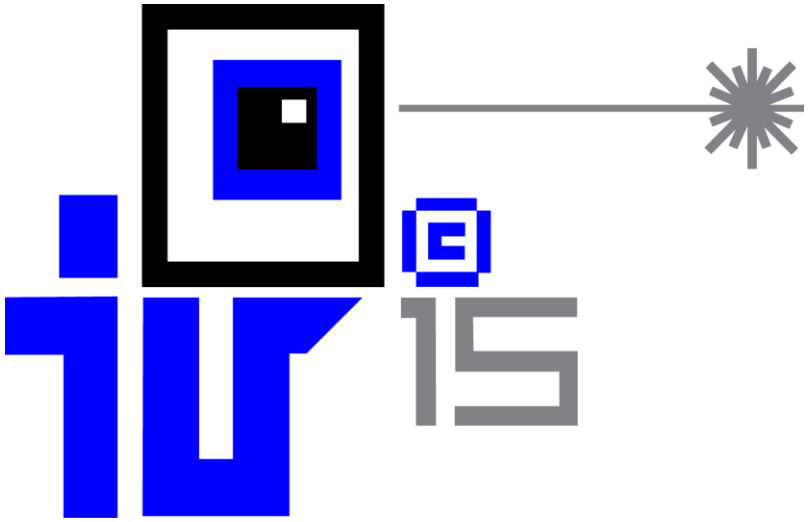
INDUSTRIAL CONTROL SYSTEMS



Measuring with Vision

www.ics-uk.net

Agenda

- Introduction
- Principles of Line scanning
- Features of Line scanning
- Basic IVis Configuration
- Display
- Reporting
- Specification

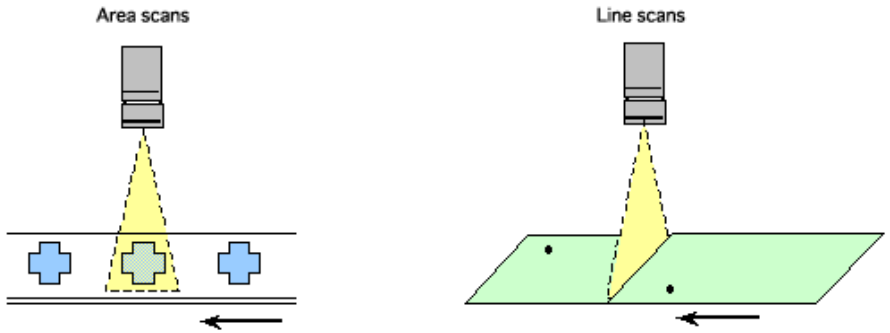
Introduction

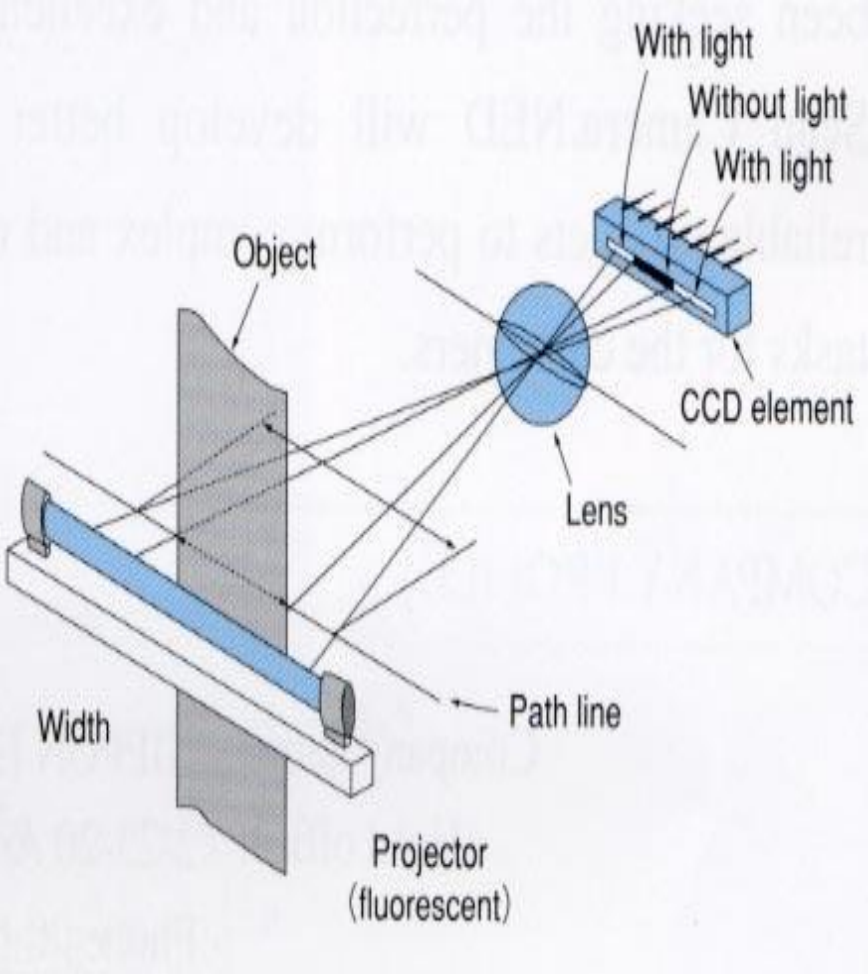
- ICS is an Instrumentation and Controls Company, specialising in machine vision solutions for use in industry and commerce applications.

IVIS

- Many industrial and commercial processes need to verify component and material manufacturing quality at all times. Providing statistical information to both the customers and their maintenance departments.
- Traditional methods rely on the manual inspection of the materials and sample checks. This relies largely on human resources and staff diligence.
- IVis will help and solve this problem.

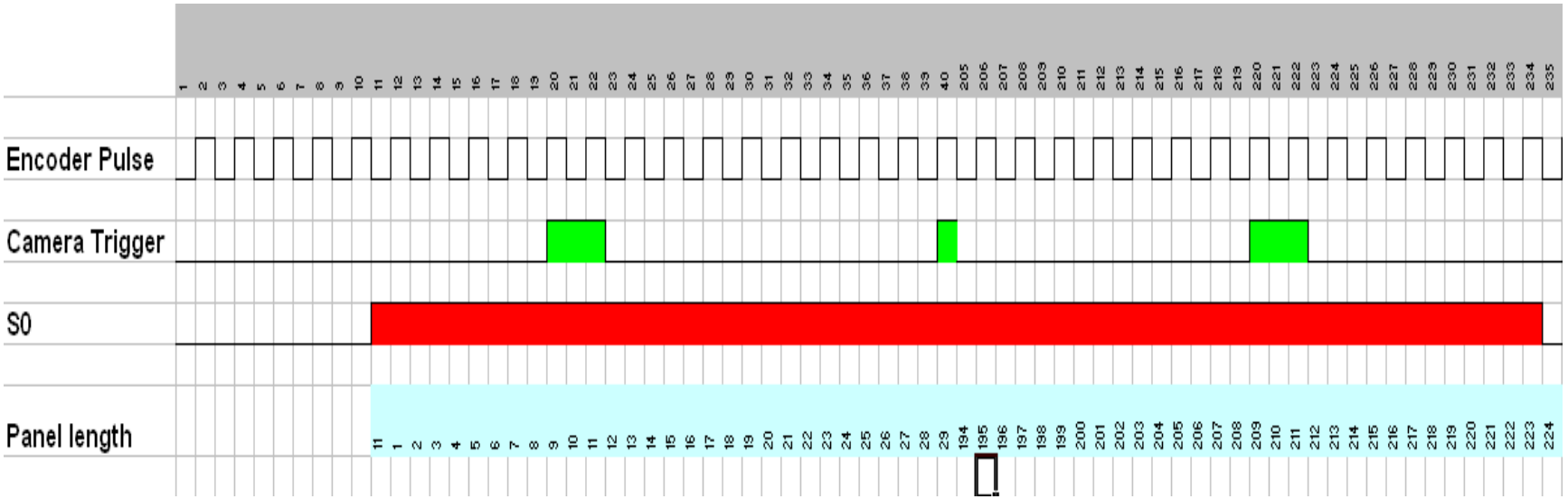
- A line scan is one line, or row, in a raster scanning pattern. Lines scans are important in representations of image data, because many image file formats have special rules, for data at the end of a scan line.
- Area and Line sensing system can be configured too have better speed and resolution than the human visual capabilities.
- Line scan cameras are installed in many of processing machines in precision, glass, film, food and medical industries as well as electronic industry.
- Line scan cameras are installed in many of manufacturing process too utilize its dimension measuring, position inspecting capabilities.





- Scan camera consists of a CCD (Charge-Coupled Device) element, lens & trigger control circuit. Image of objects created on CCD element via lens and quantity of light is converted to video pulse signal and then is output.

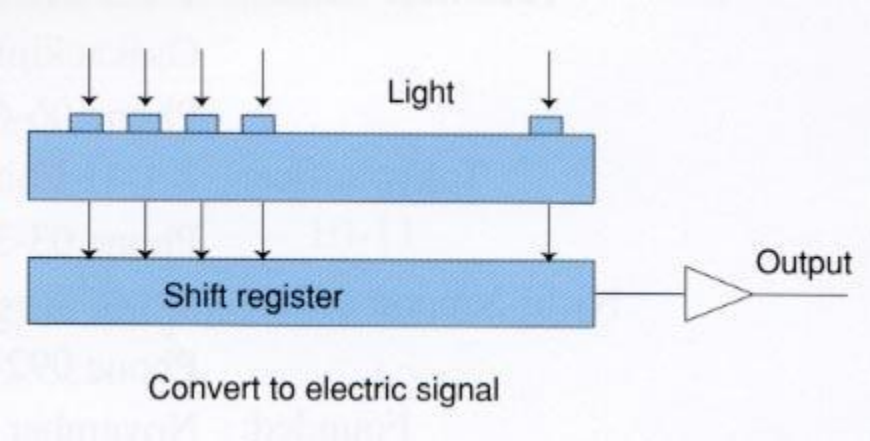
Sequence map



The Sequence Map not only provides a publication-quality representation of your sequence, but it can also be used as a powerful interactive tool to aid you in navigating and understanding your data.

Operation principle of line scan camera

- CCD (Charge-Coupled Device) sensor converts light frequency on a line of photo diode array to electrical signal and reads out its storage amount. When light is on photo diode, +/- electric charge is stored, parallel transfer signal is imposed and transferred to CCD analogue shift register at one time and image is output. Video signal is picked up as time series pulse, however, it perform average scanning at constant pitch.



Features of line area scanning

- Following features are provided in the comparison between line scan camera and area camera.

- **High Resolution**
  Simple comparison of resolution between area camera with 512 pixel and line scan camera with 5000 pixel in 100 mm field of view.
  Area camera 100/512 = 195 um/pixel

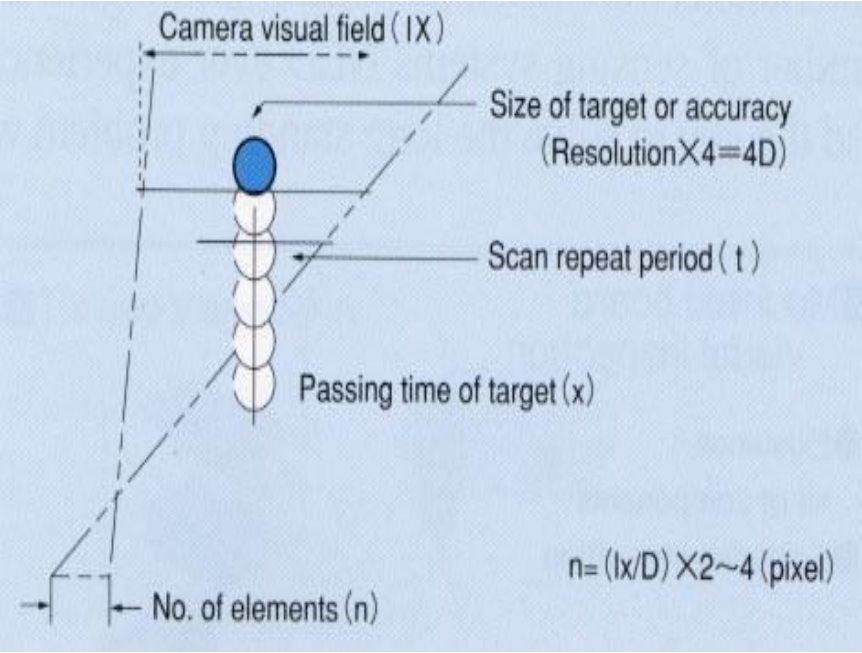
- Line scan camera 100/5000 = 20 um/pixel
  Resolution of line scan camera is approx. 10 times (102 times in two dimensional) higher than area camera.

Features of line area scanning

- **High Speed**
  Line scan camera can scan at 20 MHz per 1 scan (50 nsec/pixel). Image capture speed by line scan camera is considerably fast compared with 10 MHz (33.3 msec/ frame) of area camera.

- **Continuous Processing**
  In the inspection of the object which moves continuously like sheet, it's difficult to get synchronization by area camera, however, continuous processing is easily done by line scan camera because of its video output by each scan.

Selection by accuracy



- In general, to get necessary accuracy against camera visual field, 2 – 4 times of resolution against required, accuracy is necessary. (In case the contrast is clear. x 2) Therefore, number of elements should be selected from 256, 512, 1024, 2048, 5000, 7500 pixels.

Scan Rate

Scan rate is the speed at which a video display paints scan lines onto a screen. Generally, the higher the scan rate, the higher the resolution.

- Period for scan repeat is required more than 3 times of passing speed of minimum target.

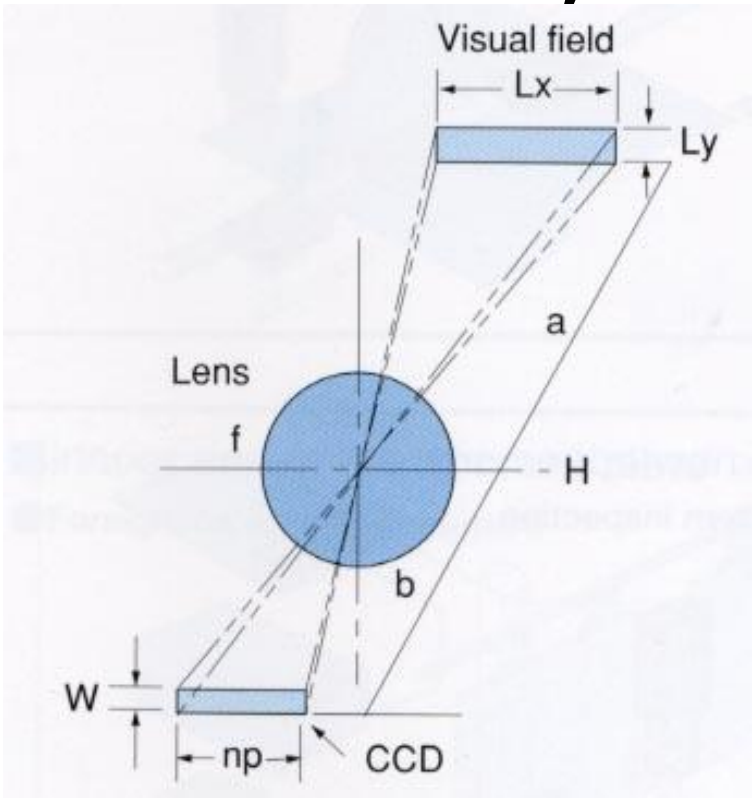
$$t = x / 3$$

- On the other hand, (t) would be calculated from camera driving clock pulse frequency (f) and number of elements (n).

$$t = 1 / f \cdot n = x / 3 \qquad f = 3 / x \cdot n$$

- If clock pulse vs. video output duty would be 1:2 depending on model, driving clock pulse would be f/2.

Calculation of optic, visual field, setting distance



- Lx Camera visual field (luminous diode, array direction)
  Ly Camera visual field (vertical)
  n No. of pixel of CCD
- P Length of 1 pixel
  np Total pixel length
  W Aperture width of CCD
  a Distance of object (PL) - Lens
  b Distance of Lens - CCD
  M Optical magnification
  f Focal length

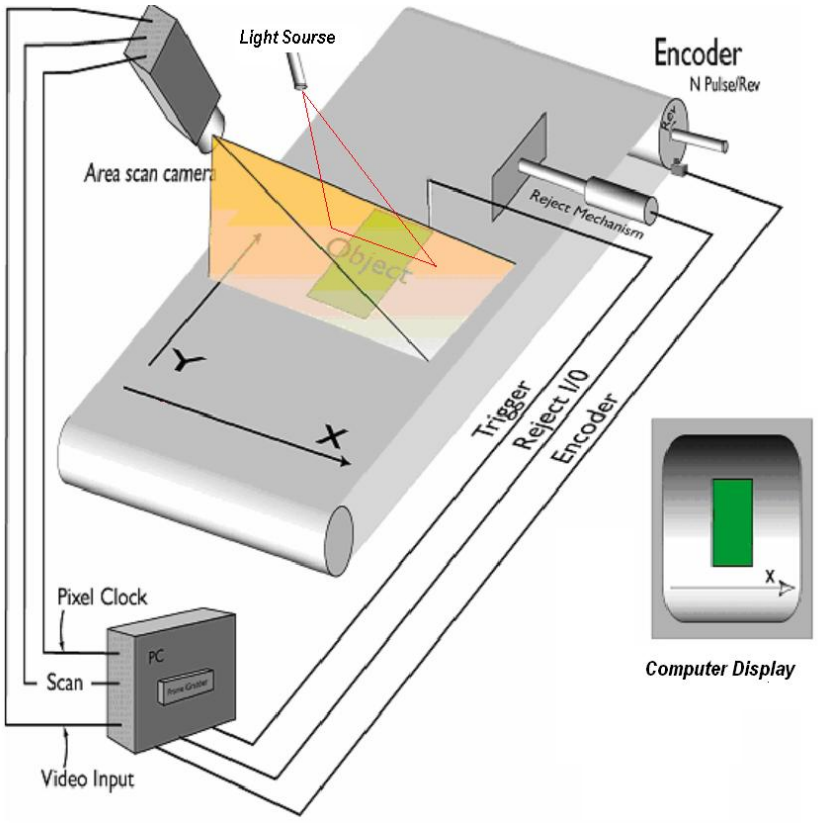
Summary

- Line scan
  - Advantages
    - Speed m/s
  - Disadvantages
    - Slippage
    - Cost
    - Special capture hardware
- Area scan
  - Advantages
    - Speed 100 m/s max
  - Disadvantages
  - Component measurement

Example

- Lens formula
- In case of calculation of setting distance (a) under fixed visual field (Lx). Example
- When FH2048B camera is used under the condition of np = 28.672 mm, lens focal length (f) = 50 mm and visual field (Lx) = 500 mm, the setting distance (a) would be come as;
- If setting distance should be more than 922 mm, it would be possible to extend lens focal length distance. In case of 100 mm, it becomes 1844 mm (2 times of f50 mm) and it becomes 1567 mm in case of f85 mm.
  In case of FD lens, shortest setting distance is 10 times of focal length, therefore, visual field would be 286.72 mm,
  10 times of 28.672 (np). If visual field would be less than it, intermediate ring would be necessary.
  Vertical visual field Ly = W x 1/M = 0.2 x 17.4386 = 2.3877 mm
  Resolution = Lx/n = 500/2048 = 0.24414 ....mm

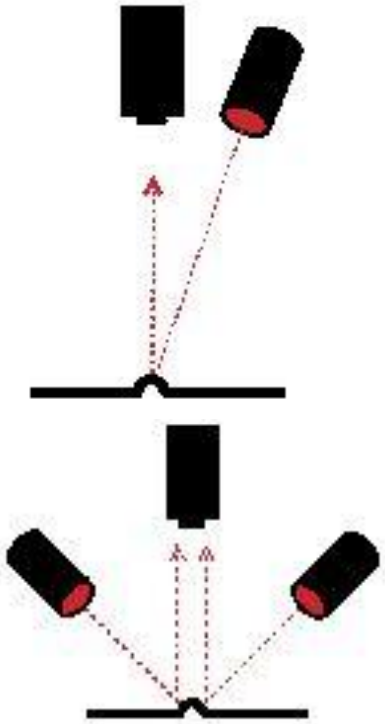
Basic IVis Configuration



- This schematic shows the basic layout of the IVis Inspection System.
- Comprising of the following items:-
- A high resolution digital camera(s), to capture the specula information
- A light source to generate the specula reference
- An encoder to track the position of the object
- A computer and display to process and configure the data
- A rejection indication or actuator

Light Technique

Some techniques requires a specific light and placement of the camera, sample, and light; others do not.

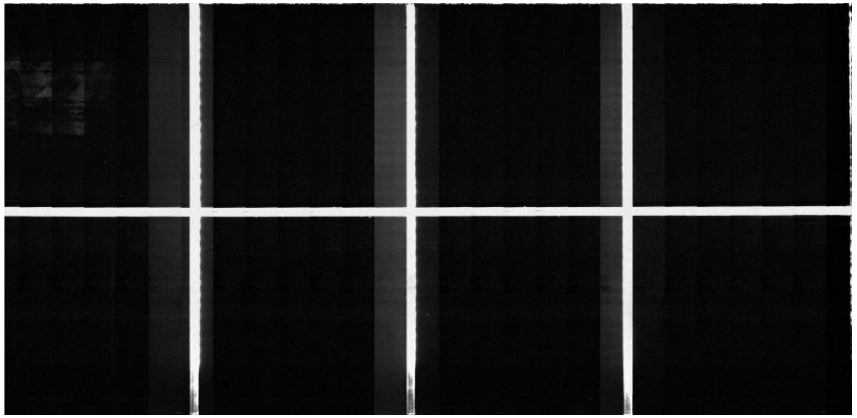


- **Bright Field**
  Light is aimed directly at an object, often creating distinct shadows. This type of lighting is effective when used on objects requiring high degrees of contrast, but creates specula reflections when used with shiny or reflective materials.
- **Dark Field**
  Light is projected at an angle to the surface, causing any variations to deflect light up into the camera, creating bright spots on a dark background or field. Nothing is seen by the vision system if there are no aberrations on the surface.

Final Image construction

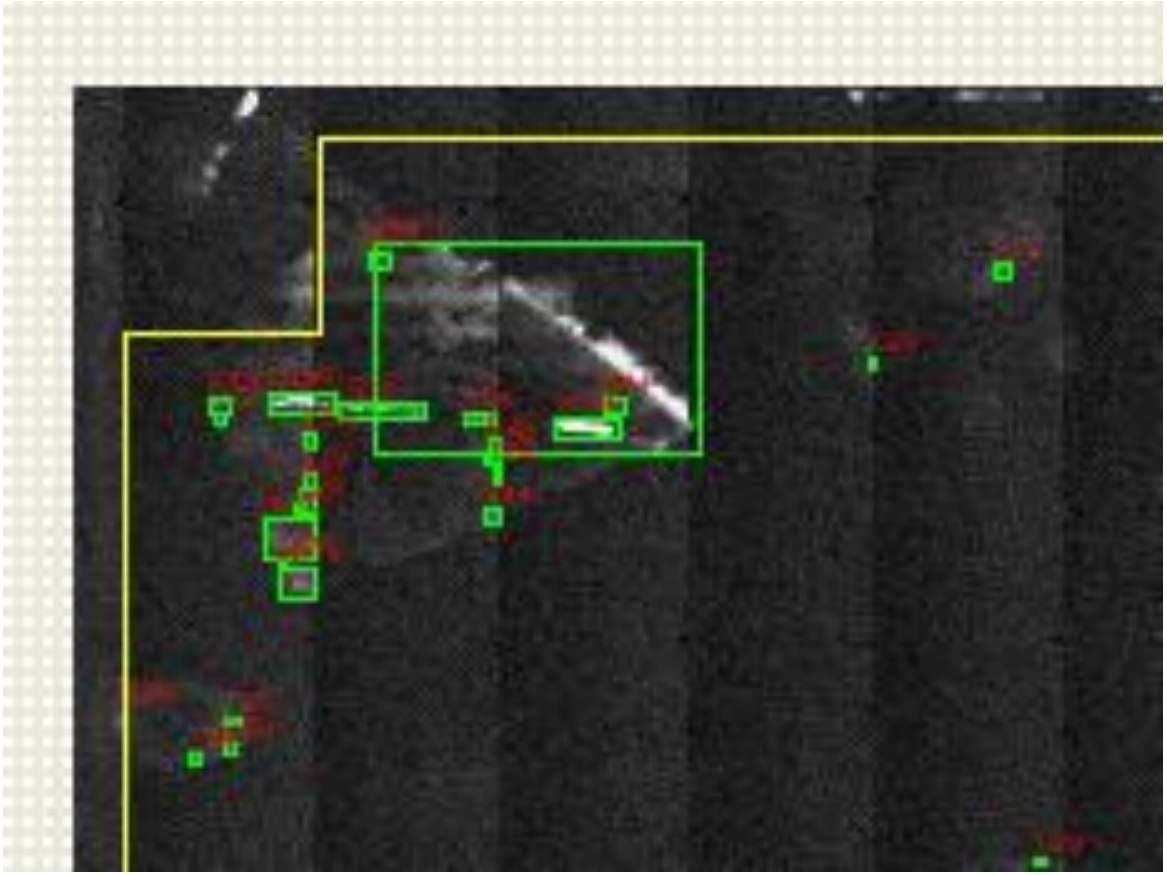
Fig 1

Fig 2



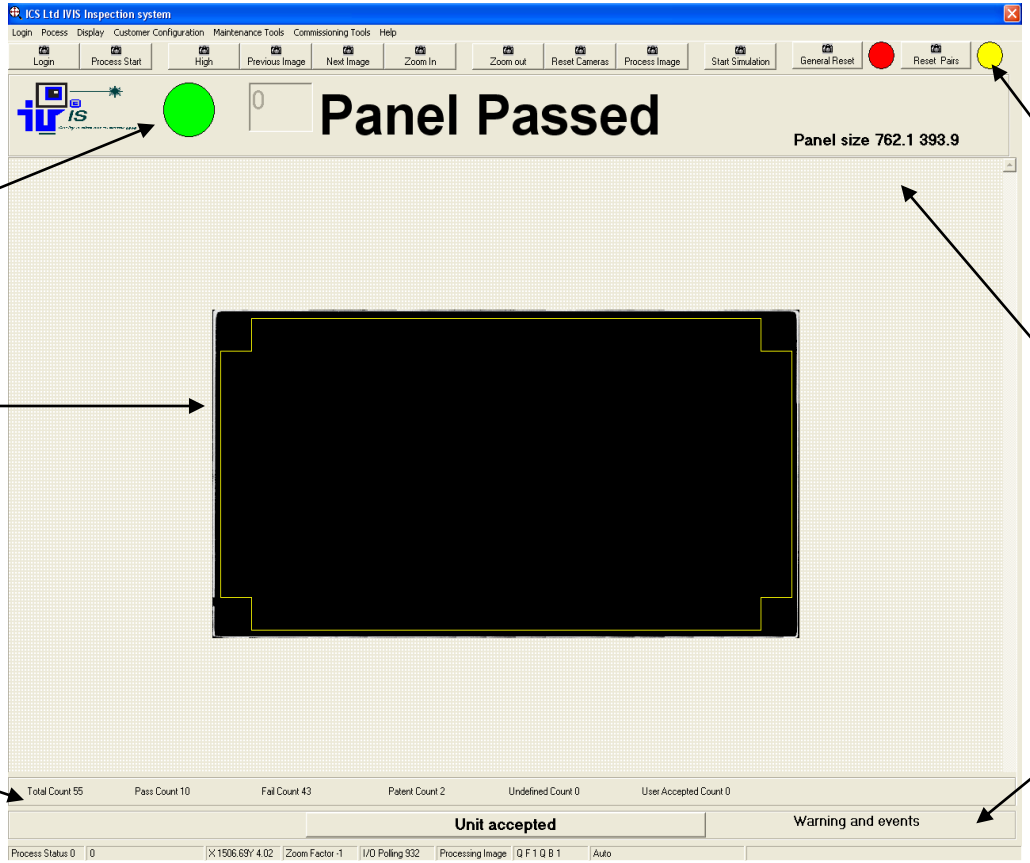
The camera (s) capture samples shown in (Fig 1) as the panel travels past the camera view, The samples are indexed by the encoder and reconstructed by the Computer to create the test image.

Process



- Defect identification
- Defect size mm or MM^2
- Defect location in mm
- Panel size in mm
- Customer defect size filter both length and area

Display



Pass Fail alarms

Result image

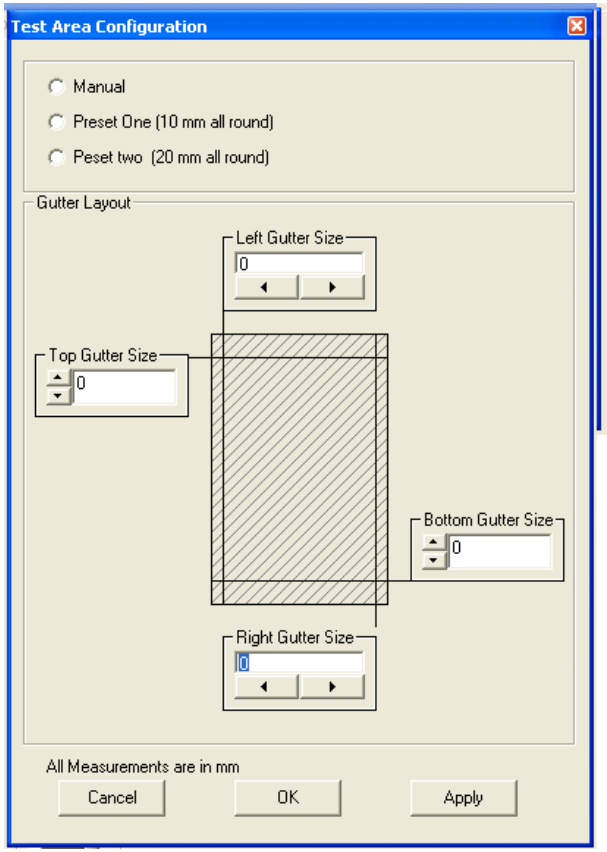
Hourly production Counts

Panel Pairing Alarm

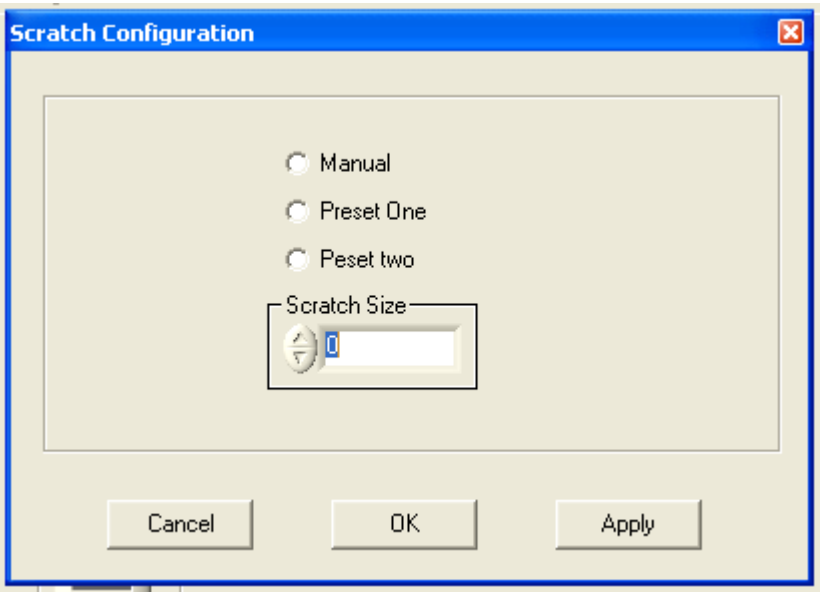
Panel Dimensions

Warning and Events

Example 1 of the user interface



- This screen capture is of the user interface to set the gutter size.
- Manual :- Allows the user to set each gutter distance separately.
- Preset one and Two :- allow the user to quickly set the gutter size to a predefined set of values.

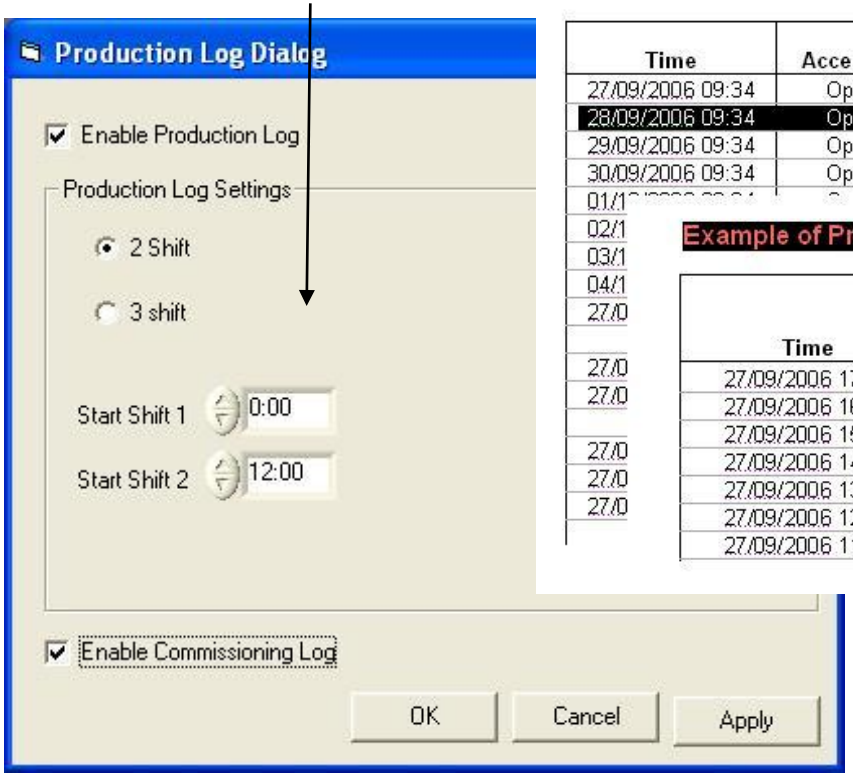


This screen capture is of the user interface to set the maximum allowable scratch size.

- Manual :- allows the user to set the scratch size manually.
- Preset one and two:- allow the user to quickly set the scratch to a predefined set of values.

Reporting

2 or 3 Shift start times options



Example of Oparator Log

Time	Accessed by	Property Name	Old Value	New Value
27/09/2006 09:34	Operator	Filter Changed from Standard to High		
28/09/2006 09:34	Operator	Filter Changed from High to Standard		
29/09/2006 09:34	Operator	Filter Changed from Standard to High		
30/09/2006 09:34	Operator	Filter Changed from High to Standard		
01/1				
02/1				
03/1				
04/1				
27/0				
27/0				
27/0				
27/0				
27/0				
27/0				

Example of Production Log

Time	Total Count	Pass Count	Fail Count	Patterned Count	Undefined Count	User Accepted Count
27/09/2006 17:00	110	63	63	11	0	28
27/09/2006 16:00	32	18	18	3	0	8
27/09/2006 15:00	79	45	45	7	0	20
27/09/2006 14:00	62	35	35	6	0	15
27/09/2006 13:00	79	45	45	7	0	20
27/09/2006 12:00	93	53	53	9	0	23
27/09/2006 11:00	64	37	37	6	0	16

Shift log and operator log

INDUSTRIAL CONTROL SYSTEMS

Specification

- Camera
  - IEEE 1394 fire wire
  - Capture rate 15 fps
  - UXGA 1628 x 1236 progressive CCD
- Lighting
  - 24 volt
  - 100000 hour lifetime
- PC
  - 2.8 Ghz + Process
  - 400 Front Head bus
  - 1G Ram
- Screen
  - 17" Industrial Chassis SXGA LCD as standard
  - Premier USB Resistive Touch screen