Automated Computer Vision Inspection System for Conveyance

Team #5

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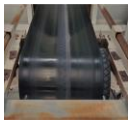
Background

Amazon houses on average 11-22 miles of conveyance belts per fulfillment center, the belt failure increases downtime and costs millions of dollars.

Belt Rips



- A **belt rip** occurs when the belt separates or tears apart, causing a complete belt failure
- Package damage or other abrasions can cause rips and tears in the belt
- **Splices** are staples joining a belt together, which are susceptible to damage and can become weak points that may result in a rip

Belt Tracking

- **Belt tracking** is when the belt veers off-center and rubs against the conveyor frame or other components, causing premature wear and damage to the belt
- Misaligned belts account for 15% of all mechanical failures in Amazon's conveyance systems

Material Defects

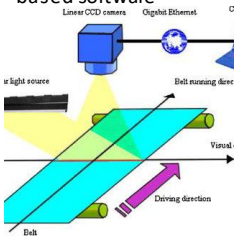
- **Material defects** such as cuts, gouges, and tears can cause belt failure

Scope of Work

- ✓ Detects rips, material defects, alignment
- ✓ Affordable (BOM <= $400)
- ✓ Non-Invasive
- ✓ Recommend maintenance from KPIs

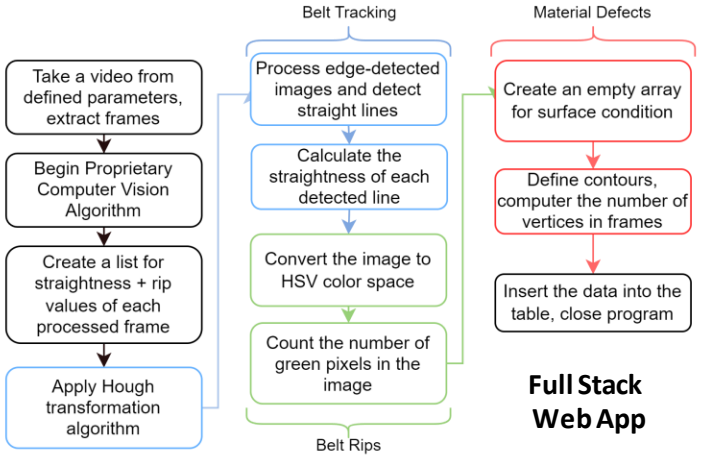
Existing Solutions

Existing solutions for conveyor belt failure mode detection at Amazon sort centers mainly rely on regular walkthrough inspections by maintenance personnel. Other systems at Amazon, such as sensors that detect changes in temperature, vibration, or motor current, do not monitor belt health or generate a predictive maintenance report utilizing vision-based software



Hardware & Software

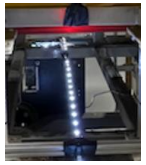
Initial Experiment	 XBOX Kinect		
Testing Hardware	 Raspberry Pi 3B	 Logitech Camera	
Final Design	 NVIDIA Jetson Nano	 USB 1080P Wide Angle	

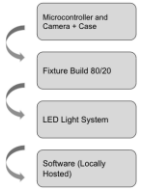


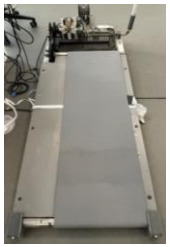

```
├── requirements.txt
├── results.db
├── run.py
├── Edge/
├── Frame/
├── Rips/
├── Surface_defects/
├── template_folder/
│   ├── results.html
│   ├── data.html
│   ├── index.html
│   └── navbar.html
└── app.py
```

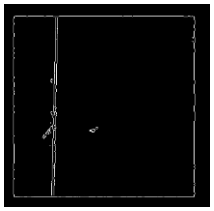
Testing

Camera Vision	Pros	Cons
ELP 2.0 MP USB Camera	• 120fps • Inexpensive: $60> • Wide Angle Lens • Ease to Use • Compact	• Only 720P at 120fps
NVIDIA Jetson Nano	• High Processing Power • Many different ports • Small Footprint	• Can be difficult to use • Expensive
Raspberry Pi 3B+	• Small Footprint • Inexpensive	• Very Slow
Logitech Desktop External Camera	• Inexpensive • Easy to use	• Requires a PC • Low frame rate and low resolution
Kinect 360 Camera	• Free	• Bulky • Low resolution
High Speed Camera Attachment	• Best framerate • Best Resolution • Compact	• Extremely Expensive

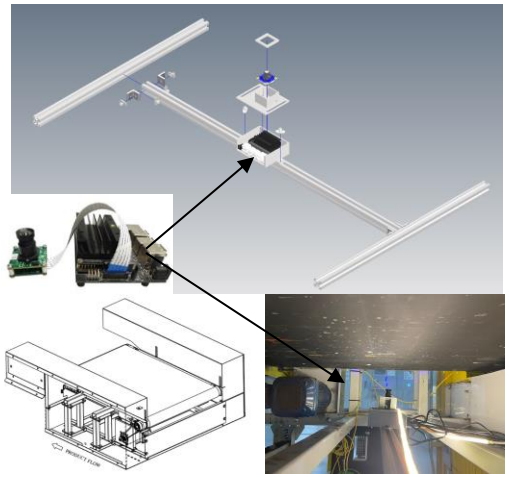


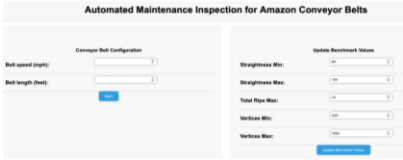






Final Design



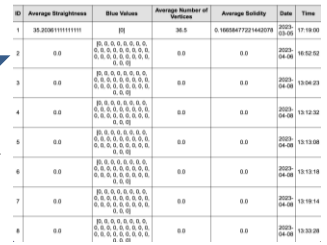


Predictive Maintenance Report

The belt is in bad condition and requires maintenance.

Performance

Metric	Value	Benchmark	Performance
Average straightness value	9.738206374955682	80-100	Bad
Total number of rips	0	less than 10	Good
Average overall surface condition	31.781818181818181 vertices	500-1000 vertices	Bad



Belt tracking
Vertical alignment within predetermined margin.

Surface Condition
Material (amnesty), belt surface condition

Belt Rips
Rips are illuminated by an isolated light beam between the belt

Locally hosted website
easily accessible, informative, configurable belt portal

Automated Maintenance Inspections
Alerting technians of major defects, with delicate reminders of minor defects.

Results are saved to a database after auto and manual run. Able to store 5+ year of data