InvertNet Digitizer Design and Components

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Goals

1. **Inexpensive**
   – $0.10/specimen, 55 million specimens, 22 institutions
2. **High Quality**
   – Gigapixel, error-free
3. **Labels**
   – *Capture & process occluded & hand-written*
4. **Advanced**
   – Support research, 3D, Data Mining Tools
5. **Automated**
   – Fast, easy repeatable.
   – Place tray and push button

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Integrated Components

- Robotic 6 DOF Camera Motion
  - 4PRR Parallel Robot
- Telecentric Optical System
- Machine Control System
  - Real-time, programmable, repeatable, automation
- High-Performance vision and image processing
  - Real-time image and object analysis
  - Image Processing,
- Real-Time custom operating system
- Invertnet SW drivers – capture, stitch, process, etc.

4PRR Industrial Robot

- Fast, agile, accurate
  - 6 DOF, .01in accuracy
  - anywhere in 50ms
- Easy, 24in square desktop
  - 1 wrench/12 bolts/20 min
  - 50 lbs in small box
  - Low maintenance
- Inexpensive

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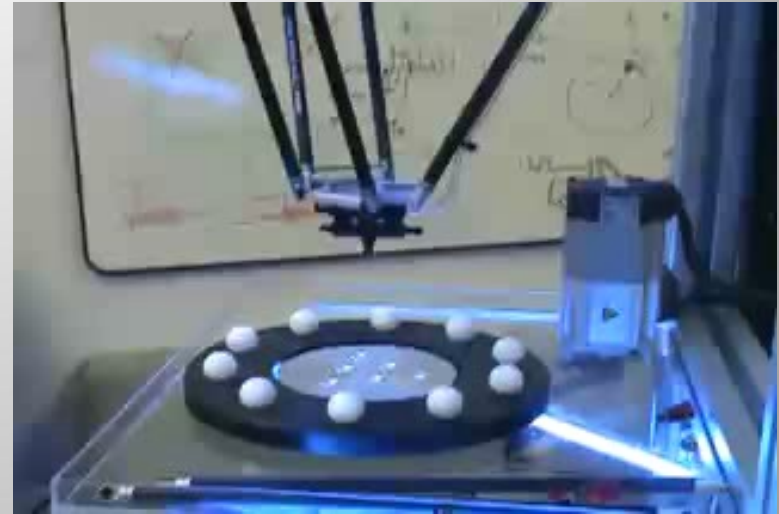
Optics

- 3MPixel Sensor
  - USB2, Minimal Processing
  - Integrated with vision libraries
- Telecentric Lens System
  - Orthographic projection to Sensor
  - No Focal Length
  - Accurate Measurements
- Approx 150 shots/tray
  - 650 mega-pixel stitched composite

Machine Control

- Real-time machine controller
  - Position, acceleration
  - Precision Motor Control
  - Kinematics for Invertnet Robot
- Programmable & Extensible
  - G-Code, Python, C++
  - Integrated with vision & imaging
- Supported & Open-source

Vision and Image Processing

- Real-time, through-lens, image analysis
  - Object & Feature Tracking
    - Labels, corners, edges, specimens
  - Image Processing – Multicore and GPU
    - Undistortion, stitching, quality analysis, 3D
- Customized and Integrated with Machine Control
  - Tray Automation - detect corners, edges, depth
  - Feedback & adapt to image quality
    - Monitor Quality & adapt during capture
- Open Source & Programmable – Integrated Scripting

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Custom OS

- Real-time Ubuntu 13.04 on Linux 3.9.6
  - Xenomai real-time kernel for machine control
  - 64bit modern processor support
  - Multi-core, performance optimized
- Integrated machine control and vision system
  - Runs real-time machine and vision simultaneously
- Open Source and Supported

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Status

- Robot
  - Major hardware design is stable
    - Frame, motion, arms, connectors, lights
  - 6-axis control plate in last tests
- Software
  - Infrastructure - final and stable
    - OS, machine control, vision
  - Capture and Stitching
    - High lab-quality - lacks error resilience
    - Adding operator simplified workflow interfaces

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