IPRO 324

Enhancing the Functionality of Residential Garage Door Operators Using CCD Camera Technology

Sponsor: The Chamberlain Group, Inc.

Overview

- 3rd Iteration of IPRO 324

- 1st semester: showed how hardware and software could be integrated

- 2nd semester: documented various issues, recommended improvements

Goals

- Use CCD camera
- Develop software package
- Solve skewing, lighting, scaling, and processing speed issues
- Determine feasibility of product for commercial use

Today's Presentation

- Hardware specification

- Software design and approach

- Project demonstration

- Conclusion

Hardware Specification

Parameters

- Problem Identification

- Possible Hardware Contribution

- Hardware Requirements

- Possible Hardware Configurations

- Hardware Selections

Problem Identification

- Previous IPRO Attempts

    Camera - Web cam

    Interface - USB Port

- Problems Encountered

    1) Lighting

    2) Scaling

    3) Skewing

    4) Processing Speed

Possible Hardware Contribution

- Image Quality

- Reduction in Processing Speed

- Address Lighting Issues
    - **Filters**
    - **Inferred**

Hardware Requirements

- No user adjustment.

- Wide depth (must focus up to 20ft).

- Camera resolution to cover 20ft (640x480 and better).

- Needs own illumination (ideally <1/2 Watts).

- Operation under extreme lighting conditions

Possible Hardware Configurations

- Acoustic Sensors

- Web cam

- Inferred Camera

- CCD Camera

Interface Selection

- Dazzle Digital Video Creator

- ADS USB Instant DVD

- Integral Flashpoint 3dx PCI Frame grabber

CCD Camera Advantages

- High Spatial resolution
- Higher Sensitivity (SN ratio)
- Lower Smear Ratio
- Wider Dynamic Range

Integral Flashpoint 3dx

- High Resolution

- Fast Image Acquisition

- Camera Control Interfaces

- Compatibility

Hardware Selections

- ## JVC 1/3 CCD
  - **1/3" interline transfer CCD**
  - **Electronic shutter**
  - **Auto IRIS**
  - **Built in back light compensation**

- ## Integral Flashpoint 3dx
  - **PCI video frame grabber**
  - **Programmable C++ Interface**
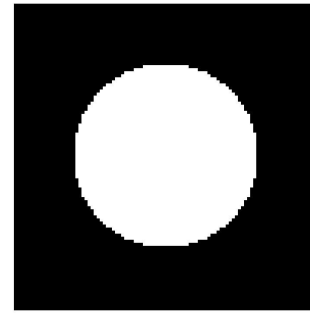
Attacking Design Problems With Software

Problems

- Skewing

- Scaling

- Lighting Issues

- Running Independent of User Adjustments

Fix Skewing

- 1. Followed suggestion from previous IPRO

- 2. Circle – can be moved or rotated but still have same aspects.
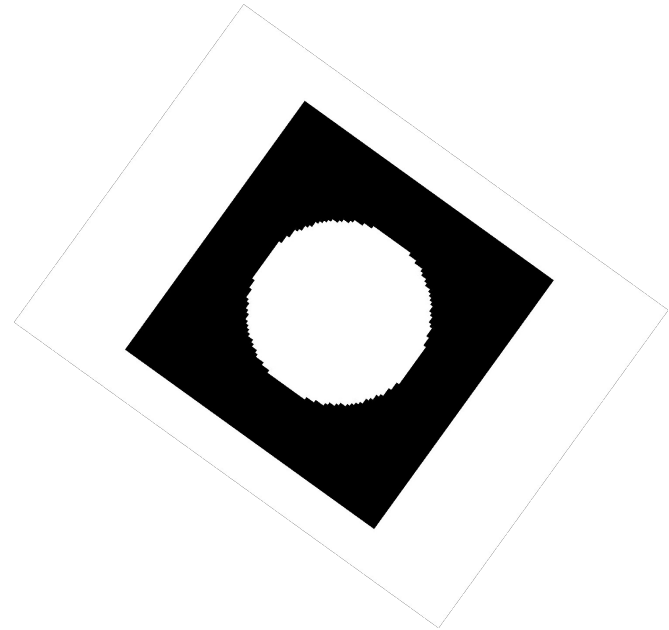
Initial Approach: *Correlation*

- How past IPROs attacked the problem

- Comparison between all aspects of an image. Obstruction determined by a correlation coefficient

- Idea was that correlation would fix all issues

Initial Approach: *Correlation*

- **Problems:**
  - What would the threshold value be?
  - Small changes in the picture may not be noticed as much as change in light
  - Other objects in picture, but in front of pattern would give bad correlation
  - Could not get it to work

Final Answer

- **Comparison of the perimeter and area of multiple objects**

- **Fix lighting issues**
  - Convert gray scale image to black or white image
  - Threshold value used to determine whether gray value became white or black. Determined through testing
  - Matlab function Edge used to find displacements between colors
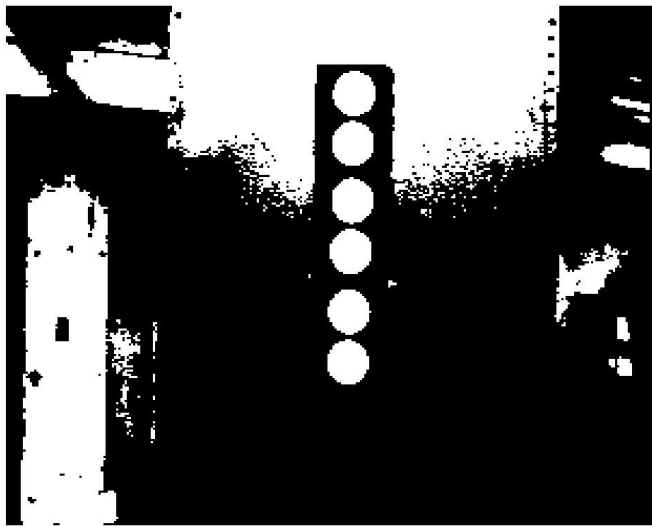
- **Example**

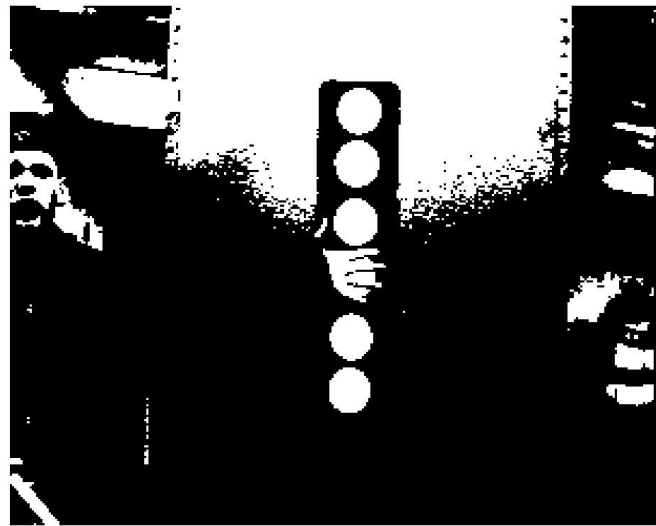# Example: Camera Images
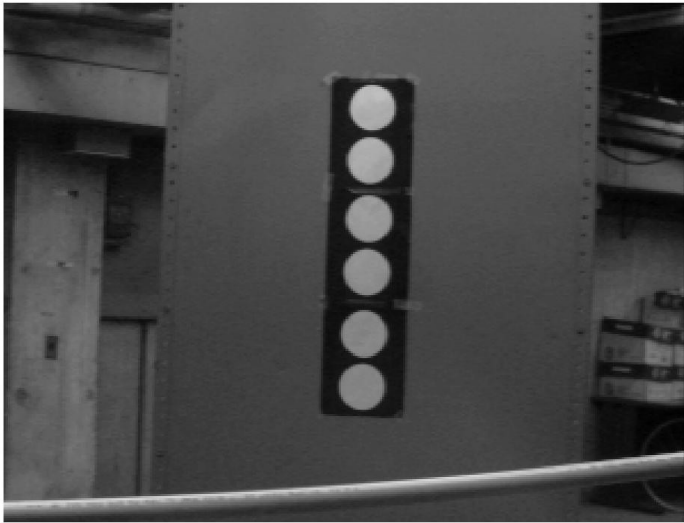
No Obstruction

Obstruction

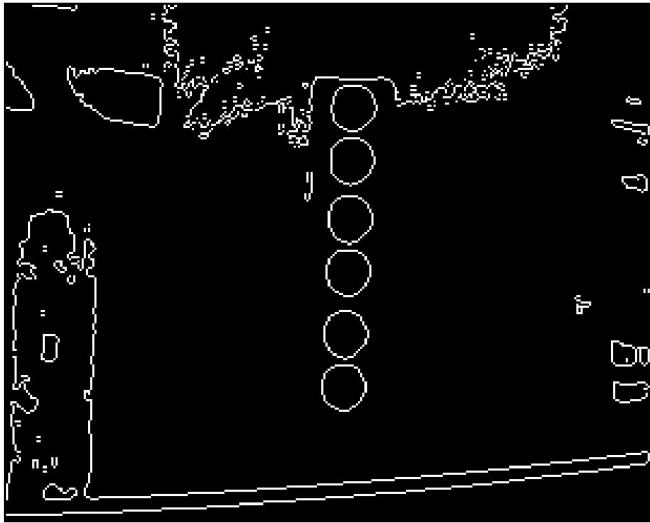# Example: Convert Black and White
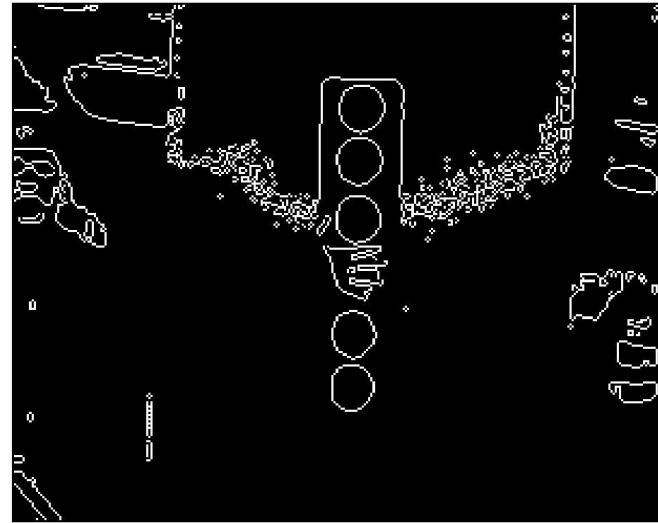

No Obstruction

Obstruction

Example: Edge Detection

No Obstruction

Obstruction

Scaling & Running Independently

- Previous methods used cropped images
- Independently create circle in Matlab
- Compare created circle with Image
- Run a Loop comparing various circles
- No user or specific distance required prior to setup

Presentation

- **Computer Simulation**
  - □ C++ Interface created
    - Controls camera Image
    - Simulates operation of Garage Door
    - Calls Image Processing Engine
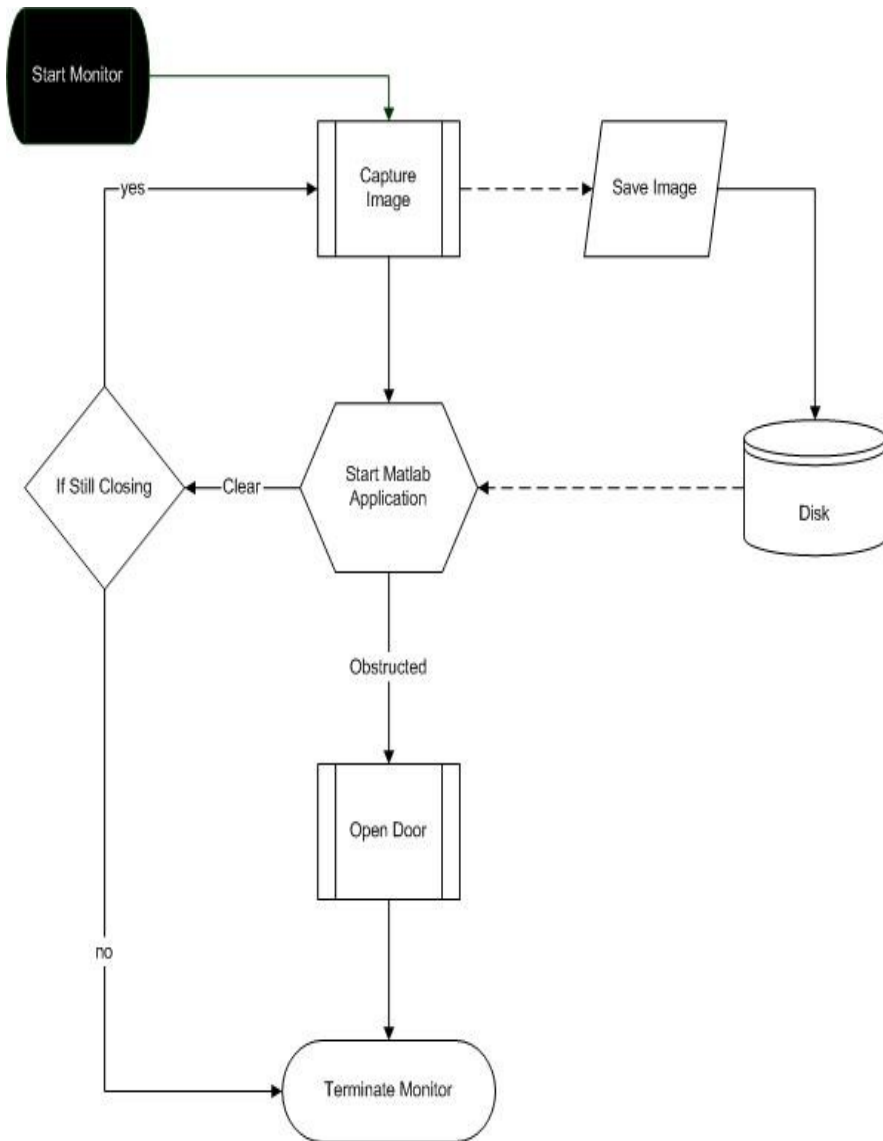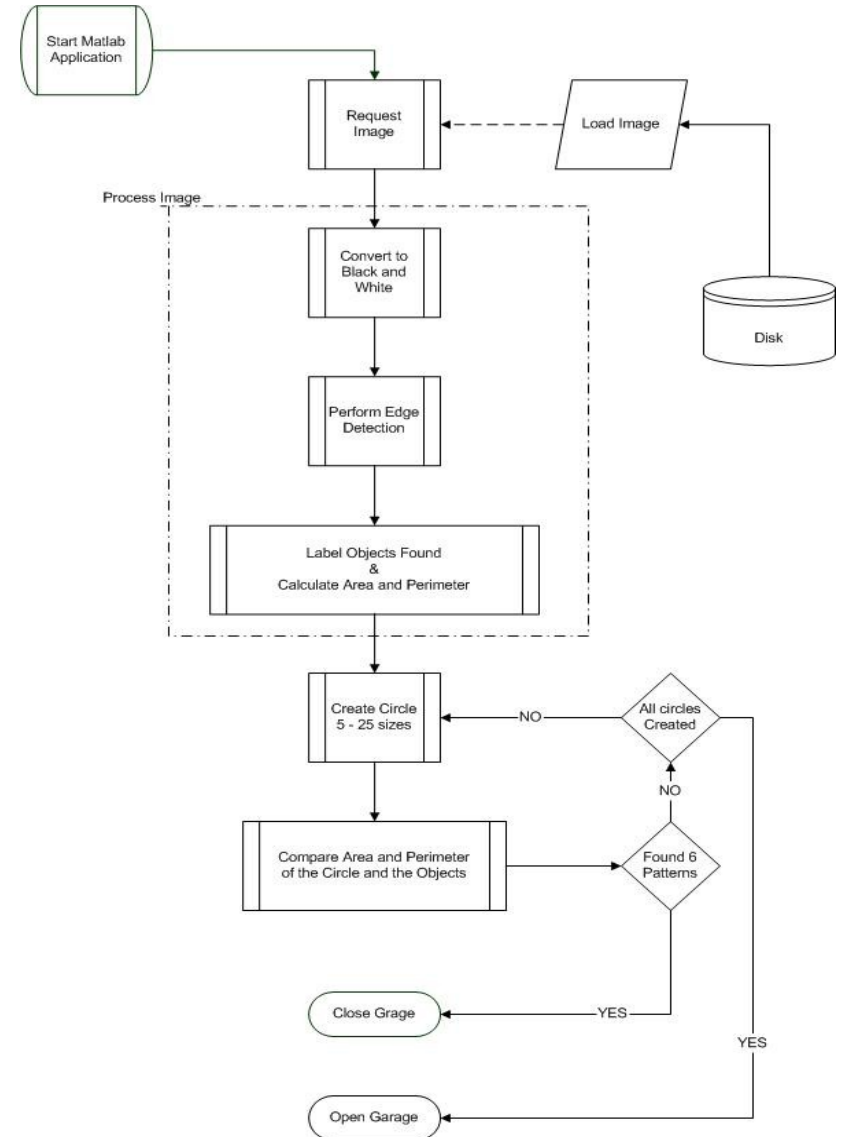   - Event Log is created
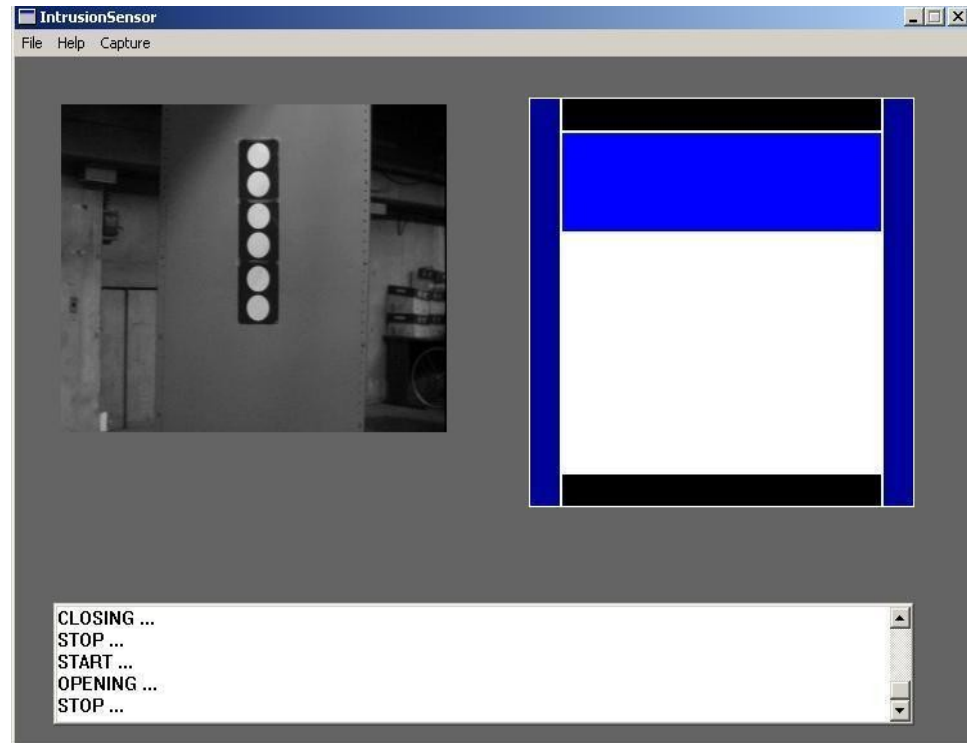
Interface

Image Processing Engine

Project Demonstration

Conclusion

Issues Encountered

- Hardware driver compatibility

- Software integration difficulties

- Processing time of MATLAB engine

- Camera performance

Accomplishments

- C++ graphical interface effectively connected hardware to MATLAB

- MATLAB successful in pattern recognition, complex image processing

- Optics issues were resolved

- In-depth documentation of code, various issues encountered

Feasibility

- Main purpose of project: to determine feasibility of system for consumer use

- MATLAB algorithm too slow for practical use

- High cost of CCD camera, capture card

Future of project

- End of this project, The Chamberlain Group, Inc. has software and hardware

- Skilled programmers could translate MATLAB functions to C++ code

- Have recommended optics requirements, now wait for cheaper camera technology

Acknowledgements

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