OMC and BAe Systems win DSP in Action Award 1998.

OMC and BAe Systems received the DSP in Action Award for 1998 in recognition of a their work creating a DSP system for use in 3-D measurement. This technology eventually went on to be used in the development of a highly advanced measurement system for a large metrology company.

If you need to measure the position of moving objects to an accuracy of one in 30,000, but they are part of a manufacturing production line in a factory. What do you do? A group of engineers at BAe Systems and the Optical Metrology Centre were confronted with just such a problem, which they have solved with an array of charge-coupled device (CCD) cameras and some digital signal processing (DSP) know-how.

What was required was a method of simultaneously measuring the position of a number of mechanical components during the assembly process in one of BAe Systems production plants. This involved obtaining precise 3-D coordinates for over a hundred measured points, and because the measurements had to be carried out on operational equipment, the real-time coordinates had to be generated 25 times a second.

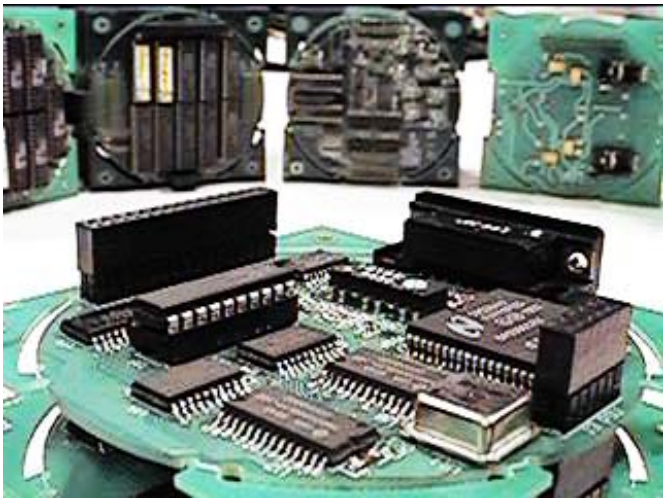
The development group decided on a system design which used an array of CCD cameras to generate the coordinate information using triangulation measurement techniques. A key element of the design was the processing of the real-time video stream which was carried out locally at each CCD camera. In each module the image data from the camera is used to produce 2-D coordinates for each target image and makes them available to the next stage in the 3-D image generation process. Typically the target images may occupy less than five per cent of the image. Target image intensity data is stored in FIFO buffers along with its location coordinates, and video frame and field maker bits.

The use of hardware-based signal processing enables the image data to be processed on the fly. High contrast target makers and detection algorithms, which operate directly on the compressed data, allow for real-time compression of the useful video data to around five per cent of the raw video bandwidth. The use of FIFO buffers allows the processor to also implement the necessary communications protocol and control functions for transmitting the 2-D image data over an Ethernet LAN. Thus real-time 2-D image data from up to 172 locations on a target object can be transmitted over a network with no more bandwidth than standard Ethernet.

“The beauty of the scheme”, says Dr Tim Clarke of the Optical Metrology Centre, “is that it supports real-time processing using a DSP no more powerful than an ADI2101. The system uses very efficient image processing and Ethernet communications data compression.”

Typically the Ethernet communications processing takes up just five per cent of the overall processing effort in a 40ms DSP processing loop. The use of multiple video images of an object for implementing accurate measurement operations is a technique known as photogrammetry. It can be applied to many applications in the manufacturing

and measurement process, or outside it. Dr Clarke believes it may find applications in medical systems where it could be used to track the movement of surgical instruments. It may also have a use in generating highly accurate animated images.



The DSP in action modular system components

The CCIR signal from the camera is connected to the video processor. The composite video sync or separate pixel, line and field clocks are alternatively used to sample the image using a 10-bit A/D converter. Target image coordinates and intensity information are stored in FIFO buffers, along with frame and field makers.

Upon start-up the DSP resets the FIFO buffers and finds the beginning of the image frame. The data is then read line-by-line using either a 20ms field or 40ms frame-based scheme. The target image objects are reconstructed on a line by line basis using only the information contained in the current and previous lines. The 2-D image coordinates are transmitted to a central processing unit which generates the 3-D data at video frame rate. Usually the 2-D image coordinates are available immediately after the camera has output the image. This data is then sent to the host unit upon request using the TCP/IP protocol.