The Challenge: Pattern Recognition

When it comes to microelectronics and photonics packaging assembly, components such as die are placed onto packages. All automated die bonding systems require some type of vision processing for the machine to accurately locate the component before picking and placing the part. Because of this dependency on vision processing, the die must possess clear features to reliably assemble packages, especially when it comes to automated processes.

Standard pattern recognition technology, known as auto correlation, uses pixel-to-pixel comparisons. Using this method, it is ideal to use pristine components with clear features to teach patterns. Using the learned patterns, components with identical conditions must then be presented in order to build assemblies in an automated process. Although this situation is ideal, it is not realistic because not all components will be identical.

The auto correlation method cannot account for variations such as damaged features and angled presentation. Due to variations of die bond components, it can be difficult to achieve high accuracy and repeatability when it comes to pattern recognition. Scratches, contamination, and even operator handling can cause two components of the same type to look different under the camera.

Another challenge that comes with auto correlation technology is its limited range of adjustable parameters when compared to other methods. For example, in order to raise production quality, one parameter that is typically adjusted is the pattern recognition threshold. By raising this threshold, only higher quality components will be recognized and assembled in production. Although this may seem like an advantage at first, this will lead to a larger amount of rejected components and unnecessary waste.

Furthermore, these challenges can lead to pattern recognition failures, manual references, and operator intervention, all of which are issues that greatly hinder automated production processes. It is critical to accurately find components in order to avoid these problems. Inconsistencies in how a fully-automatic die bonder system finds and locates the learned patterns will result in inconsistencies of die placement. This will not only introduce performance and yield issues, it will also impact downstream processes such as wire bonding.
In this example, there are two packages. They are the same type of part but they are not identical. With standard pattern referencing, it would be difficult to accurately locate these parts. Notice that the part on the right exhibits a different reflection due to variations in surface quality. Furthermore, the corner is slightly imperfect. These minor differences can lead to major setbacks in production causing lost time or wasted parts.

Below are examples of components that are typically difficult to locate with standard pixel-to-pixel referencing.

Image 1. Two of the same packages that are not physically identical.

Image 2: A capacitor exhibiting rough surface textures.

Image 3: A package exhibiting poor contrast.

Image 4: A chip exhibiting damaged edges.
The Solution: VisionPilot®

VisionPilot is a state-of-the-art referencing technology that sets a new standard for vision processing on Palomar's die bond platforms. In contrast to standard referencing technology, VisionPilot offers a wide range of tools and features to address the typical challenges of pattern recognition. This includes, but is not limited to, radar referencing, synthetic models, and active feedback.

RadarReferencing

Radar Referencing® is the key feature within VisionPilot that allows the bonder to use shapes instead of standard pixel-to-pixel comparison.

Radar Referencing finds shapes by dividing contrasting shapes. In this example, the shapes found by Radar Referencing are outlined in green (see the shapes inside the purple square). Using this method, component variations such as scratches, contamination, and probe marks can be filtered out. By only looking at shapes and outlines, the bonder can locate the component accurately and repeatedly.

In this example, VisionPilot is capable of finding the outer shape of this metallic preform component. Although we can see some surface imperfections in the center of the component, the software is able to accurately detect the outline while ignoring the imperfections.

Unlike standard auto correlation, another benefit of the Radar Referencing technique is that the die bonder will learn angle orientation in addition to the XY location. Standard auto correlation requires two points of reference to establish angle orientation. This improves the reliability of each learned reference.

With Radar Referencing, the user has full control over vision parameters and acceptance criteria. The bonder can compensate for component size variation, reference a part at any angle (full 360° range), and use one-point referencing, all the while maintaining high accuracy. With all these features combined, throughput will be significantly improved.
Synthetic Models

Synthetic models allow the user to teach perfect shapes as opposed to using a pristine component sample. In this example, due to the manufacturing process of the metallic preform component, there will be a lot of surface variation; no two parts will look identical. By comparing the actual (imperfect) components to a perfect model, the bonder can accurately locate the component.

Image 7.1 Synthetic Model:
Step 1: This metallic preform component has a rough surface. Although they are the similar in size, notice that the surrounding components exhibit different surface textures.

Image 7.2 Synthetic Model:
Step 2: A synthetic model is used to define the expected shape.

Image 7.3 Synthetic Model:
Step 3: Using the synthetic model, the bonder is able to accurately locate the outer edges of the metallic preform while disregarding variations such as surface textures and changes in contrast.

For further customization, VisionPilot offers round, rectangular, and annulus (ring-shaped) teaching tools for learning shapes. Using these tools, a customer could mask certain areas or teach specific shapes.

Image 8. VisionPilot offers round, rectangular, and annulus teaching tools.
In the example below, an annulus is used to teach the outer ring of the bond pad. The center of the bond pad (inner circle) is masked out and therefore ignored by the bonder. This allows the bonder to accurately locate the center of this pad without worrying about the bond pad variations such as probe marks or scratches from part to part; it only looks at the outline in this instance.

**Active Feedback**

Active feedback shows the user how accurately the bonder is identifying a component. It uses colors to quickly indicate strengths and weaknesses of that particular reference image.

In this example, the active feedback outlines the part with three colors. When the actual (imperfect) part is compared to the perfect synthetic model, green indicates that there is a good match, yellow is acceptable, and red is poor.

The user now has the option to provide materials that better match the model or allow the machine to skip lower quality objects. This gives the user more control over the operation and therefore improving the assembly process.

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**The Benefits of VisionPilot®**

**Reduce Development Time**
Start your production with confidence. With VisionPilot, users can create desired models with ease. Radar Referencing allows the user to create the best possible model given the materials that are available. Active feedback will verify the quality of these models so that you can proceed to production sooner.

**Save On Material Costs**
Save your best parts for production. With VisionPilot, lower-quality components with imperfect features can be used for development. Furthermore, Radar Referencing will limit failed references and skips during production producing less rejected assemblies.

**Minimize Operator Interruptions**
Radar Referencing allows the bonder to locate parts accurately and repeatably. This means less failed references and therefore less operator interruptions during production run.

Even when components are presented with some variation such as at an angle or with minor handling damage, the bonder can reliably find the part and its orientation. Valuable time and resources will be saved because there will be less time spent meticulously preparing materials for production.

**Improve Throughput**
Optimize production throughput with VisionPilot. With the ability to use one reference rather than two standard references, you can cut search time in half. With components skipped and minimal operator interruptions, VisionPilot leads to more units being built overall.
Making the connected world possible™

Making the connected world possible by delivering a Total Process Solution™ for advanced photonic and microelectronic device assembly processes utilized in today’s smart, connected devices. With a focus on flexibility, speed, and accuracy, Palomar’s Total Process Solution includes die bonders, wire and wedge bonders, vacuum reflow systems, along with Innovation Centers for outsourced manufacturing and assembly, and Customer Support services, that together deliver improved production quality and yield, reduced assembly times, and rapid ROI.

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