
YOLO
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About

Recognition and Price Computation of Products from their Image

Current Situation:

- Almost all Grocery stores use bar codes to scan items which was originally proposed in 1948.
- Slow, 1 item at a time
- Time lost in aligning bar code to the scanner

Idea

Current Situation:

- Almost all Grocery stores use bar codes to scan items which was originally proposed in 1948.
- Slow, 1 item at a time
- Time lost in aligning bar code to the scanner

High Level Idea

- Improve the shopping experience by scanning products directly from the cart and automating the billing process
- Avoid long queues and reduce cashier overhead
- Estimating total price based on the items present in the cart.
- We will be using two algorithms for the detection of cart items: SIFT(Scale Invariant Feature Transform) and YOLO (You Only Look Once)

S.O.T.A.

Current State of the Art

- Use of lasers to scan bar codes
- Can scan the barcode in virtually any orientation
- Mark2 : Protable glove barcode scanner(Released 7 days ago) is the most advance barcode scanning device with LEDs, to scan
- Scan range of up to 150 cm


YOLO
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About


S.I.F.T.
The scale-invariant feature transform (SIFT) is a feature detection algorithm in computer vision to detect and describe local features in images.
SIFT keypoints of objects are extracted from a set of reference images and stored in a database.
An object is recognized in a new image by individually comparing each feature from the new image to this database and finding matching features based on Euclidean distance of their feature vectors.

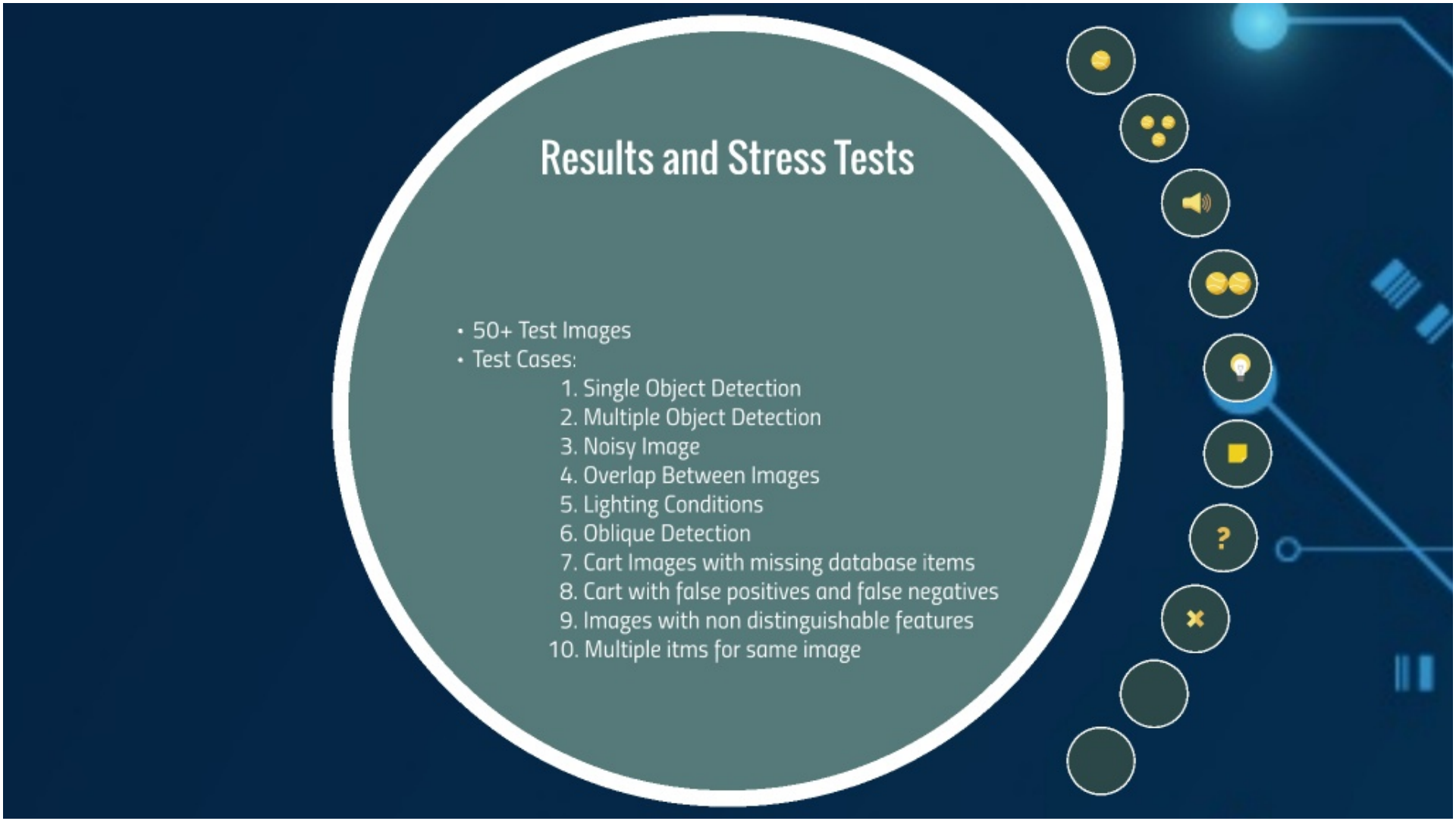
Algorithm-Overview

1. Compute query SIFT features
2. Find feature matches between query image and each database image
3. Sort database images by number of matches
4. Compute RANSAC with homography model on top match. Apply homography to template of top match.
5. Overlay transformed template image on query image
6. Record top database image information, remove from list
7. Remove matched features in overlaid template for remaining database images
8. Compute total price of detected items
9. Return query image with: -Item name and prices at location in image -Total price of detected item

Dataset

- 129 images
- 89 different grocery items
- Varied in shape, size, features, colors and structure
- Multiple sides of the same object


YOLO
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About


Results and Stress Tests
• 50+ Test Images
• Test Cases:
1. Single Object Detection
2. Multiple Object Detection
3. Noisy Image
4. Overlap Between Images
5. Lighting Conditions
6. Oblique Detection
7. Cart Images with missing database items
8. Cart with false positives and false negatives
9. Images with non distinguishable features
10. Multiple itms for same image

Single Item in a cart


Total price: $2.5
Kellogg's
Eggo
waffles
Blueberry
Naturally & Artificially Flavored
blueberry waffles
$2.5
10 Waffles
serving suggestion

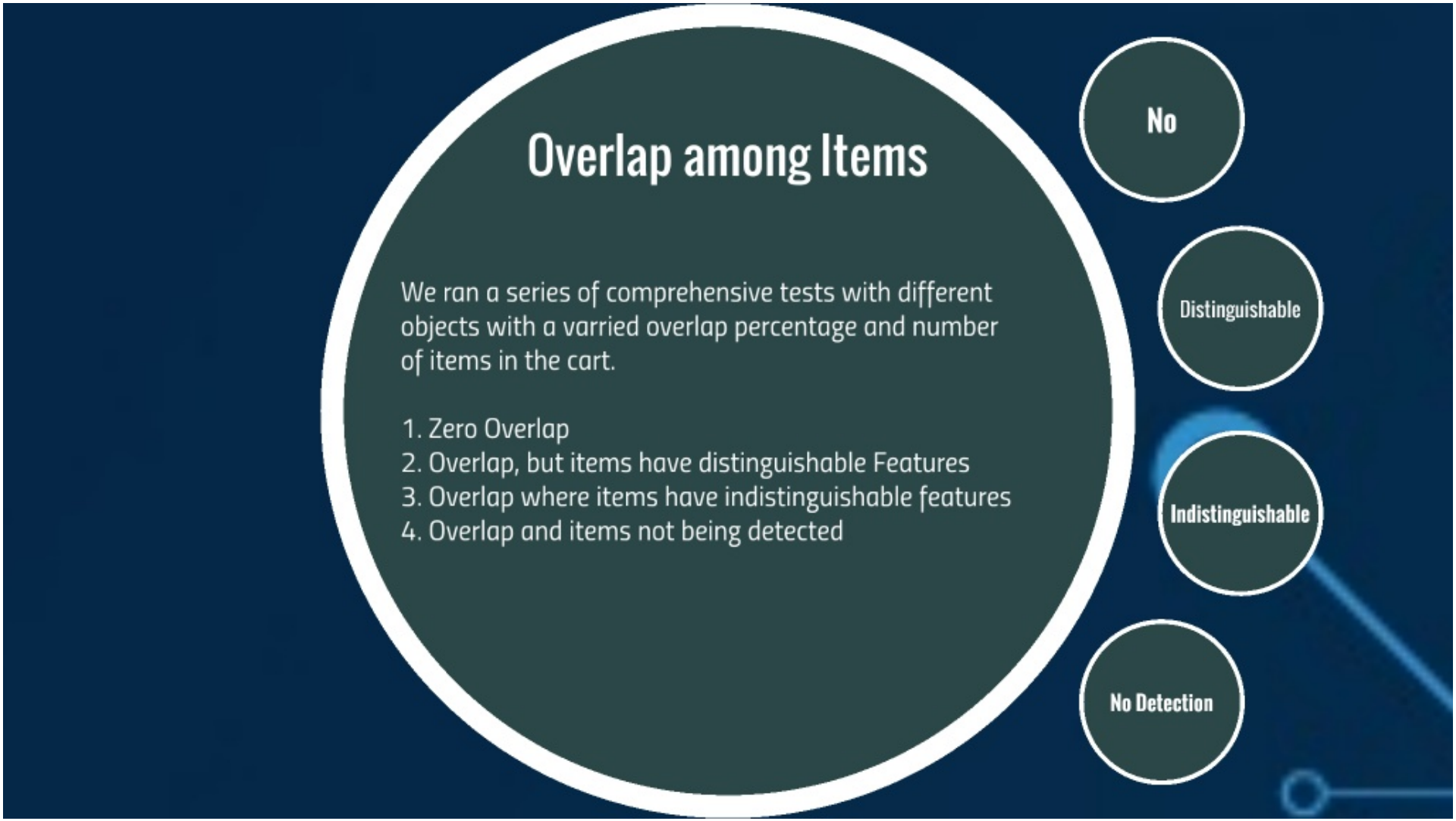
Multiple Items in a cart


Total: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

Noise


Total Price: $52.89
glue
$2.89
listerine mouth wash forks
$6.99
$1.29
sharpie
$4.99
scotch tape
$4.99
sauss
$9.99
dental floss
$2.89
match book
$2.29
charcoal
$4.99
KINGSFORD
ORIGINAL
princess book
$5.99
pen detergent
$5.99


otal Price: $52.89
glue
$2.69
listerine mouth wash
$6.99
forks
$1.29
sausa
$9.99
sharpie
$4.99
scotch tape
$4.99
dental floss
$2.69
matchbook
$2.29
charcoal
$4.99
gain detergent
$5.99
princess book
$5.99


Overlap among Items
We ran a series of comprehensive tests with different objects with a varried overlap percentage and number of items in the cart.
1. Zero Overlap
2. Overlap, but items have distinguishable Features
3. Overlap where items have indistinguishable features
4. Overlap and items not being detected
No
Distinguishable
Indistinguishable
No Detection

Images with no overlap


Total: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

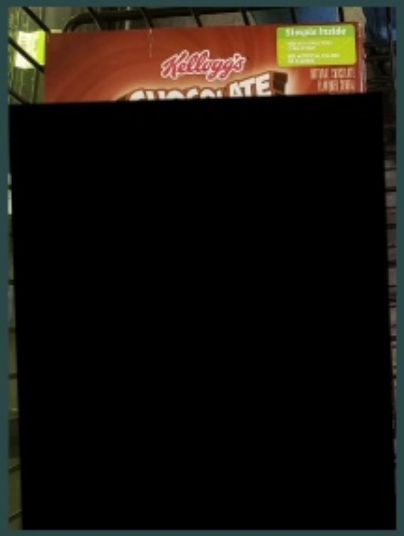
High Overlap with Distinguishable Features


Total Price: $22
Creamette Rotini
$7
Beet Chips
$2
Snuggle
Beef Flavored Broth
$3
Cheddar Broccoli Soup
$5

Overlap with Indistinguishable Features

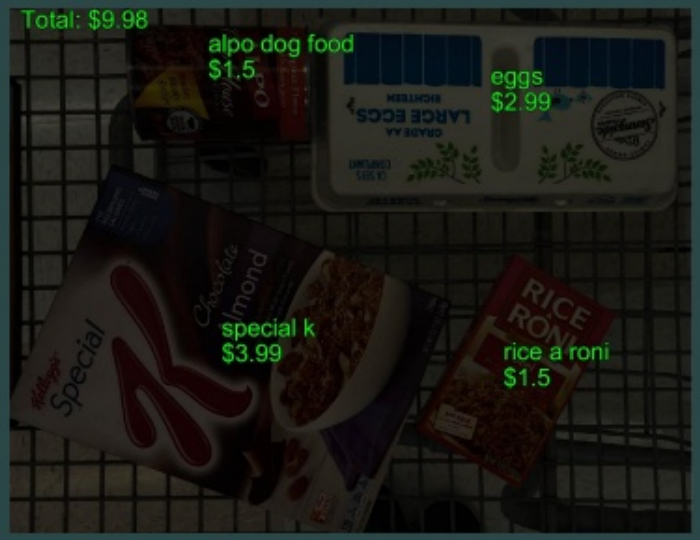

Total price: $8.49
grape juice
$3.99
Kelloggs Frosted
$4.5
Total price: $18.49
nat geo magazine
$13.99
Kelloggs Frosted
$4.5

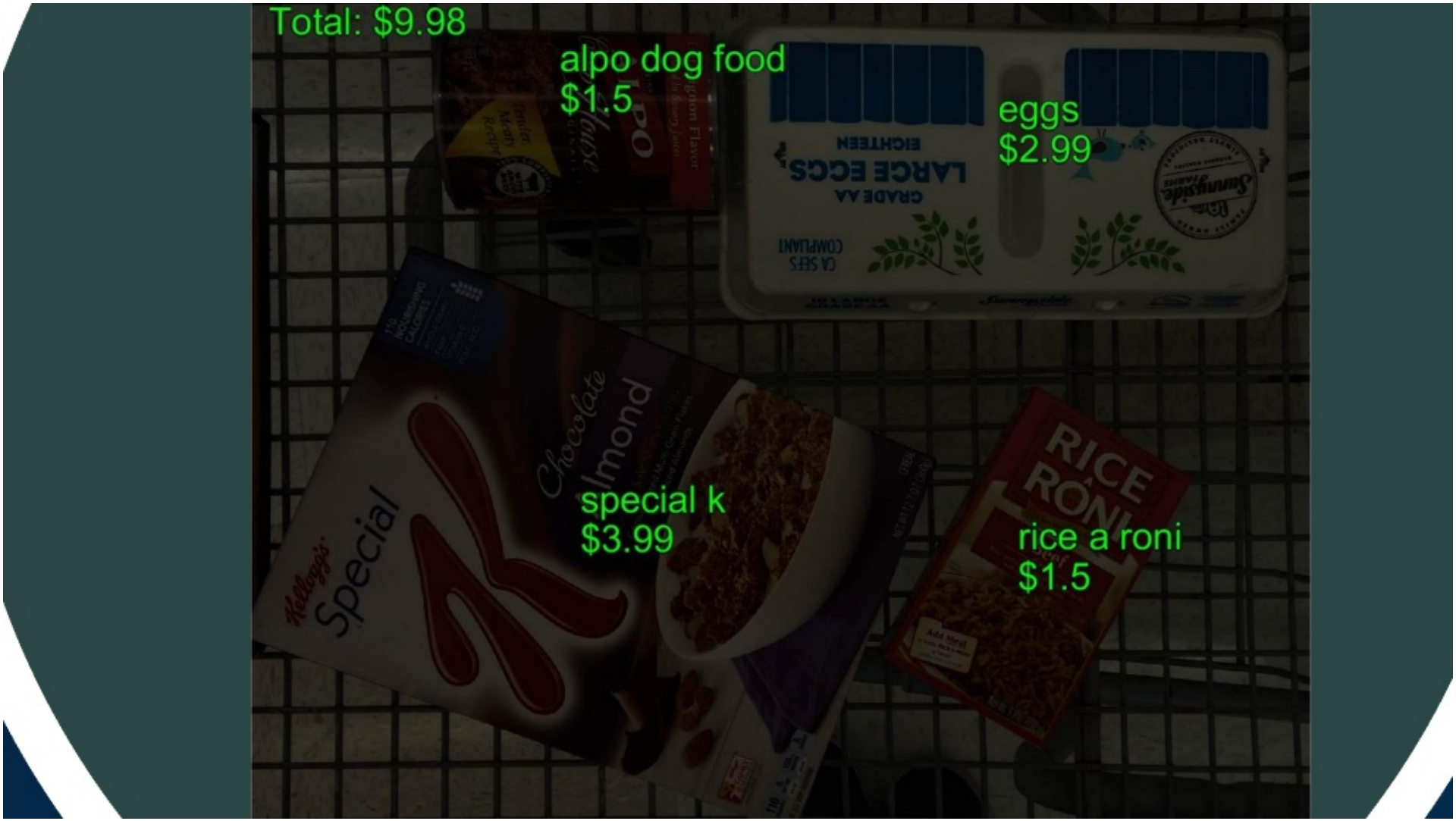
Overlap where items are not being detected




Lighting Conditions
8 Criterias:
1. Low Lighting
2. Extreme Low Lighting
3. Colored Light (Normal Exposure)
4. Colored Light (Less Exposure)
5. Colored Light (High Exposure)
6. Light with Gradient (Bottom to Up)
7. Light with Gradient (Right to Left)
8. Highly Exposed Image
1
2
3
4
5
6
7
8

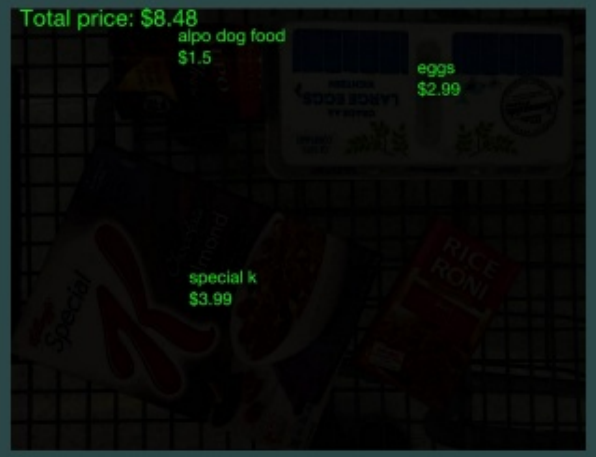
Low Light

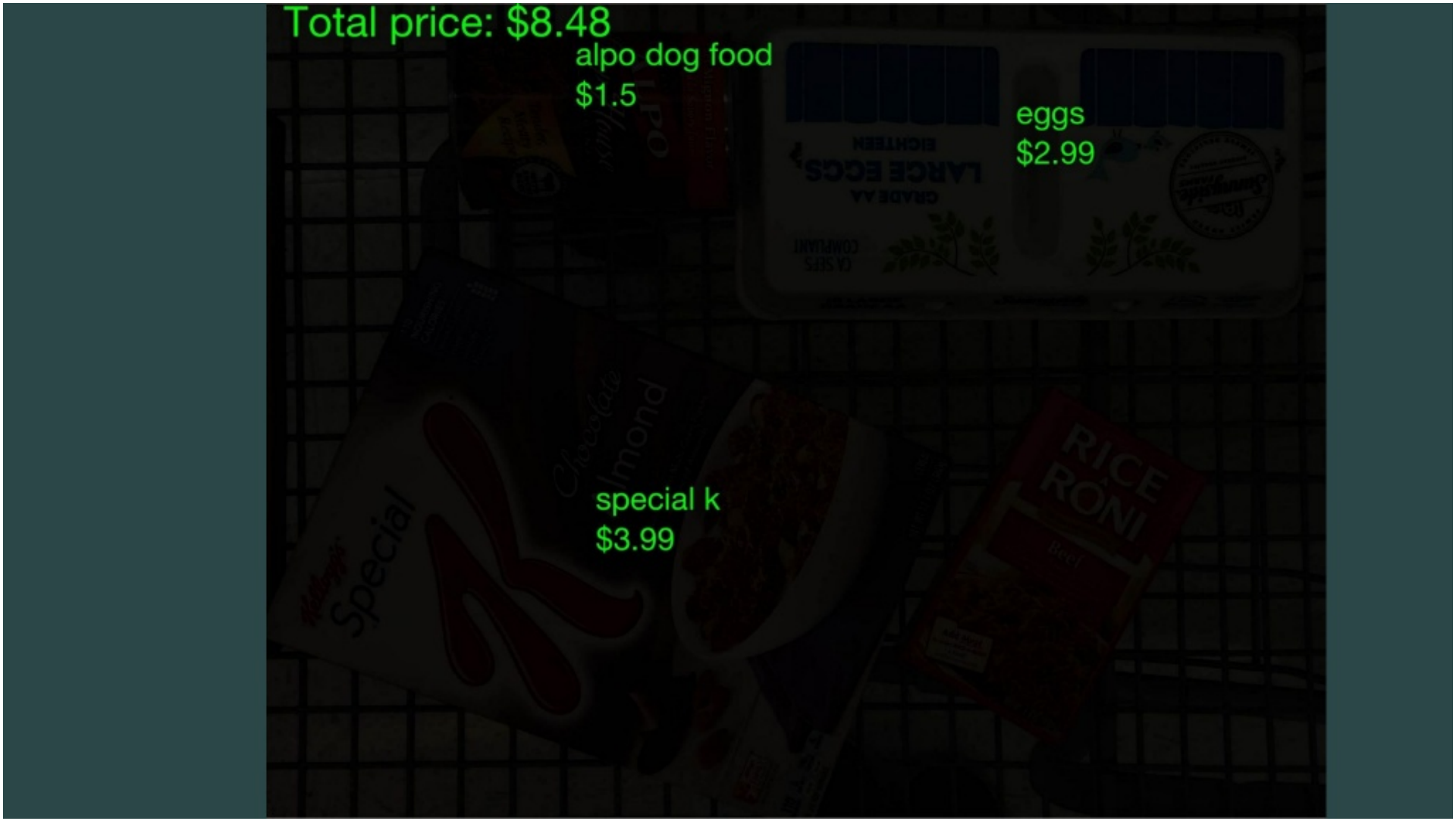

Total: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5


Total: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

Extreme Low Lighting

(breaking point)




Total price: $8.48
alpo dog food
$1.5
eggs
$2.99
special k
$3.99

Colored Light Normal


Total Price: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

Colored Light (Dark)


Total price: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

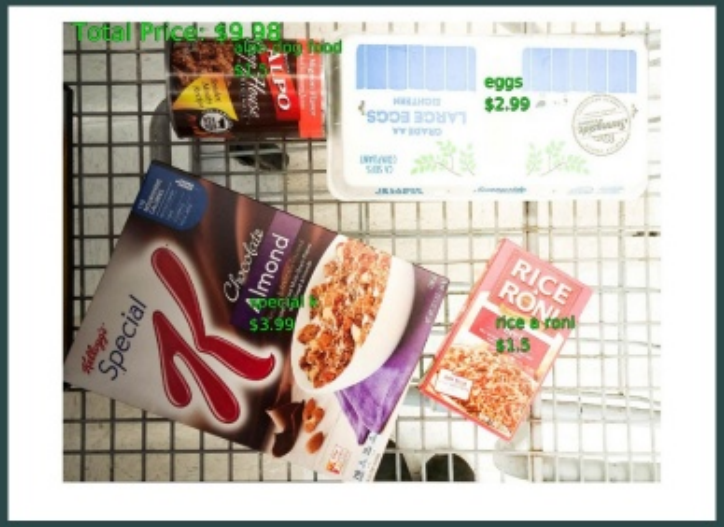
Colored Light (High Exposure)


Total: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

Gradient (Bottom to Up)


Total: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

Light with Gradient (Right to Left)




Total Price: $9.98
alpo dog food
$1.5
eggs
$2.99
special k
$3.99
rice a roni
$1.5

Highly Exposed Image

(Breaking Point)


Total Price: $17.38
eggs
$2.99
Mixed Fruit Juiceb
$8.9
special k
$3.99
rice a roni
$1.5

Oblique

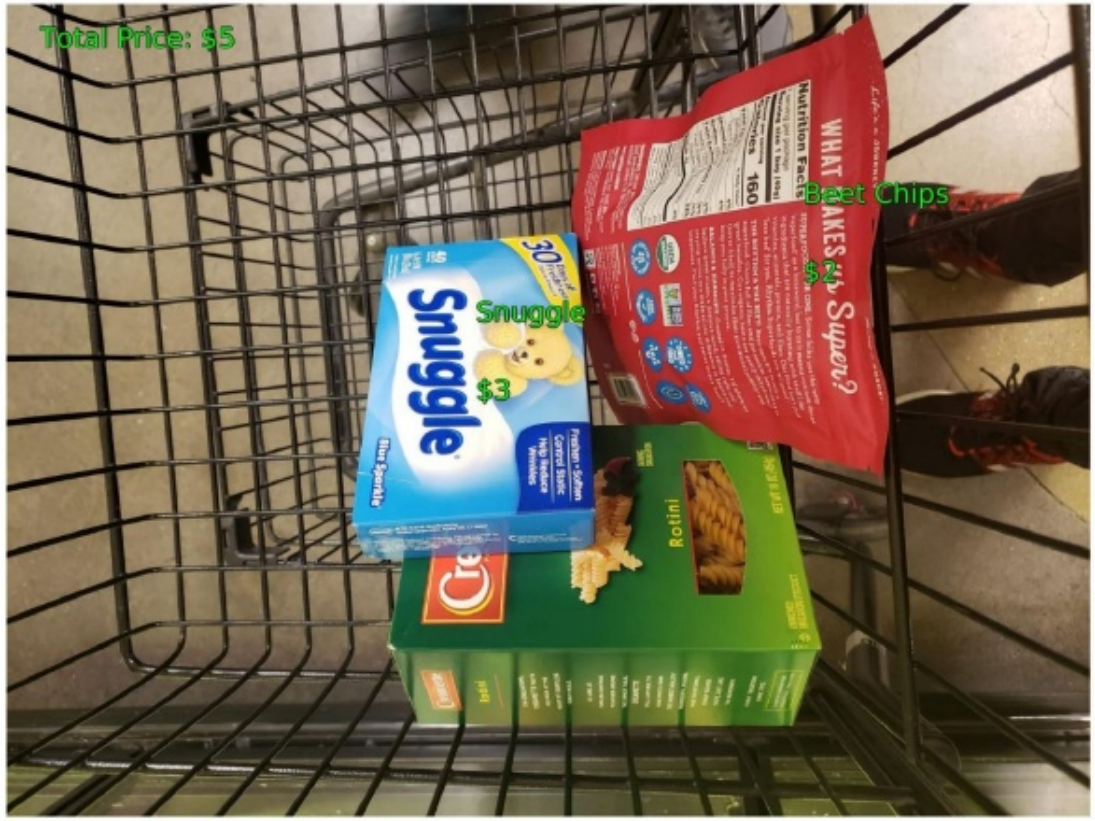
SIFT is partially accurate with Oblique images

All Detected

1 item not detected

All Detected

1 item not detected



Carts with missing Database items

Sharpie was not present in the database and hence not detected


Total Price: $11.26
scotch tape
$4.99
matchbook
$2.29
forks
$1.29
glue
$2.69

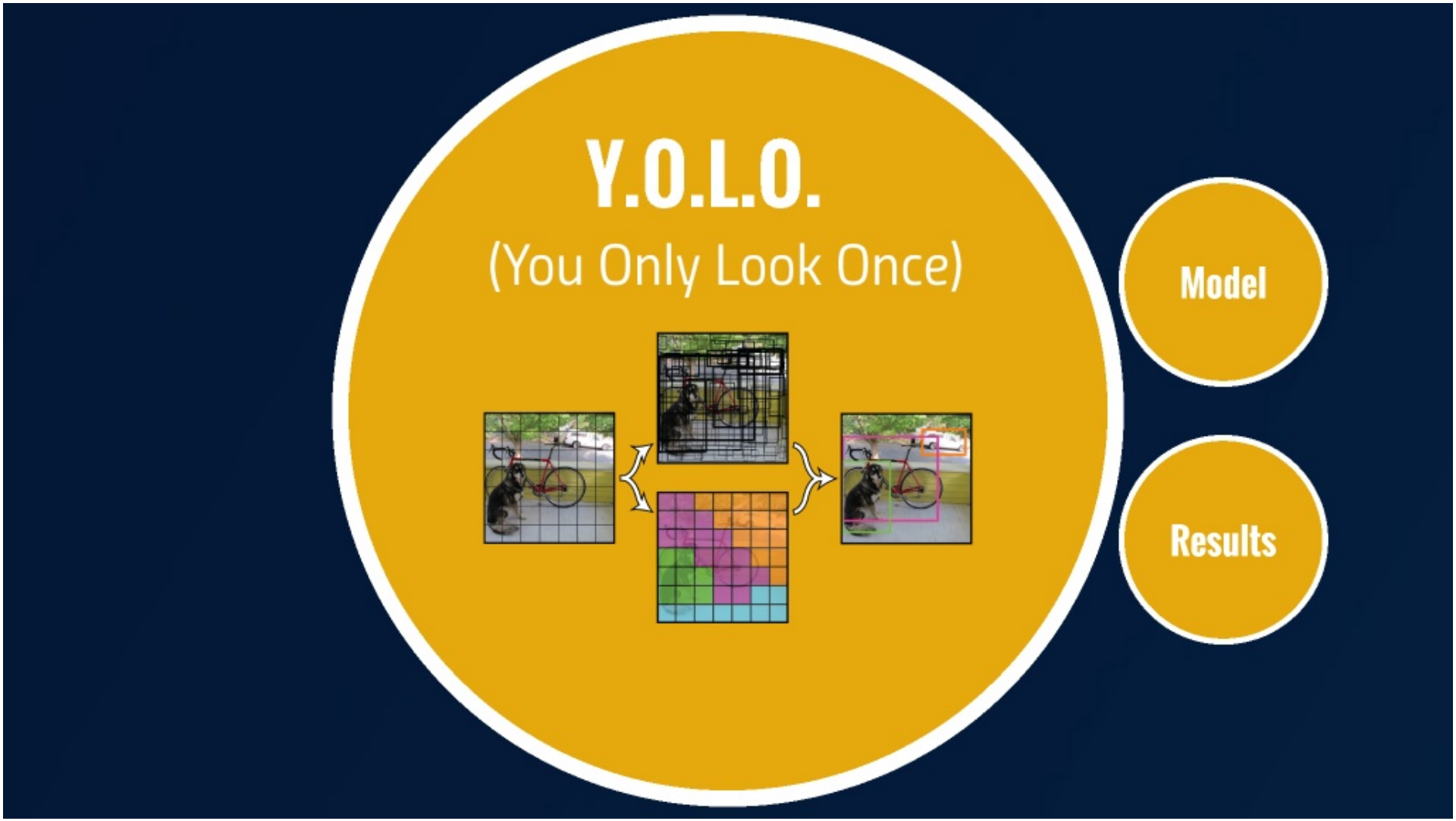
Cart with false positive and false negative detection


Total price: $40.26
toothpaste
$4.29
sausage
$9.99
curling iron
$16.99
hair dye
$8.99

Multiple detection for the same item


Total price: $18
Fininsh Detergent
3 STEPS FOR PERFECT RESULTS
$9
ADD
Fininsh Detergent
finish
$9
DEEP CLEAN
NATURE
GLUTEN-FREE
Classic


YOLO
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About


Y.O.L.O.
(You Only Look Once)
Model
Results

Our Model

Dataset: 1 Class, 'Beet Chips'
Size: ~ 600 images
Training time: 300 epochs

--image dalna hai--

Results

Confidence Percentage: %

Insert image here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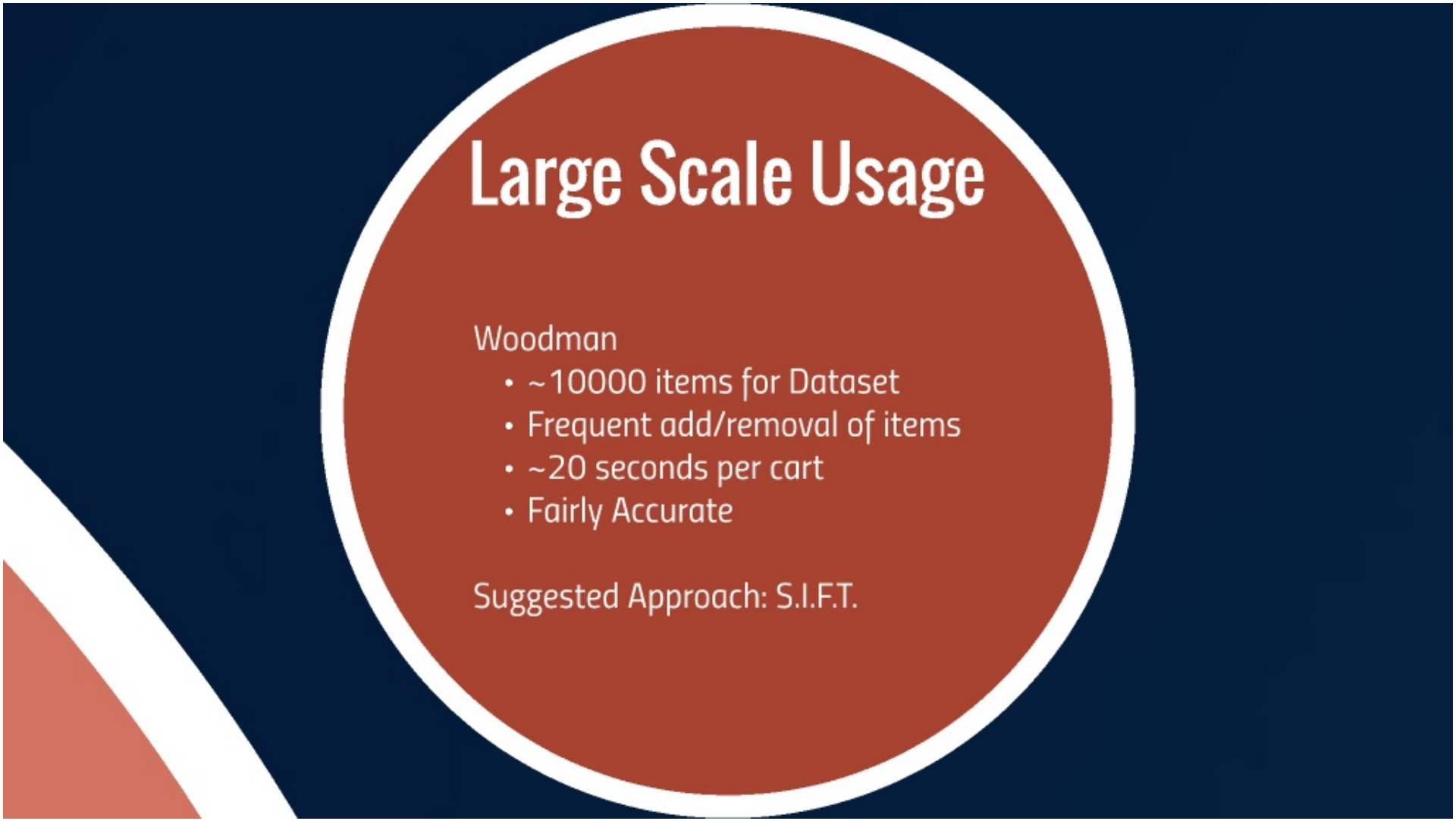
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About


Case Studies
Potential Customers and major criterias:
1. Large Scale Usage
2. High Accuracy
3. Real Time & High Speed
4. Low on Data
1
2
3
4


Large Scale Usage
Woodman
• ~10000 items for Dataset
• Frequent add/removal of items
• ~20 seconds per cart
• Fairly Accurate
Suggested Approach: S.I.F.T.

High Accuracy

For places such as Amazon Go Stores

- Dataset and Computing Power are not an issue
- Accurate and robust to Light, oblique and the orientation of the object.

Suggested Approach: Neural Networks

Real Time and Accurate

Automated Warehouses:

- The Camera keeps clicking pictures of objects on the cart(Delivery boxes) which move at a very high speed and needs to be accurate.

Suggested approach: YOLO

Low on Dataset

Small Utility stores such as Triangle Market do

- ~1000 items per database
- decent computation power
- easy to setup and use(By the non CS shop owner)

Suggested approach: SIFT


YOLO
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About

Conclusion

We have provided a comprehensive analysis of both, a State of the Art Neural Network and an algorithm developed in 2004 and give the customer the option to choose with respect to his requirements, time complexity and usage.

Future Work

- Improve Accuracy
- Use YOLO with a larger dataset
- Make SIFT Robust to Oblique by adding all sides of the item into one.
- Lower the computation time by optimizing the algorithm
- For SIFT, every face of the object is a new image and this results in multiple object detection within the same item
- Make algorithm to detect small yet significant changes such as a back of an item

Thank you!

- Akshat
- Kundan Kumar
- Swati Mishra


YOLO
Case Studies
Conclusion
Y
O
S
C
?
Grocery Item Detection
Testing
SIFT
About