

## Machine Vision for Translucent Materials — From optics design to defect inspection

### Introduction

Image processing capability integrated together, with optical/mechanical/electronics capabilities, can deliver system level solutions for manufacturing industry. These combination of intelligence in image processing and application domain knowledge are named “Machine Vision”. Among various vision inspection applications, contact lens manufacturing puts up a challenging case as the samples translucent and floating in liquid.

### Operation Principle

In order to reduce the reliance on existing labor dependent manual inspection, the defects of contact lens need to be inspected by an automatic system. Thus, increase their output when the inspection is fully automated in the manufacturing lines. The goal is to build an automated inspection system to inspect multiple contact lens in a tray and reject any of them which has wrong tool code/markings, or tears of at least 100um, with 0% miss detection and less than <5% false detection.

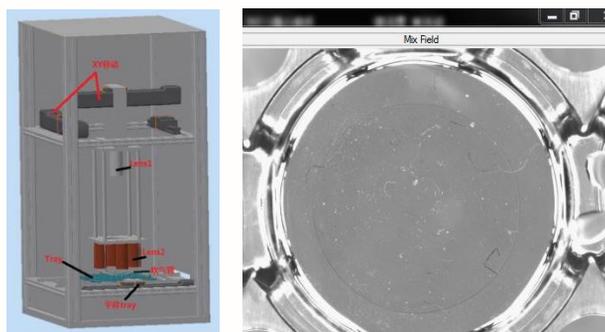


Figure 1. Schematic of the system layout and the sample under test

The whole inspection system includes the imaging optics, the lighting design, the imaging sensor, the moving mechanism, the sample holding mechanism and the imaging processing software, as shown in Fig.2.

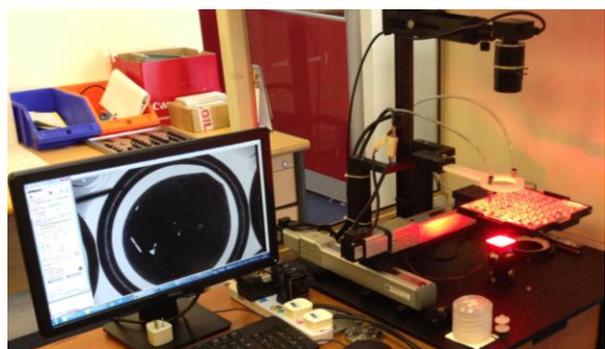


Figure 2. Inspection system in WOE optics lab.

A novel image processing algorithm and optical system was designed to handle the challenge and to achieve the 0% miss detection rate.

- **Dual light source** - Dark field and mixed field lighting for viewing different defects and tool code.
- **Dual or multi contact lens positioning** – To differentiate the defects of concern from static and dynamic noise and increase the reliability of tool code identification.
- **Dual camera set (Full view and Angled view)** – To encompass and capture all possible scattering angle of illuminated tears.
- **Accelerated image processing and pipelining process** – To maintain the minimum speed of 500 contact lens per hour.

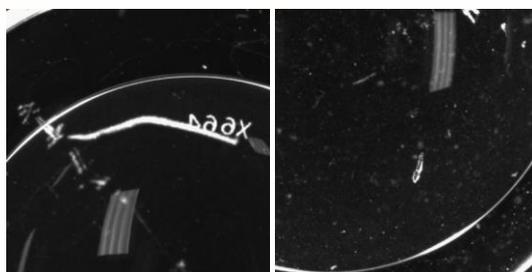
### Inspection Challenges

1. **Positioning**: Contact lens might not be in neutral position due to the used of existing tray, which has large well space compared to the size of the lens. This will lead to captured image of a distorted lens.



Contact lens is centralise and in neutral position      Contact lens is offset and in tilted position

2. **Noisy environment**: The system has to differentiate tear of concern from on trays' defect (such as scratches or water droplets); and in saline solutions' defect (such as floating particles or air bubbles)



Scratch on tray

Particles in saline

### Conclusion

As a global enterprise, leading photonics innovation since 2002, WOE has built up customization engineering capability from optical modules to systems. The system development capability can cover opaque, transparent, and translucent objects.