

# Detecting and measuring bent pins on electronic components

Yann Armand, Hideo Saito, Junichi Sugano, and Yoshinobu Takizawa

*A simple, affordable light-source rotation system provides automatic detection and defect-angle estimation of bent pins.* 

Many electronic components rely on rows of pins to establish an electric connection with circuits. A common defect is bent pins, which compromise the electric connection and can lead to defective circuits and systems. Controlling the quality of pinned components can help assure the correct functioning of most appliances we use daily.

Methods to detect bent pins already exist. Some rely on testing by contact, while others use vision systems in optimized illumination conditions. However, because they usually need specialized hardware or precise experimental settings, existing systems are often large or expensive. We developed one with simple elements to make detection affordable for small- and medium-sized companies. The system also allows estimating defect angles to quantify the bends.

The photometric stereo principle, the observation of a fixed object with a fixed camera during changing illumination conditions, has been used successfully to measure the surface of objects.<sup>1</sup> The method works especially well on objects presenting a specular or mirror-like reflection<sup>2</sup> for which the reflected light and illumination directions are symmetrical to the surface normal vector or reflection. Because component pins are metallic, they reflect light specularly. Using light-source rotation and the geometrical constraints of specular reflection, it is easy to distinguish bent pins from normal ones and to estimate their angle.

We want to detect and quantify vertical bends, the most common defects. A vertical bend pin has a surface plane that has been abnormally rotated around the x vector (see Figure 1). The idea is to move a light source around the component in a vertical plane while a camera in the same plane observes the reflected light of the pins during rotation. Because of the mirror-like geometry, the reflected light will reach maximum intensity, and at that point bent and normal pins will shine with



*Figure 1. Light-source rotation on top of a pinned component. O: Component body center. x: Component body length. y : Pin length. z: Normal to the component body and all non-defective pins.* 

distinctive light angles from the camera's point-of-view (see Figure 2).

We rotate the light source using a turntable and a common light bulb. The pin positions are found by an edge-detection algorithm. By measuring the corresponding pixel values, the light-intensity curves for all pins can be drawn throughout the rotation (see Figure 3). For each pin we get the highlight angle (the light angle at which the pin shines as the curve peaks). A statistical analysis of highlight angle distribution can detect bent pins. For the detected ones, the delay angle (the difference between the highlight angles of the bent and normal pins) seen in Figure 3 can be measured from experimental data. Using geometrical considerations, we can deduce that the pin defect angle equals half the delay angle. This allows the system to automatically estimate the pin bend angle from the experimental curves.

The setup can automatically test components of various sizes without having to adapt to each case. Satisfactory results can be achieved even with simple, inexpensive components. The current setup can detect defects as small as  $1^{\circ}$  and the estimation of the defect angles is reliable within a  $+/-1^{\circ}$  margin. Moreover,

### Newsroom

## SPIE

## Camera Reflection from bent pin bent pin Light source Light angle Defect angle Defect angle

*Figure 2.* Light reflection geometry during rotation and projection. The bent pin in the middle does not shine at the same light angle as normal pins from the camera's viewpoint.



*Figure 3. Light-intensity curves of all pins (each with a different color) during light rotation.* 

10.1117/2.1200909.1808 Page 2/2

we have determined that the detection method remains robust even in the presence of small horizontal bends (pins abnormally rotated around the *y* vector).

In summary, in order to automatically detect bent pins in electronic components, we have proposed an original system based on observing light reflected by the pins during a light-source rotation around the component. So far, the system has proven to be inexpensive, simple, and capable of both automatically detecting bent pin defects and quantifying them. Our next step will be to improve the rotation setup to increase the speed and precision while keeping the tool low-cost.

#### **Author Information**

#### Yann Armand

École Centrale Paris Paris, France and Computer Vision Laboratory Keio University Hiyoshi, Japan

Yann Armand holds a dual master's degree from Keio University and École Centrale Paris.

#### Hideo Saito

Computer Vision Laboratory Keio University Hiyoshi, Japan

Hideo Saito heads the laboratory. His research includes graph cuts, 3D displays, and virtual reality.

**Junichi Sugano and Yoshinobu Takizawa** ViSCO technologies Tokyo, Japan

Junichi Sugano is assistant director in the research department.

Yoshinobu Takizawa is director of the research division.

#### References

S. K. Nayar, K. Ikeuchi, and T. Kanade, *Determining shape and reflectance of hybrid surfaces by photometric sampling*, **IEEE Trans. Rob. Autom. 4**, pp. 418–431, 1990.
T. Chen, M. Goesele, and H. P. Seidel, *Mesostructure from specularity*, **Proc. Comput. Vision Pattern Recognit. 2**, pp. 1825–1832, 2006.