Computer Vision for Pattern Recognition

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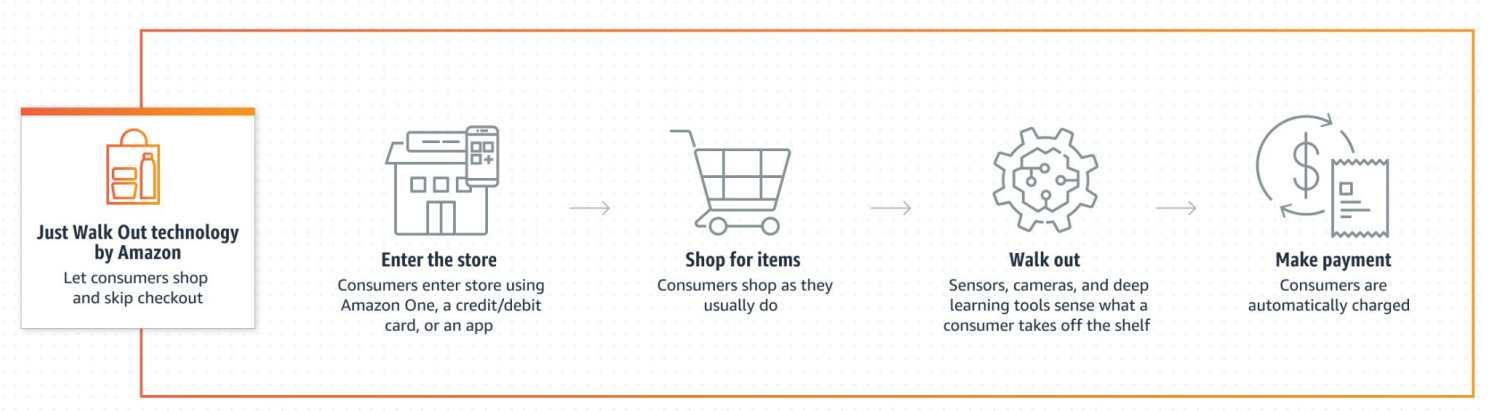
Just Walk Out Technology

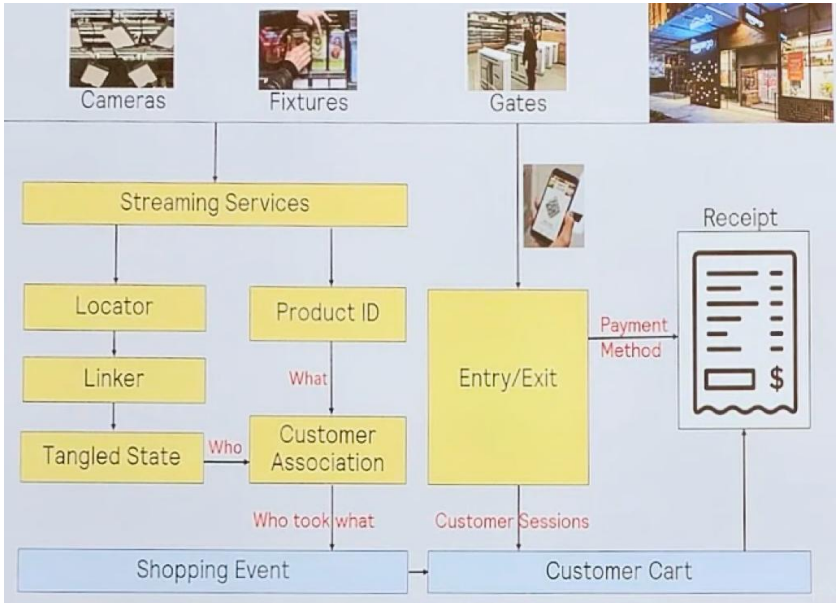
Just Walk Out technology simplifies the shopping experience by removing checkout and helping consumers to get in and out quickly and seamlessly.



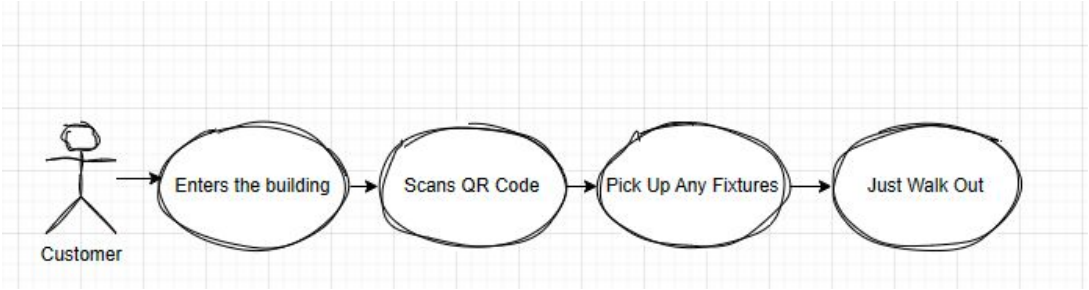
Introduction

Short Recap:

Last time we simply discuss about the system architecture, this presentation, we are going to talk about the functionality requirements for Just Walk Out System.

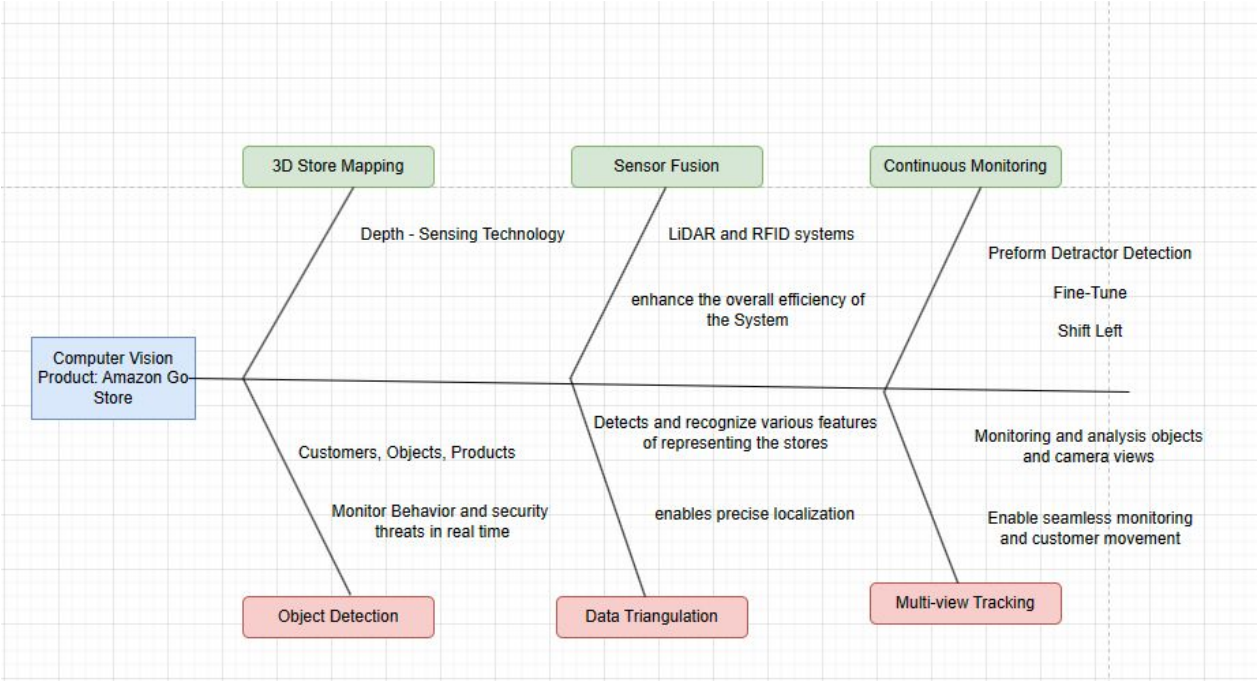


System Requirements - Business Perspective



- **User Requirement #1:** "As an Amazon Prime member, I want to enter an 'Amazon Go Store,' scan my QR code, pick up any items, and simply walk out without any human interactions."
- **User Requirement #2:** "As a Customer, I don't want to continuously feel like I am being watched when I shop by another human,and want every transaction to be accurate."
- **User Requirement #3:** "Surveillance cameras within the retail store must meet the following specifications:
  - High-definition resolution to ensure clear and detailed images and video footage.
  - Proper calibration to maintain accurate color representation and image quality.
  - Integration with knowledge within store model, fusion sensors, and object detection capabilities to enhance surveillance and security monitoring."

Requirement #3 in a CV System



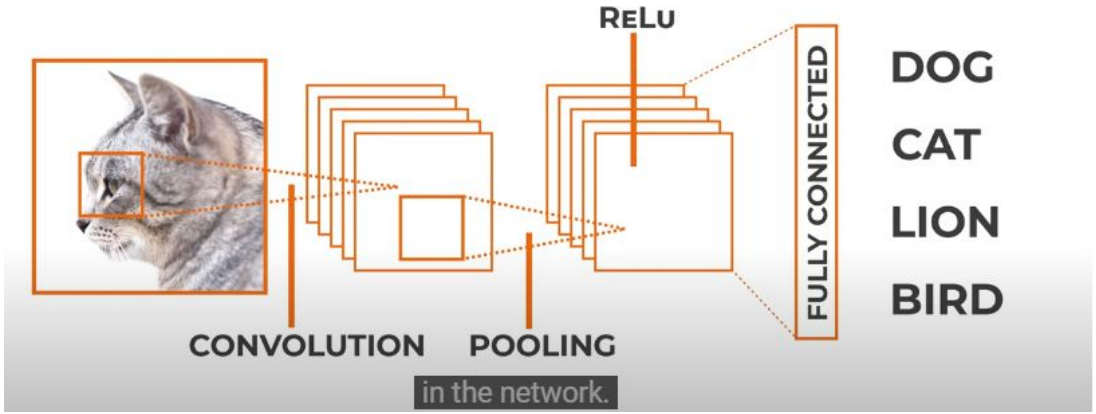
Convolutional Neural Network (CNN)

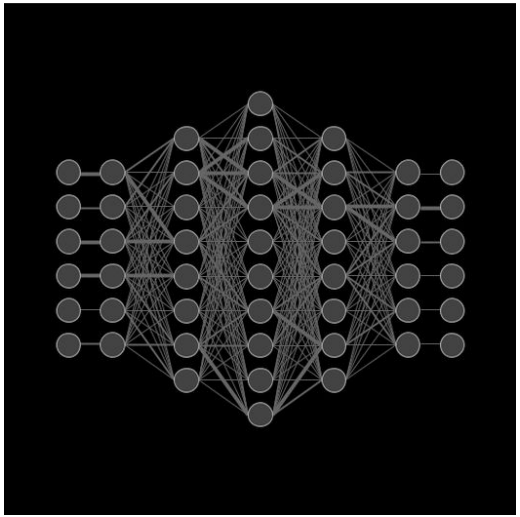
Convolutional Layer: Simplify complex images and objects through a filtering process within the network.

Polling Layer: Reduce the sample size of a particular feature map. Aiding in Feature abstractions.

Rectified Linear Unit Layer (RELU): Serves as an activation function, ensuring non-linearity in the processing of data.

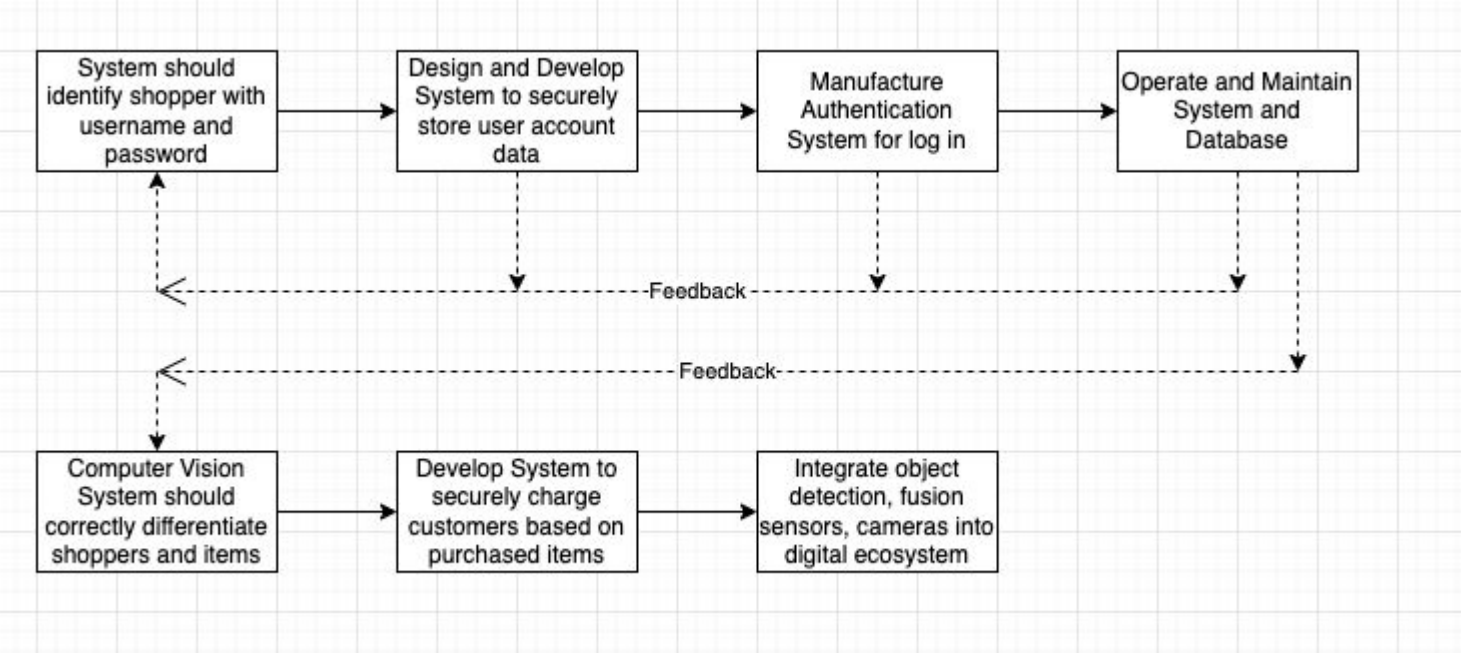
Fully Connected Layer: classification of the image by connecting every neuron to every neuron in the preceding layer.





Functional Analysis

System Requirement: Store's digital ecosystem should identify shoppers with their respective accounts and be able to differentiate items



Trade Off in Computer Vision System

Alternative 1:

Depth Cameras and Load Sensors

Alternative 2:

RGB Cameras with Palm Scanning

Pros and Cons of the Alternatives

Depth Cameras and Load Sensors

- Pros:
  - Privacy: do not capture detailed shopper images
  - Cost-effective: less expensive than advanced RGB cameras
- Cons:
  - Accuracy: hard to differentiate between similar items or handle situations with multiple shoppers in close proximity.
  - Limited functionality: do not provide additional data beyond the items they take, unable to provide targeted promotions or personalized shopping experiences

Pros and Cons of the Alternatives

RGB Cameras with Palm Scanning

- Pros:
  - Higher accuracy: pass the image through CNN, compare feature vectors in database
  - Additional functionality: have unique user identification and enable personalized shopping recommendations
- Cons:
  - Privacy concerns: collect detailed shopper palm scan images
  - Higher cost than traditional depth camera and load sensors

References

- **Performance Characterization in Computer Vision:**
  - https://link.springer.com/chapter/10.1007/978-1-4471-3201-1_1

- **Computer Vision By E.R Davies**
  - https://books.google.com/books?hl=en&lr=&id=mEuZDgAAQBAJ&oi=fnd&pg=PP1&dq=computer+vision+design+process&ots=FxJ8toOq-T&sig=dBSh7SYY11ge9lq2h_QVnKOzhWM#v=onepage&q=computer%20vision%20design%20process&f=false

- **How the Amazon Go Store's AI Works**
  - https://books.google.com/books?hl=en&lr=&id=mEuZDgAAQBAJ&oi=fnd&pg=PP1&dq=computer+vision+design+process&ots=FxJ8toOq-T&sig=dBSh7SYY11ge9lq2h_QVnKOzhWM#v=onepage&q=computer%20vision%20design%20process&f=false