SMT Package

Automated Recognition, Inspection, & Guidance for Surface Mount Systems

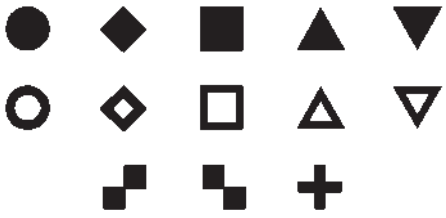
Datacube® provides machine vision solutions for surface mount technology (SMT) applications in the form of a hardware and software package for automated visual registration and inspection. In an ever-widening variety of semiconductor and electronics applications, Datacube technology assists with such tasks as the following:

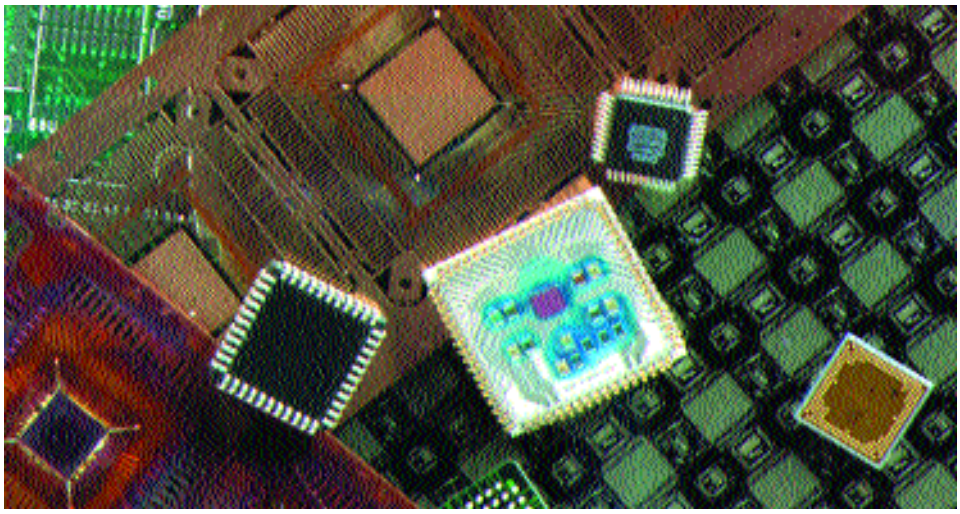
- Board assembly (pick-and-place, chip shooters, etc.)
- Screen printing
- Liquid dispensing
- Wafer steppers
- Wafer and reticle inspection
- Die cutting and bonding
- Wire bonding
- Lead frame inspection

Machine vision provides highly accurate alignment, inspection, and placement assistance in surface mount systems operating at high speeds. Advanced technology from Datacube, including superior vision technology and highly precise metrology algorithms, gives manufacturers of automated semiconductor and electronics machines a competitive advantage. Datacube offers solutions to meet any machine vision need with products ranging from individual hardware and software components to application-specific black boxes, fully configured and installed.

Fiducial and General Pattern Recognition

The SMT Package quickly recognizes standard fiducial shapes like those pictured below with high sub-pixel accuracy in gray-scale images. The robust recognition algorithms even work with partially oxidized fiducials. (See the table on the reverse side for typical results from accuracy tests.)





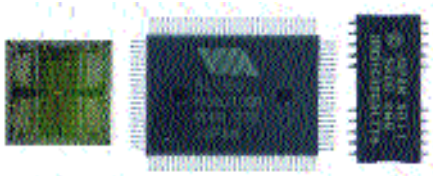
For non-standard fiducials or any arbitrary shapes, the SMT Package uses general pattern recognition (GPR). The package's primary GPR algorithm for orienting printed circuit boards, dies, wafers, etc. is a process called *normalized gray-scale correlation*. The patterns to be recognized (templates) include standard fiducials, arbitrary fiducials, board artwork, pads, bumps, etc.

Defining a template and using GPR is easy. An operator defines a template by outlining the area within a captured image to be used as an identifying pattern. The SMT Package automatically configures search parameters based on the template and the surrounding image. When a new image is captured, GPR searches the image for instances of the template. When matches are found, sub-pixel position information is computed. (See the figure of the paraboloid on the reverse side.)

Component Recognition and Inspection

Component recognition and inspection is essential for automatic board assembly. The SMT Package includes algorithms specially developed for recognizing and inspecting a wide variety of surface mount components:

- QFPs, PLCCs, SOICs, SOJs, SOPs, and TSOPs
- Ceramic and PCB-type BGAs
- Surface mount connectors
- IC sockets with both inward and outward bending leads
- Transformers



- Flip chips and bare chips

The system verifies the component's dimensions, lead pitch, and lead lengths, and also detects bent leads and missing leads or balls.

Adaptive Algorithms

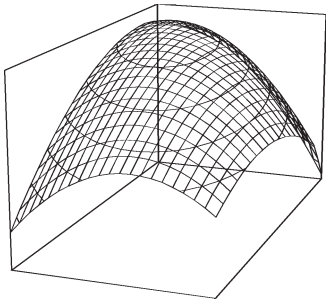
The SMT Package automatically adapts recognition and inspection tasks to changes in illumination and cosmetic variances in the imaged objects, providing the following benefits:

- Simplifies the operator interface with fewer operating parameters
- Locates fiducials with high sub-pixel accuracy
- Uses pattern recognition to locate arbitrary artwork or non-standard fiducials
- Provides numerous vision utilities for calibration and set-up
- Recognizes the position and orientation of a wide variety of surface mount components with a high level of accuracy
- Inspects leaded components for bent or missing leads, correct lead pitch, and correct lead length using high-speed metrology routines

and good default values for the parameters
- Reduces the detailed interaction between the vision system and host computer
- Provides reliable performance – day and night – for weeks of operation

Examples of the SMT Package's adaptability include the ability to:

- Automatically determine the optimal gain and offset to apply to the analog image signal prior to digitizing in order to maximize the dynamic range in the captured image
- Automatically compute good gray-level and edge thresholds
- Auto-train for general pattern recognition, setting good operating parameters
- Automatically identify a fiducial's shape and dimensions during training



A 3-D surface is fit to a neighborhood of correlation scores to achieve location accuracy exceeding 1/16 pixel.

- As an aid to the operator during setup, automatically determine a component's dimensions, lead pitch, number of leads on each side, ande missing leads

System Description

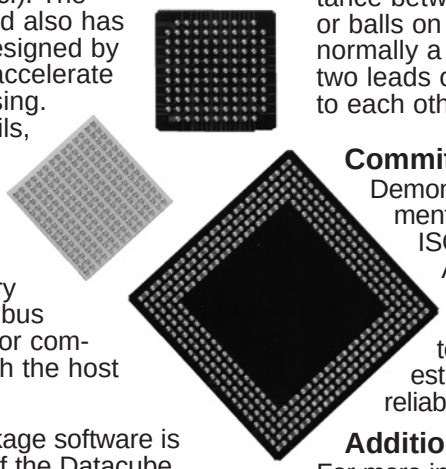
Datacube provides the SMT Package at a component level and in black-box solutions:

Black-Box Solutions: Customers may purchase a fully developed vision solution designed to meet their specific needs. Communication options include serial or Ethernet, plus binary input/output for synchronization with external events.

Vision Components: Customers may choose to purchase a combination of vision hardware and software components to develop their own applications. Hardware components include the following *mvPower*® board running the VxWorks® real-time operating system:

- *mvPower-VME*: a single-board solution on the VME bus with an embedded CPU

The embedded processor is a 100 or 200 MHz PowerPC 603e. The *mvPower* board has a modular camera interface for use with most cameras (RS-170, CCIR, digital, linear array, color, etc.). The *mvPower* board also has four ASICs, designed by Datacube, to accelerate image processing. For more details, see the *mvPower* data sheet. Serial ports, Ethernet, or shared memory buffers on the bus may be used for communication with the host computer.



The SMT Package software is an extension of the Datacube MaxVision Toolkit. The toolkit provides a library of fast, highly accurate, and easy-to-use machine vision tools to speed and simplify application development. For more details, see the MaxVision Toolkit data sheet.

SMT Development Systems: A development system is required for customers who buy the SMT Package at the components level. The software development environment is Tornado™, a product of Wind River Systems. Tornado includes the GNU C/C++ toolkit, graphical debugger, shell, linking cross loader, networking, and more. Tornado is available for Windows 95™, Windows NT™, and UNIX®.

Cutting Edge Accuracy

The table below shows the results of accuracy tests performed using X-Y and rotating micrometer stages. "Diagonal size" is the maximum distance between the tips of two leads or balls on the component. This is normally a measurement between two leads or balls diagonally opposed to each other.

Commitment to Quality

Demonstrating a strong commitment to quality, Datacube is an ISO 9001 certified company. All stages of product development are governed by ISO-compliant procedures, to provide you with the highest possible levels of service, reliability, and product quality.

Additional Information

For more information about the products mentioned in this document, please refer to the following literature available from Datacube:

mvPower Data Sheet

MaxVision Toolkit Data Sheet

Results from accuracy tests conducted with the SMT Package

	Type of Movement	Standard Deviation	Maximum Error	Diagonal Size	Field of View[1]
Circular Fiducial	Translation	0.42 mm	1.75 mm	N/A	8.4 x 6.3 mm
Square Fiducial	Translation	0.38 mm	1.96 mm	N/A	8.4 x 6.3 mm
Correlation on Circular Fiducial[2]	Translation	0.23 mm	1.09 mm	N/A	8.4 x 6.3 mm
Correlation on Square Fiducial[2]	Translation	0.29 mm	1.24 mm	N/A	8.4 x 6.3 mm
PGBA, 1.21 mm pitch[3]	Translation	0.78 mm	4.07 mm	42 mm	72 x 54 mm
PGBA, 1.21 mm pitch	Rotation	0.005 °	0.016 °	42 mm	72 x 54 mm
PLCC-84, 1.275 mm pitch	Translation	1.72 mm	6.27 mm	39 mm	72 x 54 mm
PLCC-84, 1.275 mm pitch	Rotation	0.009 °	0.018 °	39 mm	72 x 54 mm
QFP-100, 0.65 mm pitch	Translation	1.30 mm	5.95 mm	26 mm	72 x 54 mm
QFP-100, 0.65 mm pitch	Rotation	0.008 °	0.022 °	26 mm	72 x 54 mm
QFP-208, 0.5 mm pitch	Translation	1.43 mm	6.01 mm	40 mm	72 x 54 mm
QFP-208, 0.5 mm pitch	Rotation	0.009 °	0.019 °	40 mm	72 x 54 mm

(1) In all cases, the fields of view were 640x480 pixels. (2) Control parameters for correlation were automatically computed. (3) Only the 84 balls on the perimeter of the BGA were analyzed.

D A T A C U B E

Datacube, Inc. • 300 Rosewood Drive • Danvers, MA 01923 • Voice 978-777-4200 • Fax 978-777-3117 • http://www.datacube.com • info@datacube.com