

Edge Vision AI for Loss Prevention at Self-Checkout



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Loss Prevention at Self-Checkout: How?

Vision



Object-based

- rely on objects
- abnormal behaviors



Behavior-based

- detect abnormal behaviors
- cannot recognize objects

Sensor



Barcode Scanner

- scanned item info.

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Sensor

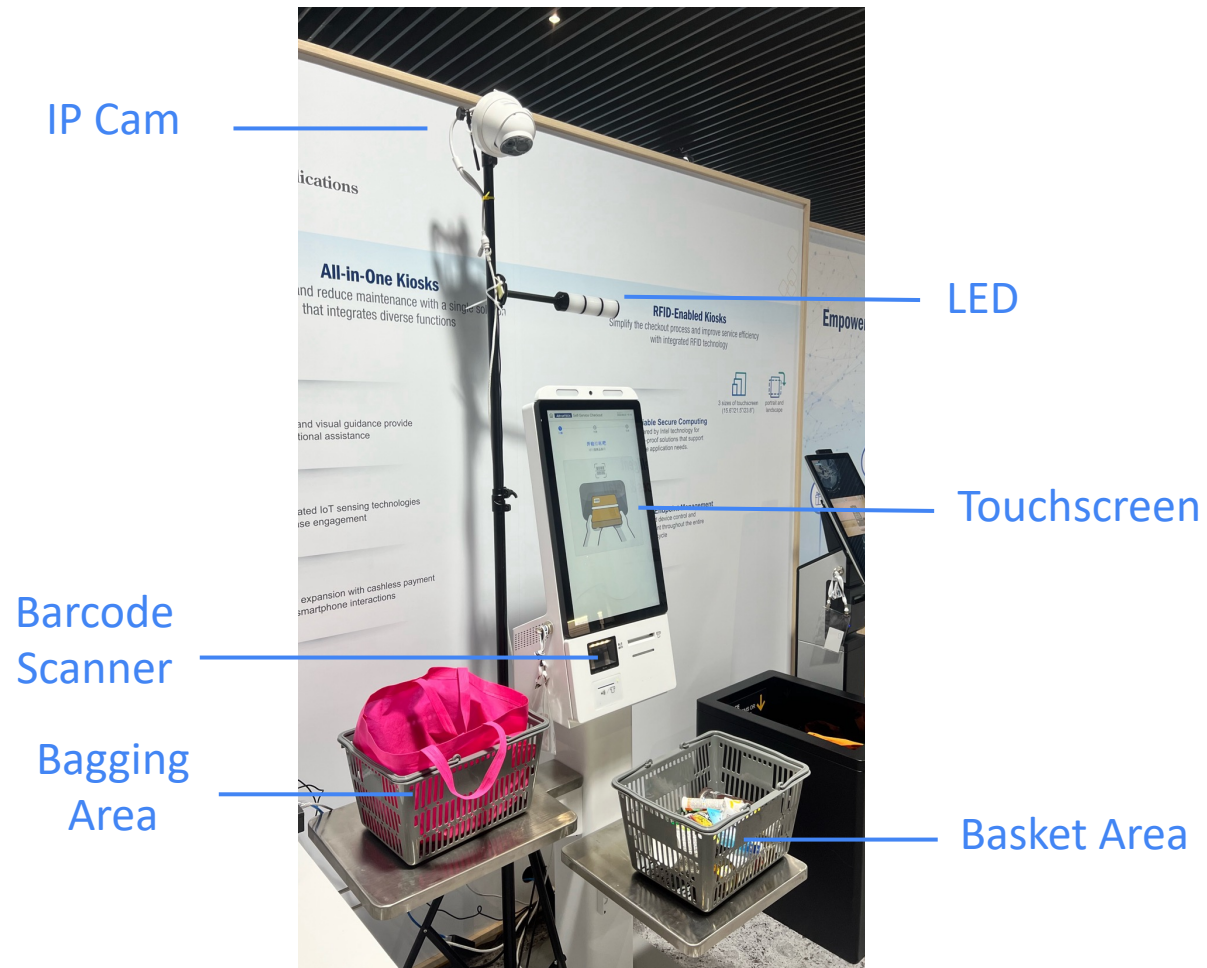


Barcode Scanner

- scanned item info.

My Project Scope

System Setup



Model No: UBX-310

- Intel Core i3-6100U CPU@2.30GHz

- Intel HD Graphics 520

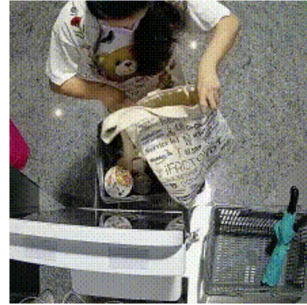
Self-Checkout Behaviors



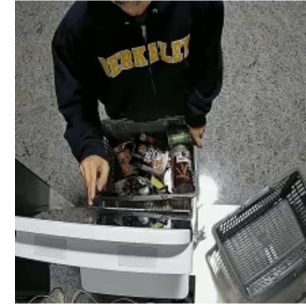
Background



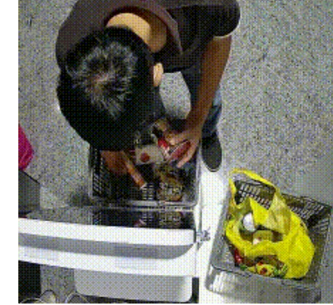
Entry



Bag Operation



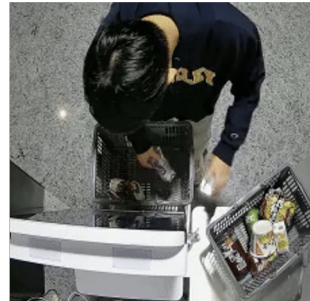
Machine
Operation



Item
Pickup



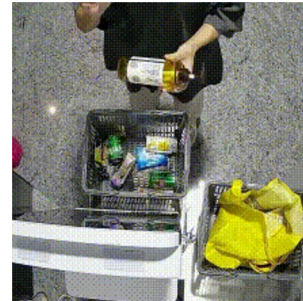
Normal
Scanning



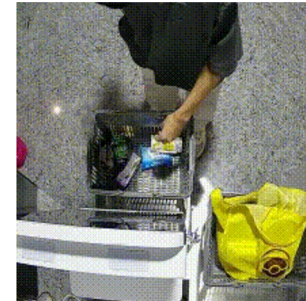
Skipping



Two At A Time



CoverUp

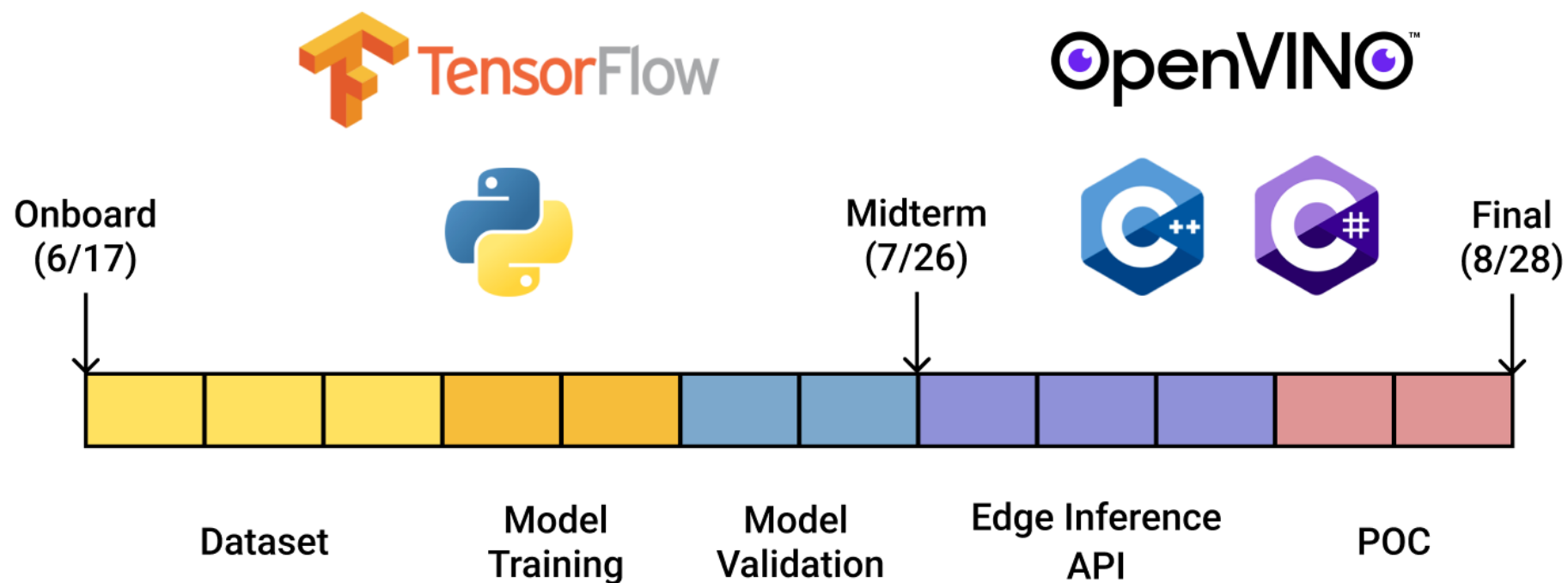


Hiding Behind

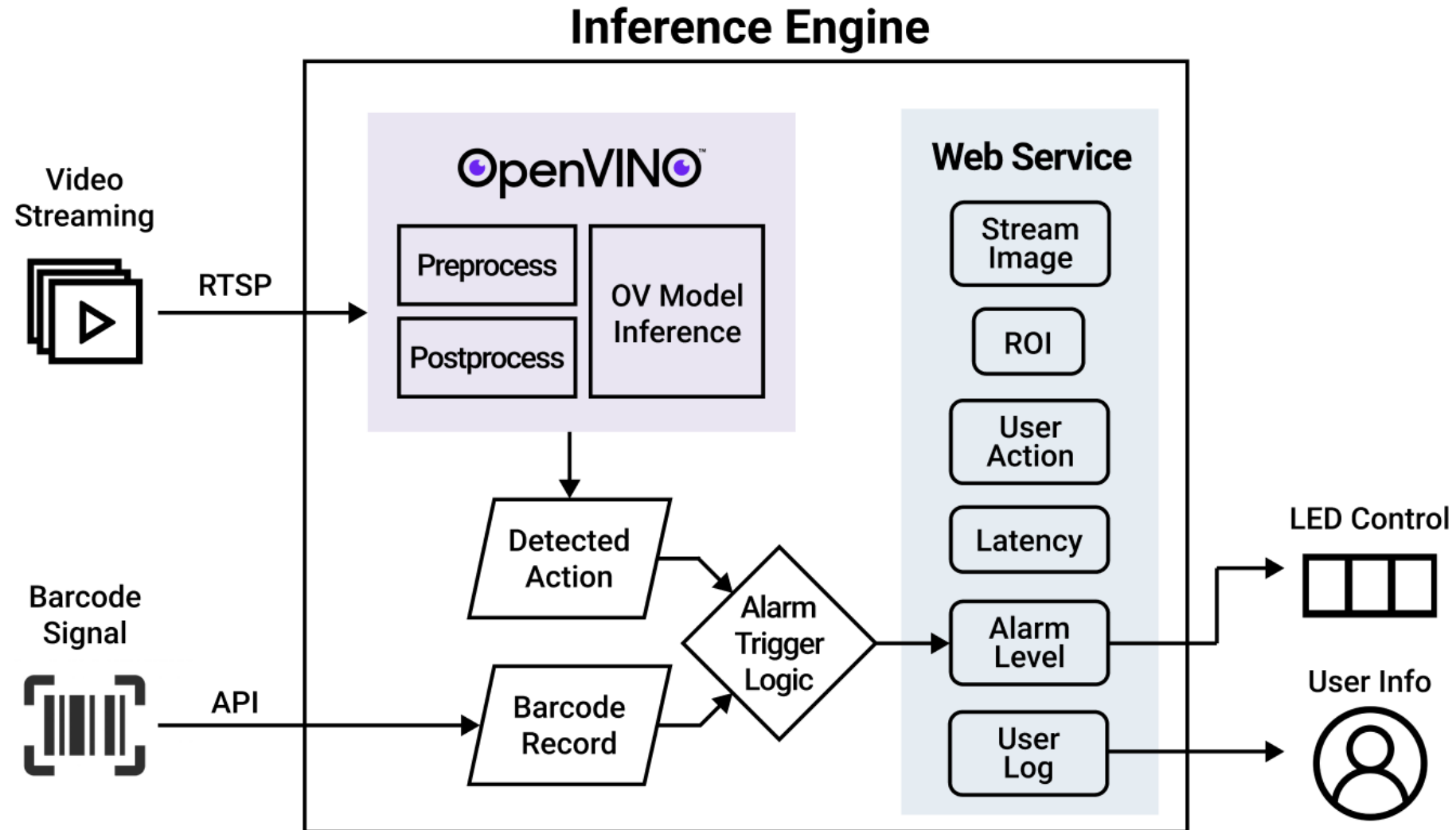


Leaving

Project Timeline

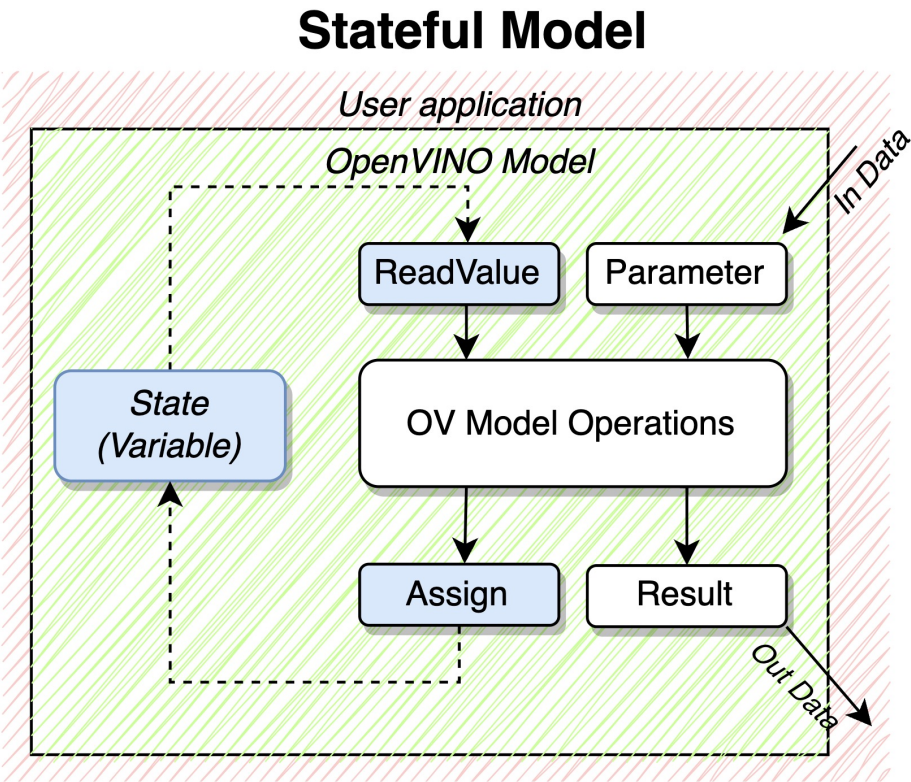


System Architecture



AI Inference Engine

Framework	OpenVINO
Language	C++
Model	MoViNet-Stream-A2
Input Source	IP cam via RTSP
APIs	api/stream/ api/detect/ api/getroi/ api/setroi/ api/barcode/input



Alarm Level Determination

		Action Detected			
		Normal Scanning	Skipping / Coverup / Hiding Behind	Two At A Time	Other
Barcode Signals	2+	Safe	Safe	Safe	Safe
	1	Safe	Warning	Danger	Safe
	0	Warning	Danger	Danger	Safe

AI Model Performance

	Safe	Warning	Danger
Normal Scanning	84%	14%	2%
Skipping	31%	52%	17%
Coverup	9%	24%	67%
Hiding Behind	2%	17%	81%
Two At A Time	19%	24%	57%

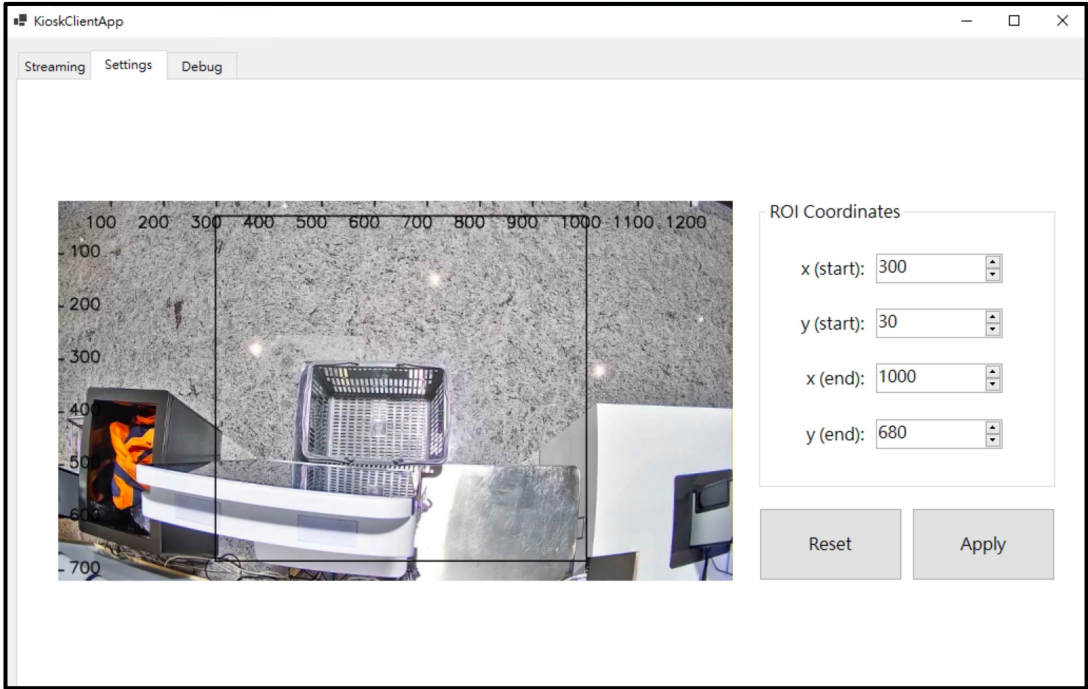
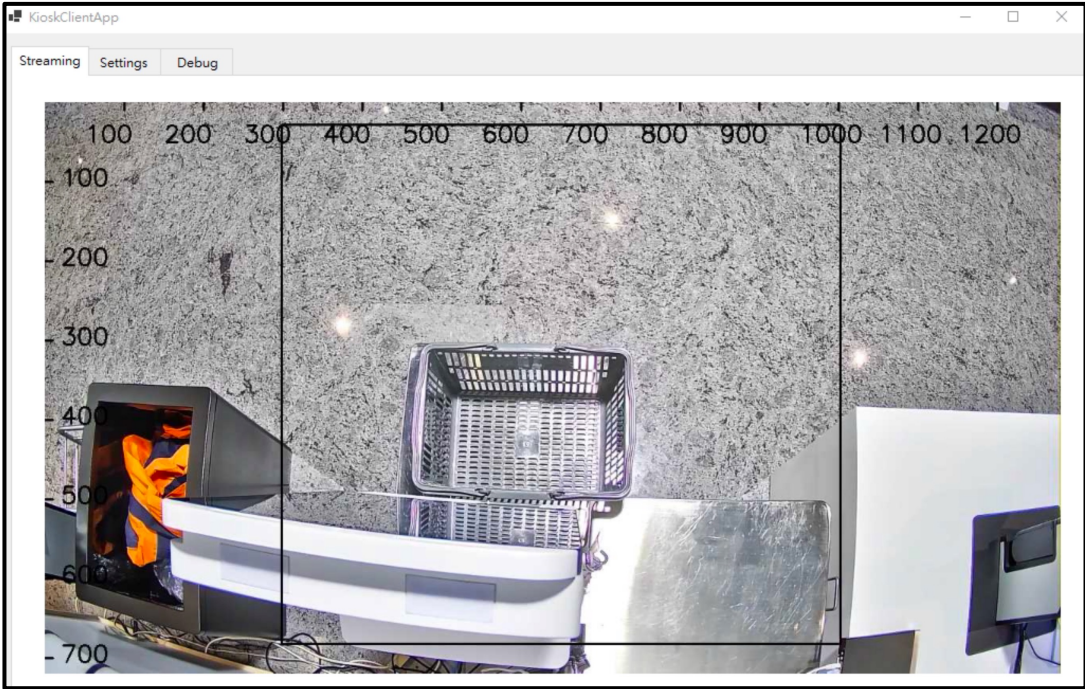
False Alarm Rate (誤報率)	2%
Precision (精確率)	99%
Detection Rate (異常行為檢出率)	56%

Hardware Performance

Framework	Processors	Inference Time	Process Time	CPU Util	GPU Util
TensorFlow (Python)	CPU	115 ms	115 ms	55%	-
OpenVINO (C++)	CPU*	SPEED UP 2.7 X !! 42 ms	63 ms	52%	-
	CPU+iGPU	172 ms	194 ms	46%	32%

- Intel Core i3-6100U CPU @2.30GHz / Intel HD Graphics 520

Video Stream Viewer and Config Tool



User Self-Checkout Record

Timestamp

```
-----
[2024-08-23 14:03:01] user 0001 enter
[2024-08-23 14:03:06] action: Two At A Time, barcode: 0, alarm level: 2
[2024-08-23 14:03:08] action: Bag Operation, barcode: 0, alarm level: 0
[2024-08-23 14:03:10] action: Bag Operation, barcode: 0, alarm level: 0
[2024-08-23 14:03:11] barcode type: code128Barcode, value: 7471024001170
[2024-08-23 14:03:15] barcode type: code128Barcode, value: 9471058731630
[2024-08-23 14:03:16] action: Normal Scanning, barcode: 2, alarm level: 0
[2024-08-23 14:03:18] action: Normal Scanning, barcode: 1, alarm level: 0
[2024-08-23 14:03:20] action: Normal Scanning, barcode: 0, alarm level: 1
[2024-08-23 14:03:22] action: Coverup, barcode: 0, alarm level: 2
[2024-08-23 14:03:25] action: Bag Operation, barcode: 0, alarm level: 0
[2024-08-23 14:03:27] action: Item Pickup, barcode: 0, alarm level: 0
[2024-08-23 14:03:28] barcode type: code128Barcode, value: 7471023500010
[2024-08-23 14:03:29] action: Machine Operation, barcode: 1, alarm level: 0
[2024-08-23 14:03:31] action: Normal Scanning, barcode: 1, alarm level: 0
[2024-08-23 14:03:35] barcode type: code128Barcode, value: 7471587230086
[2024-08-23 14:03:37] action: Item Pickup, barcode: 1, alarm level: 0
[2024-08-23 14:03:39] barcode type: code128Barcode, value: 3471008841161
[2024-08-23 14:03:42] barcode type: code128Barcode, value: 7462837262717
[2024-08-23 14:03:43] action: Normal Scanning, barcode: 1, alarm level: 0
[2024-08-23 14:03:44] barcode type: code128Barcode, value: 3948726153627
[2024-08-23 14:03:46] action: Normal Scanning, barcode: 2, alarm level: 0
[2024-08-23 14:03:48] action: Normal Scanning, barcode: 1, alarm level: 0
[2024-08-23 14:03:50] action: Two At A Time, barcode: 0, alarm level: 2
[2024-08-23 14:03:51] action: Bag Operation, barcode: 0, alarm level: 0
[2024-08-23 14:03:53] action: Normal Scanning, barcode: 0, alarm level: 1
[2024-08-23 14:03:56] action: Machine Operation, barcode: 0, alarm level: 0
[2024-08-23 14:03:58] action: Leaving, barcode: 0, alarm level: 0
[2024-08-23 14:04:08] user 0001 exit
[2024-08-23 14:04:08] checkout time spent: 1m 58s
[2024-08-23 14:04:08] barcode scanned: 7
-----
```

Action, Barcode, Alarm Level

Barcode

Total Time

Items Scanned

Demo Video

*Edge Vision AI for Loss Prevention
at Self-checkout Kiosk*

SW Intern I Po-Lin Chen

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