Center for Computer Vision Activities:

Computer vision for visual quality inspection

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Outline

1. About machine vision in general
2. Case study:
   Machine vision for fault prevention
3. Case study:
   Simple machine vision toolbox
Basic structure of an industrial machine vision solution

product/material/process flow

handling

image acquisition

process control and image processing unit

user interface

camera and illumination

products
Designing a Machine Vision System

• Camera:
  – type (line or area), field of view, resolution, frame rate, sensor type, sensor spectral range

• Lens
  – focal length, aperture, flange distance, sensor size, lens quality

• Illumination
  – direction, spectrum, polarization, light source, mechanical adjustment elements

• Software
  – libraries to use, API ease of use, software structure, algorithm selection

• Putting everything together
  – accuracy, time performance, cost, development and installation
Desing guidelines

• Camera, lens and illumination are the most important part of a machine vision system
  – acquisition errors are difficult or impossible to remove or correct during processing

• Also keep in mind:
  – mechanical reproducibility (often overlooked by software people)
  – tolerances
  – distances
Case 1: Fault Prevention

• Molding the base of an energy regulator for electrical stoves at Elektro-kontakt d.d. Zagreb plant

• Motivation
  – if molded part is not ejected properly serious fault can occur
  – repairs are 5000 to 10000€
  – downtime up to 1 week

• Requirements:
  – at least 1 meter clearance for robotic manipulators
  – maximal inspection time is 1 second
  – must be self-calibrating
What is inspected?

- Dimensions
  - 41 mm wide
  - 43 mm tall
- 8 contacts must be inspected
- There are 8 products per mold
- Total of 64 inspections
Laboratory setup
System design

- **Camera:**
  - Smartek Giganetix GC2591C, 2592x1994, 1/2.5”
  - area type, CMOS, rolling shutter, up to 15 fps
- **Lens**
  - Fujinon 2/3” HF12.5SA-1
  - high resolution C-mount lens
- **Illumination**
  - custom made white LED field using 32 Hebei I.T. S12PW6C high efficiency white LEDs
- **Software**
  - Smartek GigEVision SDK, Advantech BioDAQ SDK, OpenCV
  - three layers to the application:
    1. processing part C++ (speed)
    2. C++/CLI middle layer (link to GUI)
    3. WPF for graphical user interface
Workflow

1. Image acquisition
2. Registration
   - additional filtering of registration parameters (Kalman Filter) required
3. Part inspection
   - preformed concurrently
   - adopted line detection algorithm [Steger1998, PAMI]
   - length is measured
   - adjustment for individual contacts required
4. Result output
   - stop signal
   - result storage for offline analysis
Factory setup
Case study 2: Vision Toolset

• Quality inspection requires similar measurements at different locations along the assembly/production line
  – length, area, angle and intensity measurements
• Ideal task for under-graduate or master students
• Each inspection tool designed as a simple plug-in
  – image acquisition, display and process control parts are already solved
Interface

Inspection tools
Contact alignment inspection
Rivet inspection
Contact type inspection
Shaft classification
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