Solder Inspection Machine Vision Techniques

Solder Inspection Utilises Latest Generation Machine Vision Techniques

Solder inspection is one of the most complicated machine vision tasks to complete, primarily due to the issues surrounding reflections from the metal, the organic nature of the solder flow, and the additional problem of flux on the part. All these points give vision systems a tough time when it comes to automatic inspection of solder. Historically PCB manufacturers have had to use very expensive custom made inspection machines which give the end user little scope in setting up and making changes to the inspection criteria and screening levels for acceptability.

Industrial Vision Systems Ltd (IVS), sister company of NeuroCheck GmbH, has created a generic machine concept for PCB manufacturers to allow robust solder inspection for a fraction of the price of some of the larger Automated Optical Inspection (AOI) machines on the market. The latest generation of NeuroCheck Firewire cameras and system software removes a lot of the notable issues associated with solder inspection and gives users the latest generation of machine vision which can cope more reliably with changes in light and surface quality.

At the heart of the solution is the industry standard NeuroCheck software, giving Industrial Vision Systems Ltd the ultimate flexibility in completing industrial image processing in a number of key areas. The latest generation of machine vision cameras and software allows changes in ambient light and surface quality changes to be addressed easily and at speed.

System Set-Up

A generic machine concept was developed by IVS which could be applied to cased and non-cased PCB units. It gives the ability to inspect both manual and automatic fed parts through a conveyor system. Due to the flexibility of the NeuroCheck Firewire camera concept, the resolution for the machine can be changed at will, from 782 x 582 pixel resolution – up to 1624 x 1236 – all cameras are the same physical size with the same mounting points, thus giving the ability to change the camera as required (Fig.)
The Firewire camera is mounted on an X-Y-Z servo system with a telecentric lens arrangement. Under the optics is mounted a custom designed lighting arrangement with switchable banks of white LED lights – each solder joint is subjected to varying lighting conditions to process the various fault types. Typically a solder joint can fail due to the following problems:

- Pin missing or broken
- Pin in the wrong position
- Non presence of solder
- Failure in the shape of the solder fillet
- Holes in the solder
- Excess solder and solder balls
- Bad flow of solder around entire pin
- Bridging of solder
- Unforeseen gross defects

**Vision Inspection**

Solder inspection requires high magnification of the solder joint in order to accurately confirm whether a joint is good or bad, this also gives the ability to concentrate the light around the joint area with a combination of darkfield, on-axis and direct LED lighting. The strobing light arrangement captures the solder in differing lighting conditions through the image tray facility of *NeuroCheck*. Each lighting condition can then be processed according to a different check routine as shown in Fig. 2.

Typically four solder joints are checked at the same time, giving an approximate field of view of 9–10 mm square. Each check within the global check routine offers a unique set of image pre-processing functions to allow differing faults to be
analysed. Typical pre-processing filters include: smoothing, dilation, enhancements and look up tables. Each feature of the solder is analysed to check its criteria is within tolerance. The screening levels for failure can be set by the enduser to allow flexible quality control.

**Solution**

Optimised, custom designed **LED lighting** was used to give overall clarity to the image and offered the best overall solution given the changing surface conditions (Fig 3). The latest Firewire camera technology combined with the **NeuroCheck software** offers some huge technological advantages in changing surface conditions, by allowing the camera set-up to be dynamically changed dependent on the brightness and reflection of the solder – a step forward compared to some older vision system solutions available; and crucial for this application. The decision to dynamically change the camera set-up is automatically controlled and triggered by **NeuroCheck** as part of the inspection process.

Upon acquisition of an image, **NeuroCheck** assigns appropriate preprocessing algorithms based on the quality of the captured image. The next stage utilises neural network classification for reliable detection of the solder position and other features. Neural networks enhance the solution with the capability of cognitive intelligence. Contrary to template matching, the neural network has the ability to automatically train itself against the presented images, but does not utilise specific differences for individual samples – thus offering an advantage where surface quality is poor and changing. This information is enough to develop a system with the necessary intelligence to guarantee reliable recognition.

**Human Machine Interface (HMI)**

The **NeuroCheck software** gives real time feedback during automatic operation of the solder inspection. The camera moves around the board automatically to cover all the solder joints requiring inspection. During this time the **HMI** is updated to show the results as shown in Fig. 4.

Finally, all images and data can be automatically saved during inspection giving historic SPC visual data for the Quality Control department to use.

**System Reliability**
The machine offers the electronics industry a new, lower cost for Automated Optical Inspection utilising standard off the shelf vision hardware and software components; and the NeuroCheck software offers new OEM manufacturers a rapid time to market for new, innovative inspection procedures.

**System Hardware**

- NeuroCheck IEEE 1394 “FireWire” digital camera with 1624 x 1236 pixels
- Industrial telecentric zoom machine vision lens
- Industrial LED lighting rig custom designed by IVS
- Panel PC with 3.0 GHz P4; 512 MB RAM; 60 GB HDD; integrated 15” TFT monitor
- Digital IO-card with 32 opto-isolated inputs and outputs
- XYZ servo system

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