.As in, "image analysis may be performed on the first image to determine a skin tone color of the user's hand and pixels including that color, or a range of colors similar to the identified skin tone color, may be identified to represent the user's hand."That could potentially be used to distinguish between two people each reaching for things on adjacent shelves, as skin tone is very individual.

Static cameras watching the shelf also determine whether multiples of the same items are taken, such as several sticks of gum or a few bags of chips. If you pick up several bags of chips just to get the one on the inside, the camera is supposed to know that you ended up putting the other bags of chips back as well. If it is not confident about how many items you took or what exactly you took (i.e., a Colgate versus Crest toothbrush) it may end up confirming with you in your Smartphone to charge the right amount.

2.5.3 QR code (Quick Response Codes)

When the customer scans the QR code in the Smartphone with the sensors in the store, the surveillance identifies the customer and keeps track of him.

2.5.4 RFID tags (Radio Frequency identification)

It uses electromagnetic waves to identify and track labels that are attached to products. Passive tags harness the energy from nearby RFID readers to transmit electronically stored information to the reader. It is a well- established technology in large scale in asset tracking and inventory management. RFID tags (constitute a small chip and an antenna) can carry similar information as the barcodes about the products. They remove the requirement of line of sight and short range between the tag and the scanner. RFID tags can be scanned at distances of a few meters. They can be read or written to, which is a radical new capability compared to barcodes which can only be read. The technology behind it is patent- pending.

It works similarly to an anti-theft RFID tag in in which when an item of stolen clothing is passed through the RFID sensors near the exit of a store an alarm goes off. But in this case, there is no alarm; this event triggers the just walk out app to add items to the customer's virtual cart.

Key Benefits are:

a) No alignment/orientation requirement such as in barcodes
b) Simultaneous scanning of numerous products
c) Read/Write capability helps with reducing shrinkage
d) Integration with billing and inventory management
e) Scan distance requirement will be relaxed
f) RFID tag reads ~1000x faster than the next fastest method.
g) Patent- pending localization method that locates RFID tags 20x more accurately than traditional methods (10cm vs. 2m).
h) Enhanced inventory control: RFID provides to product visibility, and better control of inventories, which in turn results in better customer experience outcomes.
i) Enhanced product identification: One of the many benefits of RFID tags is the capacity to store distinctive identification numbers as well as modest amounts of data that enables individual

items to be identified and tracked from virtually anywhere in the store.

j) Reduced checkout times: Imagine a shopper filling a shopping cart and having the entire contents of that cart scanned and paid for without having to remove even one single item. RFID makes this form of auto payment not only possible but preferable.

2.5.5 Virtual mirrors

Storefronts will use augmented reality technology to entice shoppers. Interactive ads will allow you to "try on" virtually something before you even walk into the store in case of apparels. This technology will also be utilized throughout the store, complete with software that helps identify products that the shopper may be interested in.

2.5.6 Smart digital signage

Smart digital signage shows advertising messages personalized to the shopper. Using RFID tags to identify which items they are carrying through the store or looking at past purchases, the displayed message can suggest other products the shopper might be interested in. Brands whose products are sold at a retailer can advertise on their digital signs, creating another revenue stream for the store. It provides both video and touch screen. It is an interactive screen to display information or offers, getting input from digital sources. AI can be used to predict their needs and wants. Through Artificial Intelligence, brands can provide accurate, relevant product recommendations to customers who are guaranteed to spark interest and bring about conversion. AI will even take into consideration factors such as the weather conditions, time of day and day of the week to deliver the right recommendations, something a human being could never do.

2.6 User documentation

2.6.1 For customers

E-manual and online help is available in the just walk out app. Manuals can also be downloaded. The app will display the support contact numbers for the store they visited.

2.6.2 For store administrators

Information regarding Maintaining and managing the user details, product details. FAQ'S is available for both customer and stores

3. External Interface Requirements

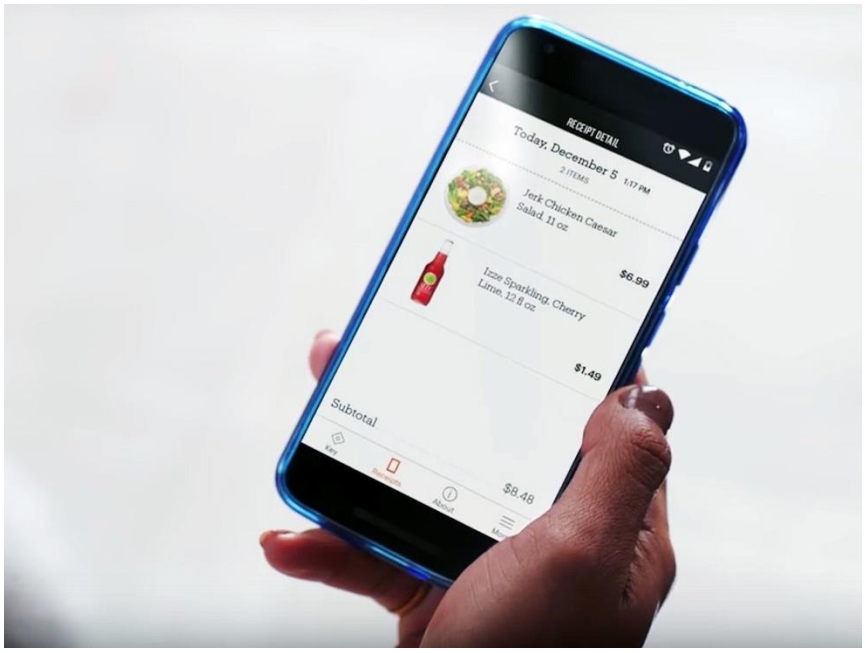
External interface requirements specify hardware, software, or database elements with which a system or component must interface. This section provides information to ensure that the system will communicate properly with external components. If different portions of the product have different external interfaces, incorporate an instance of this section within the detailed requirements for each such portion.

3.1 User interface requirements

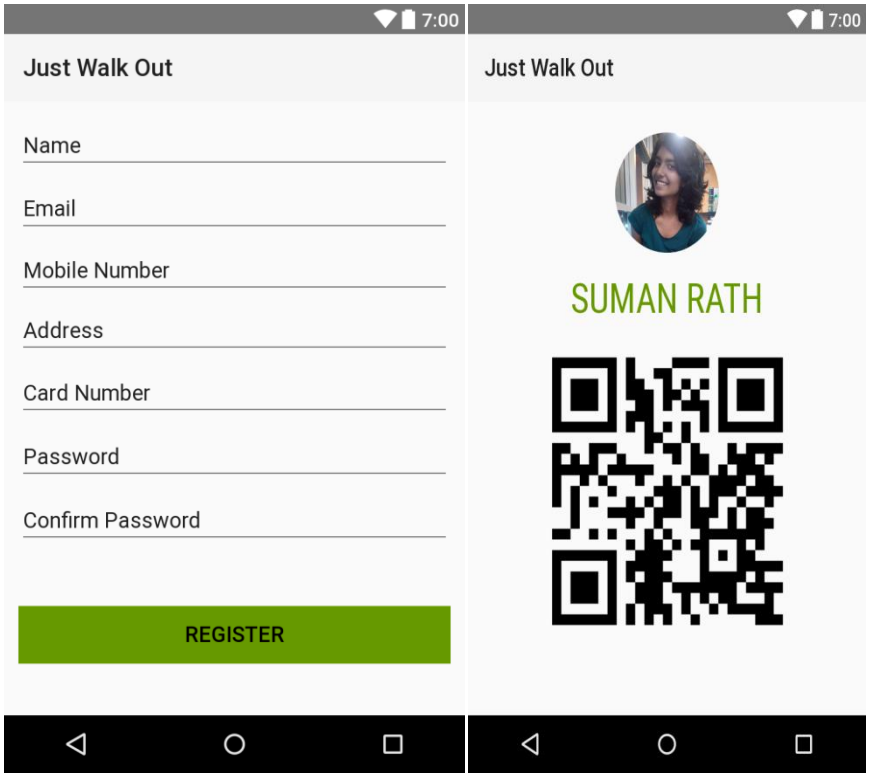
Just walk out involves a minimalistic approach to user interface while shopping. It is designed in such a way that the user can conveniently shop The app is to be designed in such a way that it involves the user not interacting with it too much because he or she should only focus on the hassle free shopping experience. The Qr code scanning through the app ,the picking up and removing of items, the register page is what will be the components of the app. Sample design screenshots are included to give an understanding that how the best user experience is with minimalistic design approach. Earlier versions involved logging in, pointing and clicking but this project will eliminate the pointing and clicking approach as well and would add items to cart automatically as they are picked from the shelf.

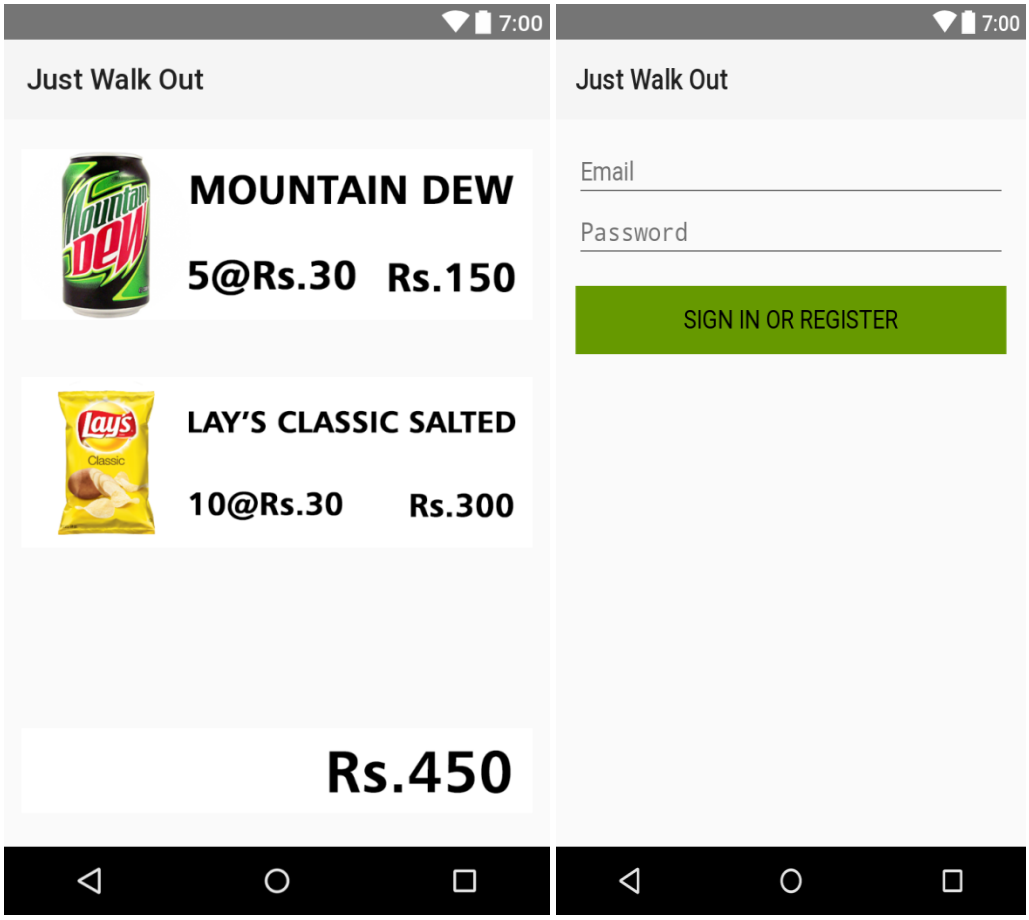
QR code scanning:

Checkout bill receipt after you have been charged:



Design screenshots:



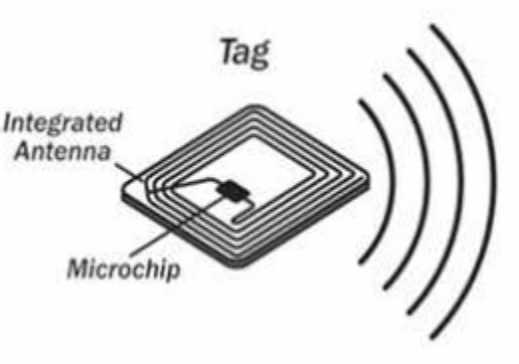


3.2 Hardware interface requirements

The project, Just walk out will use cameras and sensors as hardware. These cameras can track your location as well a what you are looking at. Sensors in the shelves can detect whether an item is picked up from the shelf or put back into the shelf so that the store can charge you accordingly .The sensors at the check in place also scan the RFID and accordingly keep adding items to your virtual cart. The shelves will be having pressure sensors. Just like the products have a barcode they will be having an rfid tag which is radio and frequency identification tag where digital data in the rfid tag are captured by reader through radio waves. The interaction between the sensor and rfid tag is the main part of the communication part of the just walk out product which will be explored further. The QR code reader will help you in

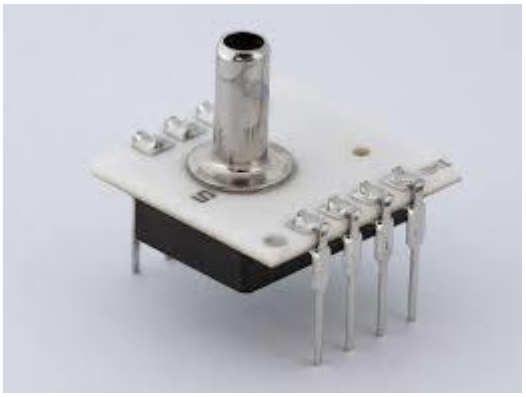
checking in. QR code reader working: So, now that you have the tools you need, let's get to scanning. Go out and find yourself a code. Get out your phone and open the app you've downloaded or that it came with. Do your best to steady your hand while the QR code is centered on the screen. Voila, as soon as it is done scanning, whatever information, videos, webpage URL's, etc. were stored in the QR code should present itself for your viewing pleasure.

RFID TAG



Camera

Pressure sensor



QR code:

3.3 Software interface requirements

The hardware components mentioned above should interact effectively and send signals to corresponding software.The software will be having two components i.e one interacting with the customer which is the customer software and the other will be interacting with the store i.e store management software.The store management software will analyze the signals coming from the sensor and rfid interaction and combine them to form the purchase data which in turn will be sent to customer software when the purchase is done . .In case the device is lost where the app has been installed, the mac address of the device should be blocked or the malicious activity should be notified using email (backup mail of someone who the customer trusts)or through personally contacting the user. Such a feature should also be included in the software. So suppose you lose your previous device which had an account. Logging in to the new account should give a prompt detecting activity in the previous account and ask you whether you

want temporary or permanent removal of previous account. Such a security requirement is necessary in the software.

3.4 Communication interface requirements

The communication interface requirements will involve a QR code which is unique for a user and while checking in this will be the only part communicating between customer and qr code scanner.The interaction between rfid and pressure sensor will follow TCP\IP which has been explained through an example. RF Code, for example, offers the R160 Air Pressure Sensor, designed specifically for use in data centers. The sensor tags gather environmental data and transmit it via radio frequency communication to fixed and mobile readers every 10 seconds. The readers decode the data and make it available via a standard TCP-IP connection (either wired or Wi-Fi) to the company's Sensor Manager software, which runs on a server within the data center. The software then aggregates the collected information and correlates it to the asset's location, and can issue alerts if action needs to be taken. The software can also analyze the environmental information and issue various reports and graphs. After the payment is received the customer will be notified through an email or a text message.

4. System features

4.1 Description and priority

Just walk out is an e-commerce mobile application that enables consumers to purchase items in physical stores without waiting in lines or checking out with registers. Just walk out uses machine learning, sensor technology, machine vision and artificial intelligence (AI) similar to that found in self-driving cars. Of course this application has higher priority because the customers don’t need to spend time standing in the queues.

4.2 Functional requirements

- Computational co-op

  The next big breakthrough was being able to use (Graphics processing unit) GPUs as essentially desktop supercomputers. Simulating a neural network requires aggregating the inputs and computing outputs for many neurons, a process that is easily parallelizable. Computations that took hours on the most powerful CPU became the work of minutes on a mid-tier GPU.

  Parallel computing with GPUs allowed researchers to finally follow up on an earlier discovery: how to structure a neural network for vision. Remember, even a simple network of a few hundred thousand neurons could have billions of connections that would need to be simulated unless there was some intelligent pruning of those connections.

  Fortunately, to create networks that could see, we could cheat we have fantastic examples of neural networks optimized for vision tasks right in our own heads. Neuroscientists have spent decades mapping out the mammalian visual cortex, and this proved to be a great inspiration. From this, the Convolutional Neural Network, or CNN, was born, inspired by the structure of the animal visual cortex. In the past few years, CNN has become one of the most popular and powerful tools in computer vision.

- Fusion foodies

  To understand this concept, head back to the 1960s. NASA's engineers ran into a big problem at the time. They had multiple navigation instruments, ranging from gyros to star trackers, and they needed to combine all the measurements into a single, best estimate of a spacecraft's position. Similarly in just walk out, this initiative needs to combine observations by multiple different cameras over different time periods into a single coherent picture of the customer's cart in order for the whole ordeal to function. The key is that the world is inherently an uncertain place, and the solution is to embrace uncertainty. Instead of attempting to specify everything precisely, a successful setup models everything using the language of probability.

- Virtual cart

  For a grocery store, there is one primary question just walk out needs to answer when a customer leaves the store, what are they taking with them? To put it another way, what's in the shopping cart?

  When you boil it down, there are only two ways to answer. just walk out needs to either look in the cart when a customer leaves or keep track of what's going into the cart. The first approach is what we call a checkout line, and it's what most retail stores do today (examine the customer's items as they leave, all at once). The other approach I'll call the bar tab. Like a bartender who keeps a tab of every drink a customer orders, a business can figure out what's in our customer's cart by keeping track of what goes in or comes out. If done perfectly, you'll know exactly what's in a customer's cart without ever forcing consumers to show their items.

  It aims to not only know what's in any given cart, the system needs to know whom to charge as well. To charge the right customer in a cashier/checkout line-less world, you must track customer identity, too.

  So how will just walk out do all this? How will the company keep track of people in the store, and what they're picking up and putting down, without making mistakes? The answer obviously starts with cameras. They're unobtrusive and cheap, and you can put them everywhere. Just walkout told us as much by mentioning computer vision.

  But how do you make sense of what the cameras see and use that to track shoppers and their actions? That's where the second set of buzzwords comes in deep learning.

Now just walk out presents...

  Bayes' Rule helps complete a pretty realistic picture of how this newfangled system might work.

  As you enter the store, you swipe in. Cameras running deep learning vision algorithms see you and track you as you move about the store. Each time you pick up an item or put it down, cameras recognize that

action. Observations from multiple cameras are combined using Bayes' Rule, delivering a reading of what you took. All the while, the system tracks all the possible combinations of items that you might have in your possession. Every time you pass by a door or a gate, an RFID scanner takes a reading, which lets the system narrow down the list. When you finally leave, the system can look through what it thinks you might have, pick the most probable guess, and charge you accordingly.

5. Nonfunctional Requirements

5.1 Performance requirements

As you enter the store, you swipe in. Cameras running deep learning vision algorithms see you and track you as you move about the store. Each time you pick up an item or put it down, cameras recognize that action. Observations from multiple cameras are combined using Bayes' Rule, delivering a reading of what you took. The system must be interactive and the delays involved must be less .So in every action-response of the system, there are no immediate delays. In case of checking in, adding products to the cart and billing there is delay much below 2 seconds. Also when connecting to the server the delay is based editing on the distance of the 2 systems and the configuration between them so there is high probability that there will be or not a successful connection in less than 20 seconds for sake of good communication.

Deep learning, cloud computing, and probabilistic reasoning, machine learning, parallel computation, and Bayesian estimation currently lurks behind self-driving cars, AI, translation engines, and much more makes the just walk out technology effective and helps in having higher performance.

5.2 Safety Requirements

Hackers will probably target just walk out as the place to figure out how the sensors work, and also detailed schematics of the cameras as a way to circumvent any security measures related to Eggo Waffles and most energy drink brands. To avoid this main security concern is for users account hence

proper login mechanism should be used to avoid hacking. The tablet id registration is way to spam check for increasing the security. Hence, security is provided from unwanted use of recognition software.

5.3 Security Requirements

In case of the device is lost where the app as been installed the mac address of the device should be blocked or the malicious activity notified using mail (back up mail of someone who the customer trust). Such a feature should also be included in the software so suppose if the customer lose their previous device which had an account, logging into the new account should give a prompt detecting activity in the previous account and ask whether user want temporary or permanent removal of previous account. Such security requirement is necessary in the software.

5.4 Software Quality Attributes

5.4.1 Availability

If the internet service gets disrupted while shopping then the user can continue shopping the products purchased will be saved in the app and the amount will be deducted once the internet get connected.

5.4.2 Reliability

As the system provide the right tools for discussion, problem solving it must be made sure that the system is reliable in its operations and for securing the sensitive details.