Enabling Smart Retail with Visual AI

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365 Retail Markets

What is Unattended (Smart) Retail?

Vending Machine

Cashier-less Store

Micro-Market

Customer scans products one at a time, then pay using POS terminal in the market

AI Micro-Market

Customer pre-authenticates to enter the store, take products and leave

Self-Service Kiosks

Self check out

Customer scans barcodes one at a time and pays

CV-AI smart machines

Customer unlocks kiosk with credit-card, takes products and walks away

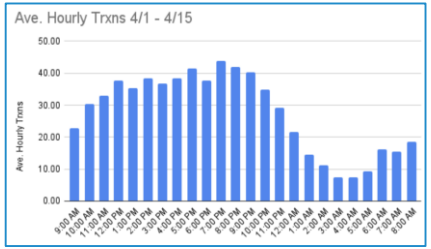
Why is Unattended Retail Taking off?

Labor Shortage

US Retail Workers Are Fed Up and Quitting at Record Rates
- **Bloomberg News Sep 8, 2023**

30% of retail jobs are unfilled
- **U.S. Chamber of Commerce, June 2023**

24/7 Anywhere



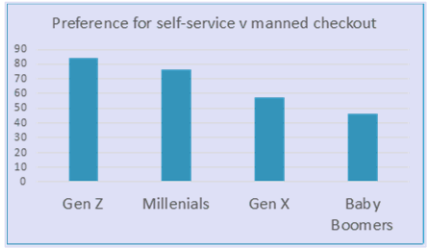
Manufacturing

Warehouses

Gig-economy

Varied Products

Customer Preference



66% prefer self checkout

14% will wait for SCO!

Health, hygiene, and beauty products

CV + AI + Retail

Inventory

Foot Traffic

Spills

Fraud

Queue lengths

Product Identification

365 Retail Markets

Empowering Global Retail By Creating The Most Innovative, Market-leading Technologies

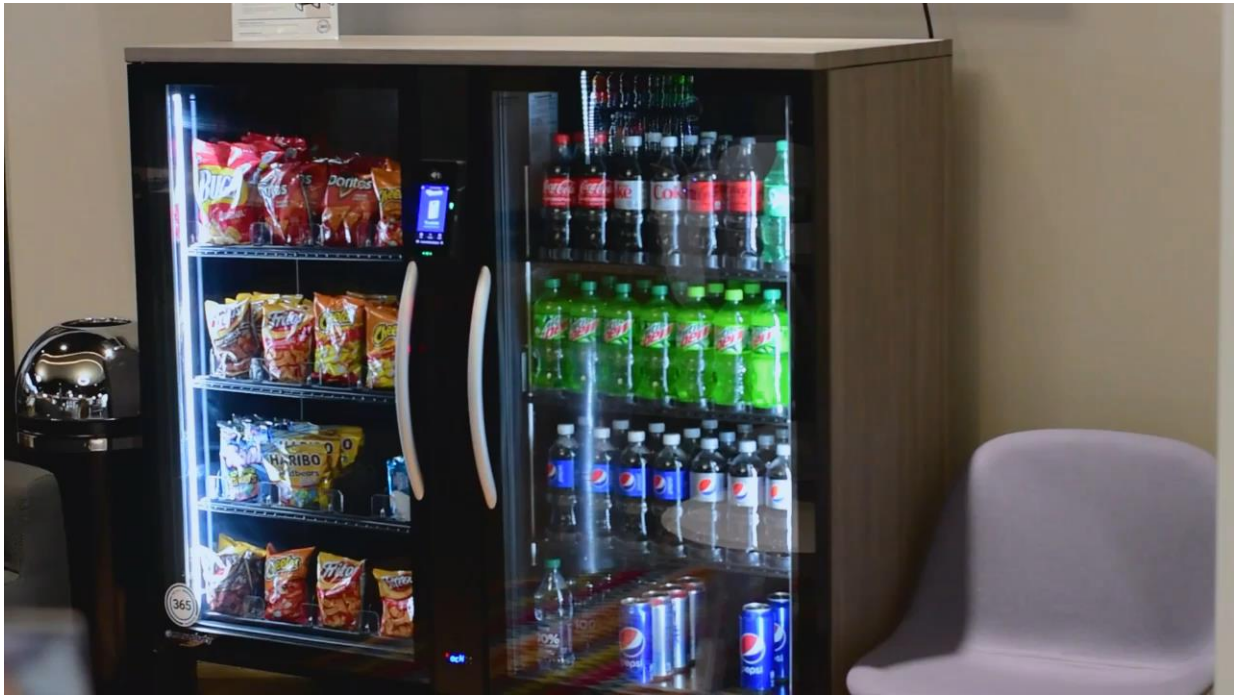
CEO and Founder

Joe Hessling

- Largest Unattended Self-Checkout Technology Provider in the world
- 500+ Employees
- Over 50,000 Points-of-Sale worldwide
- Operations in 30 Countries – and growing!
- Award Winning Company with Great Products and Great People!

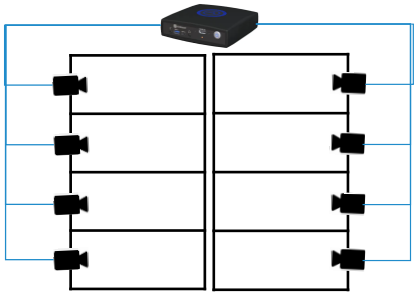
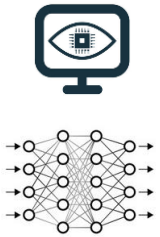
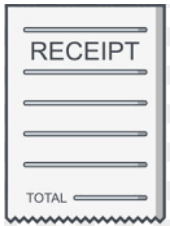
Product Portfolio

Stockwell 2.0



https://www.youtube.com/watch?v=-uPv4IA24pE

Transaction Flow

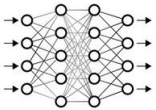
Authenticate	Record Transaction	AI Recognition	Receipt
			
Credit card Digital wallet App	Multiple cameras Save video on device	Edge Cloud Hybrid	Auto-charge Manual review

AI Inference Pipeline

Multiple camera feeds

Object detection per camera frame

Aggregating ‘object crops’ from multiple cameras



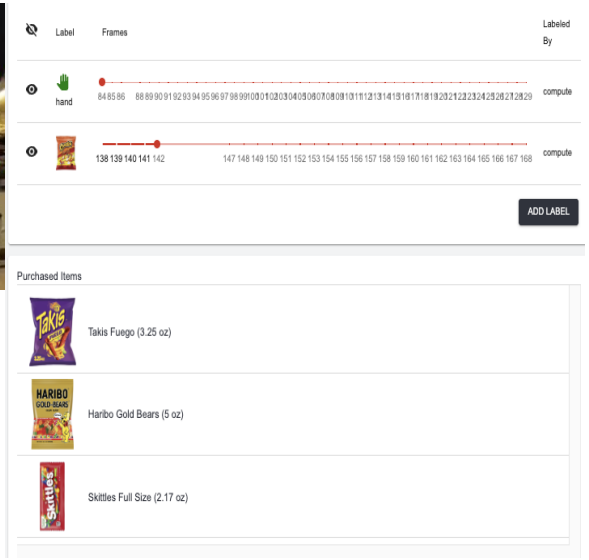
Classification model

Identify item

Why not use a single-shot detector?

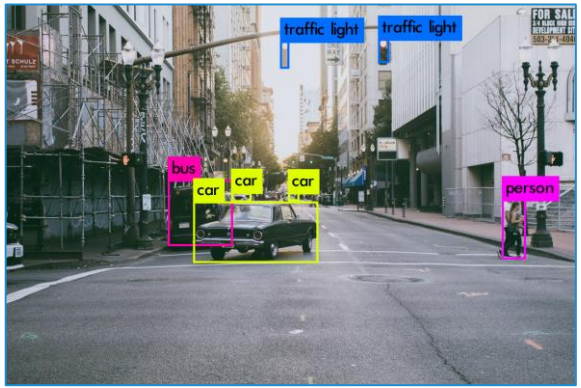
AI Labeling Pipeline

- Inline labeling for transactions
  - Low confidence
  - Not enough training samples
- Manually reviewed transaction
  - Use receipt items as a guide
  - Use detection boxes
  - Relabel items
- Use statistics for retraining



Self Driving vs Retail Object Recognition

Self Driving



Objects of interest do not vary

Latency is critical

Generous sensor, compute budget

No second chances

Product Recognition

Ever expanding product catalog

Some delay acceptable

Very cost conscious

Fallback is to manually review

Challenges in Object Recognition

Motion Blur

Color Distortion

Occlusions

Similar Packaging

Small Sizes

Seasonal Packaging

Make it Harder! — Do it in Real Time

Why real-time?

Confidence for new customers

Easily find item prices

Promotions and subsidies

Why edge processing?

Real-time identification

Cellular bandwidth cost/GB

Smarter use of compute resources

Technical challenges

Streaming high-resolution, high frame-rate videos from multiple cameras to the PC

CPU cycles to handle kiosk functions while recording/processing video-streams

Model management

AI-CV Kiosk Design

Sensing

Only Cameras

or

Additional Sensors?

- Weight

- Time of Flight

Compute

Cost

CPU

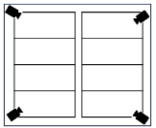
GPU / TPU / ?

#USB ports, PCIe

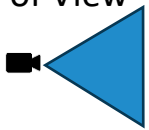
Cameras

Placement

Number



Field of View

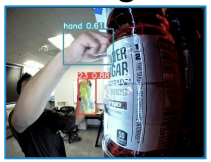


Frame-rate

Resolution

AI

Training Data



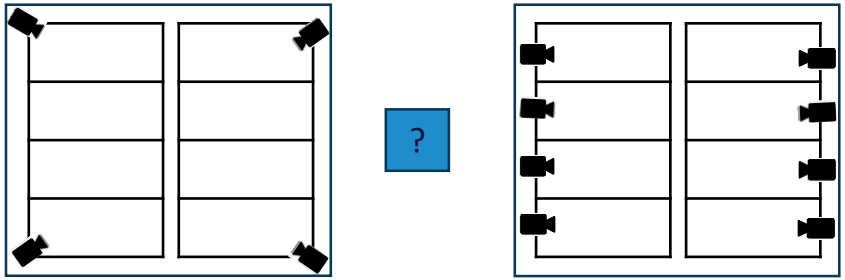
Partition the Catalog

Deployment

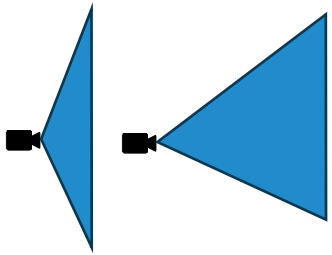
Update Strategy

Camera Considerations

Camera Placement



FOV



Resolution

#pixels on target

Compression through the video and AI pipeline

Imaging Parameters

Frame-rate, resolution

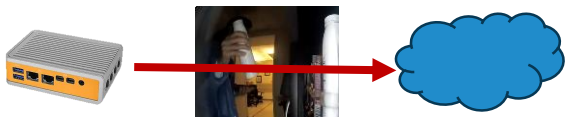
Global / rolling shutter

Gain, color correction
Anti-fog lenses

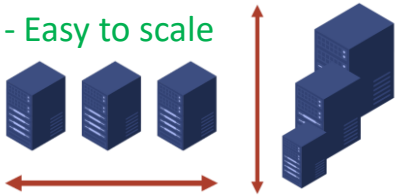
AI Considerations — Compute

Cloud

- Device only uploads video



- Easy to scale



- Longer receipt time

- Bandwdith

Edge

- Instant feedback

- Lower operational cost

- High upfront cost

- Hardware selection is critical

- Tuning software

- Model management

- Inflexible

Hybrid

- Store only uploads ‘clips’

- AI processes run on cloud

- Best of both worlds

- No live feedback

AI Considerations — Model

Model Training

Partition catalog

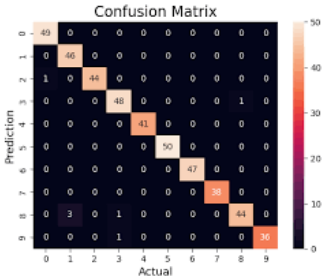
Data collection
- Alpha stores
- Augmentation
- Label quality

Model selection
- Model capacity
- Inference time

Model Update

Why update?
- Add new products
- Improve performance on existing products

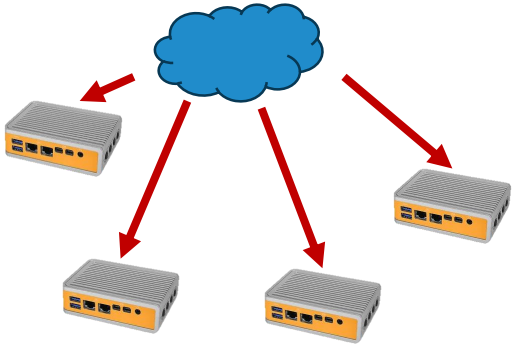
Metrics
- Quantify improvement
- Tradeoff performance on existing vs new items



Model Deployment

Trivial for the cloud
- One place to update
- Easy to monitor perf.

Edge considerations
- Cost to deploy



Enablers

Custom Industrial Computers

Work with integrators to customize every aspect of the PC

- USB ports
- Image
- GPU
- CPU

Data Labeling Platforms

Managed labeling platforms

- Data hosting,
- Labeling tools
- Managing labeling teams, QA

or

Offshore contractors

- Provide your own platform
- Train and manage workforce
- QA

AI Platforms

Complete solution for data labeling, augmentation, model training, optimization, versioning, …

Opportunities

Cameras and Lenses

- High speed
- Moderate resolution
- Global shutter
- Firmware control
- Fog resistant lenses

Sensors

- Time-of-flight
- Weight
- What else is out there?

Compute

- Reasonably priced edge compute — per camera or multi-camera
- Existing pipeline of cameras and edge processing

Generative AI for Training Data

- Transactions with “unknown” items have to be manually reviewed
- Takes multiple transactions to collect the data, followed by training and deployment
- Would like recognize a new item on the very first transaction
- However, training the model requires data from live transactions
- Question?
  - Given a stock image of an item, can we generate data of people’s hand holding and moving the item?

Conclusions

Unattended retail is rapidly expanding

Vending machines → Smart kiosks

Sleek machines → New venues

Small format stores at transit locations

Stores within stores

Overlap with other markets

Attended retail

Restaurants

Classrooms and schools

Machine vision

Opportunities

Cameras

Compute

Video pipelines

AI pipelines

Retail product identification as a service

Questions?

Resources

- Company websites
  - 365retailmarkets
  - Stockwell
- About us
  - Facilities
  - What we do
- Product Spotlights
  - PicoCooler
  - PicoCooler Breeze
  - PicoMarket
  - Stockwell 2.0
  - MM6 – MicroMarket Kiosk
  - Order Ahead for Cafeteria Dining