Defect Detection System
Final Presentation

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by
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Objectives

- Design electronic testing equipment to detect individual and patterned flaws in the blankets.
- Notification must be activated when the testing equipment detects an unacceptable situation.
- Testing equipment must be designed such that it can be installed in the machine without disrupting the manufacturing process.
- Defect is identified before it reaches the stitching area and becomes permanent.
- Minimize danger with interaction of dust.
Functions and Specifications

Detection

• Lighting - Low heat emission, dust proof, more intense than ambient light such that it provides enhancement of image for analysis.

• Filtration - Create a color differential between the product and the belt to provide the most contrasted image for analysis.

• Camera – Must provide steady video stream of blanket as well as operate in the dusty production environment.

• PC – Captures information from camera and perform real time analysis of data.
Alert

• PC – Send signal to communication circuit and provide real time on screen feedback of image and defect analysis.

• Communication circuit – Serves as the interaction between PC and machine relay.

• Relay – Accepts signal from communication circuit to activate visual alert.

• Visual alert in production – Once activated by relay, provides a luminous alert of defect.

Halt machine

• Communication circuit - Serves as the interaction between PC and machine relay.

• Relay – Accepts signal from communication circuit to halt all machine function.
Design Evolution

- Lighting
- Filtering
- Camera
- Hardwire
- Machine
- Relay
- Communication Circuit
- PC
Lighting and Filtration System

Lighting → Filtering → Camera → Hardwire

Machine ← Relay ← Communication Circuit ← PC
Coco Image Analysis

Before  Lighting Effects  Filtering Effects  Resultant Image
Software Design

- Two Separate threads of execution
- Main (messaging) thread – Directing operations and Calibrations
- Scanning thread – Used to search for defects every tick of the timer
Image Analysis

Lightinng → Filtering → Camera → Hardwire

Machine → Relay → Communication Circuit → PC
Start Defect Scanner Program

Initialize Parameters / Draw Main Window

Create Scanning Thread
- Handle defect size modifications
- Handle Threshold modifications
- Handle Contrast modifications
- Handle Masking Image

Scanning Thread
- Grab image
- Convert image data
- Modify image data (Compress blocks)
- Compare compressed image data to Threshold
- Report defects
- Send stop signal to relays
Evolution of Design

- Originally planned for Linux or console mode
- Planned 2 scanning threads
- One PC checking 2 machines
- Considered direct communication with digital camera
- Wireless communications
- Possible use of Touch-Screen
Actual Implementation

- Windows Application by request of client
  - Needs no keyboard to use
  - Allows graphical user interface
- Uses only 1 scanning thread
- Analog camera signal transmitted to computer via coax cable
  - Simplifies design, reduces interference
- Uses Matrox image capture card
Compression of Data

- Image data is captured and compressed
- Squares of a given dimension are compressed into a single value. (All the pixels are summed and the value stored into an array of compressed data)
- The compression occurs in 2 steps
  - Horizontal summing
  - Vertical summing
Compression Mapping
Adjusting Contrast

• Increasing Contrast means improving the system’s sensitivity to defects.

• Too high of a Contrast setting may result in spurious defect notifications.

• If Contrast settings are too low, most defects will go undetected.
Contrast Adjustment Screen
Threshold Adjustment

- Threshold compares the number of pixels that are dark in a compressed slot with the minimum number to declare it defective.
- If the Threshold has a high value, it will take a higher number of bad pixels to trigger a defect report.
- Too low and it will report too many defects
Threshold Screen
Defect Size Selection

- The ability to select defect size was added to allow more flexibility.
- The default dimensions are 85x85 pixels, which corresponds to a defect of approximately 8” in diameter on the blanket.
- Range of selection is from 50 to 100 pixels.
Defect Size

- If the defect size is changed, it will require changing the Threshold value too.
- This feature was added to allow adjustments in the future based on changing specifications, and also to allow for use on different products.
Defect Size Screen
Frame Selection

• To prevent scanning of objects other than the blanket, a selection to set the search area is provided.

• This allows masking out the dust collector, mesh rolls, edges of the conveyor, and anything else that might interfere with proper scanning.
Search Area Selection
Communication and Relay Interaction

Lightning → Filtering → Camera → Hardwire

Machine → Relay → Communication Circuit → PC
Printed Circuit Board (PCB)
PCB Considerations

- Custom tailored component therefore it was designed to be ultra reliable.
  - Power dissipation abilities of components are at a minimum of 2.5 times for transistor and 17.5 for the collector resistance.
  - Redundant configuration with secondary/backup system built into the board.
Relay Functions

- Relay is engaged by PC defect signal through communication circuit.
- Relay will be responsible for opening automatic and manual power lines to the machine when that function is desired.
- Relay holds power to defect alert light for 10s (hold time can be modified from 0.3 to 30s).
- Allow for on/off control of entire detection system in production area.
Machine Interface
System Interface

- PCB Signal
- PCB GND
- A1
- A2
- QC

24V Supply: Production System ON/OFF Switch

120V Supply: Alert ON/OFF Switch
Areas for Future Improvements

- Allow the software to compensate for lighting variation and shadows.
- Improve user interface
- Capability to load and store settings for different products
- Storage of a defect record to disk.
- Track multiple borderline defects in a series and report them as a defect
Milestones/Benchmarks

- Proof of concept demonstration 30 April 2004
- Confirmed RS232 communication 12 November 2004
- System install 13 November 2004
- System integration 15 November 2004
- PCB designed 22 November 2004
- Software completion 03 December 2004
- Project realization 03 December 2004
Necessities and their cost to add BT1 Defect Detection

- PC ($500.00)
- Matrox card ($595.00)
- RS232 extension ($13.00)
- 16/3 signal wire ($75.00)

- **Total Cost** (w/out shipping) $1183.00
## Project Spending

<table>
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<tr>
<th></th>
<th>Cameras</th>
<th>Computer</th>
<th>Lighting (Prototype)</th>
<th>Lighting (Actual)</th>
<th>Data Transfers</th>
<th>Misc Prototype</th>
<th>Misc Actual</th>
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SI Deliverables

- Updated wiring diagrams.
- Quality Checker users manual.
- Future improvement bill of materials.
- Copy of code with documentation.
Questions?
DDS group kudos and acknowledgements

- SI Corporation
- Jim Frenzel
- David Egolf
- Keith Prisbrey
- Greg Klemesrud