Imaging Insight

Autumn 2000 Vol. 2, No. 3

One year later...

It's hard to believe a full year has passed since Matrox Imaging published its first issue of Imaging Insight in Autumn 1999. The newsletter has received positive feedback and is fulfilling its role as a communication link between Matrox Imaging and its customers. As customers indicated in a recent online survey we conducted, efforts like Insight, our Developers' Forum and email up-dates are necessary – and much appreciated – to nurture our relationship with customers around the world. So, we'll keep on listening and keep on publishing!

In this issue read all about our latest industrial computer – 4Sight-II – which boasts increased power and PC performance, about how the Matrox Meteor-II has become a robotic football star, check out MIL benchmarks, and much more.

Thank you for your continued interest in Matrox Imaging!

François Bertrand
Director, Sales & Marketing
Matrox Imaging

Inside...

Matrox 4Sight-II Q&A	2
Application Spotlight	4
Show Time!	6
Software Corner	7

Matrox 4Sight-II packs a good punch

New addition to family of industrial imaging computers features more powerful desktop PC performance

Matrox Imaging's latest industrial computer, 4Sight-II, offers more power, desktop PC performance, flexible video capture and leading-edge graphics capabilities. This addition to the 4Sight family of self-contained imaging platforms includes the tools OEMs and integrators need to build cost-effective machine vision, medical imaging and surveillance applications.

4Sight-II integrates image processing, display, networking and general purpose I/Os, and can acquire from just about any video source, including IEEE-1394 cameras. Some of the key PC technologies found on this system include an embedded Intel® Celeron™ or Pentium®-III processor for applied computing, as well as Matrox's own G450 graphics controller – featuring DualHead™ display technology and graphics overlay on live video output.

On the software side, this imaging platform runs Microsoft® Windows® NT® Embedded and is compatible with Windows 98/NT and 2000. 4Sight-II is programmed using Matrox Imaging's award-winning software development library.

For more information on Matrox 4Sight-II pricing and availability, call: +44 (0) 1753 665511 or email: image.info.uk@matrox.com.

Want to learn more about 4Sight-II? Turn the page for a Q&A with Fabio Perelli, Matrox Imaging's Product Manager for Stand-alone Systems...

Matrox 4Sight-II Q&A

Imaging Insight discusses the latest addition to Matrox Imaging's family of self-contained industrial imaging computers with Fabio Perelli, Product Manager for Stand-alone Systems...

How does 4Sight-II differ from its predecessor 4Sight?

"Like 4Sight, 4Sight-II is a compact, industrial computer for cost-sensitive machine vision, medical imaging and video surveillance applications. The difference, however, is 4Sight-II's desktop PC performance. Along with a very powerful CPU, 4Sight-II offers high-performance graphics with the Matrox G450 graphics controller, which includes DualHead display technology. And, with fast switching between multiple video inputs plus the ability to grab from just about anything, including 1394, 4Sight-II provides very flexible video capture.

"Aside from these features, all else is pretty much equal between 4Sight-II and 4Sight. With the same small footprint and rugged construction, these two integrated and expandable platforms allow for ease of development and deployment."

How does desktop PC performance benefit customers in the imaging industry?

"There are two main requirements for image processing. The first is a fast CPU to perform image analysis in real time. One of the biggest concerns amongst OEMs and integrators is to not lose production efficiency by adding vision to the application. Secondly, image display is crucial. A doctor, for example, has to have the highest image quality and fastest image updates possible in order to achieve the best diagnosis. Recognizing these requirements, we have designed 4Sight-II to include the latest PC technologies including an embedded Intel Celeron or Pentium-III processor for applied computing, and the G450 graphics controller.

"With this product, we've leveraged PC technology for high-performance, low-cost components while ensuring interoperability by offering a single, integrated solution from one vendor. We went with the Intel Embedded processors in order to ensure long-term supply – a design stability required by OEMs and integrators. In short, 4Sight-II allows you to spend less time integrating individual system components and more time developing your application."

With the 4Sight-II now available, where does 4Sight fit into the picture?

"While 4Sight-II is specifically designed to handle processing-intensive imaging applications, 4Sight is still the choice for low-cost applications and situations where the computer is housed in a sealed box and heat can't dissipate easily. 4Sight, which is for embedded applications only, consumes less power – in fact, you can use it with batteries – and therefore generates less heat, which is good for highly embedded applications. As well, for certain applications that may not require huge processing power, 4Sight has more than enough power to get the job done."

For what applications is 4Sight-II most suited?

"Because of its size, power, ruggedness and other capabilities, 4Sight-II is suited for such industries as semiconductor, pharmaceutical, automotive, robotics, ultrasound, endoscopy, traffic control, bank security, to name a few."

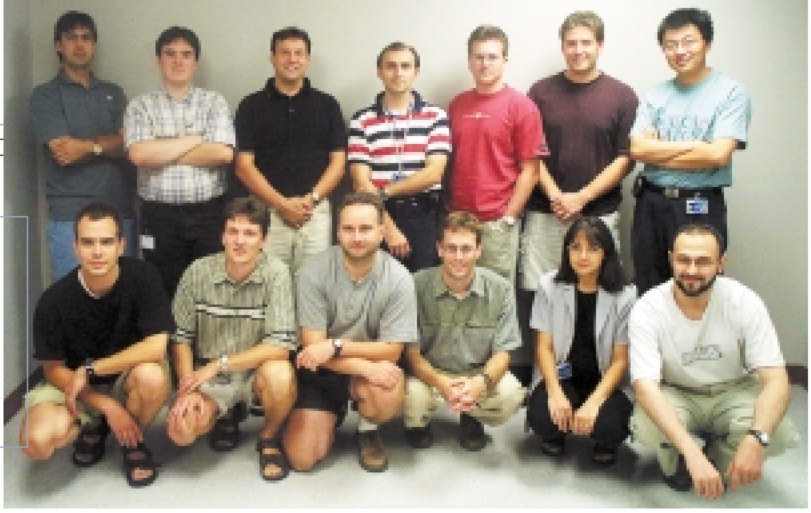
What does the future hold for this family of industrial imaging computers?

"Our 4Sight-II team is dedicated to continually improving upon this technology and expanding our line of industrial imaging computers in the future. The possibilities are endless, really!"

For more info, go to:

4Sight-II:
www.matrox.com/imaging/prod/4sight2/

4Sight:
www.matrox.com/imaging/prod/4sight/



Stand-alone Systems Product Manager Fabio Perelli (centre, back row) and the 4Sight-II development team at Matrox Imaging, Montreal, Quebec, Canada.

4Sight/4Sight-II comparison table

Key features	4Sight	4Sight-II
CPU	MediaGX 266 MHz	Celeron 566 MHz, Pentium-III 850 MHz
Display		
• VGA	Analogue	2 analogue or 1 analogue and 1 digital (DualHead technology)
• TV	VGA desktop	VGA desktop or VGA video-in-a-window (DualHead technology) * 1 TV output can be combined with either 1 analogue or 1 digital output.
Storage		
• Hard Drive	6 GB	6 GB
• Flash Disk	48 MB (DiskOnChip) (standard density)	64 MB (standard density)
• RAM	Up to 128 MB	Up to 1 GB
Peripheral ports		
• USB	Not available	2 ports (keyboard/mouse)
• PS/2	2 ports (keyboard/mouse)	Not available
• Serial	2	2 (one is configurable for RS-232 or RS-485/422)
• Parallel	1	1
• Network	10/100 Base-T Ethernet	10/100 Base-T Ethernet
• Floppy	1 (on motherboard)	Not available
• IDE	2	2
• Auxiliary I/Os	20 discreet LVTTL	16 discreet LVTTL or opto-coupled
• 1394	3 ports	3 ports
PC/104-*Plus* expansion	Both ISA and PCI buses	Both ISA and PCI buses
Video capture	Meteor-II Standard, Multi-Channel frame grabbers for PC/104-*Plus*	- Meteor-II Standard, Multi-Channel, Digital for PC/104-*Plus* - Basic frame grabber module - RGB frame grabber module
Audio	16-bit stereo line in/out	16-bit stereo line in/out
Operating system	- Windows NT Embedded - Windows NT 4.0 Workstation	- Windows NT Embedded - Windows NT 4.0 Workstation - Windows 2000
Matrox Imaging Library	Version 6.1	Version 6.1
Dimensions	8.2" x 7.25" x 2.952"	8.2" x 7.25" x 3.302"

Imaging Insight

Publisher: Matrox Imaging
Editor: Kelly Davis
Art Director: Jean Simard
Production: Kristen Banham
Marketing Communications: Catherine Overbury, Manager

For more information on articles published in this issue, or to share your comments, please contact the Editor at +1 514-685-2630 ext. 7970 (tel), +1 514-822-6273 (fax) or kdavis@matrox.com.

All written comments or requests may be sent to:
The Editor – Imaging Insight
Matrox Imaging
1055 St. Regis Blvd.
Dorval, Quebec H9P 2T4
Canada

Want to subscribe?

Go to: www.matrox.com/imaging/whatnew/newslet.htm

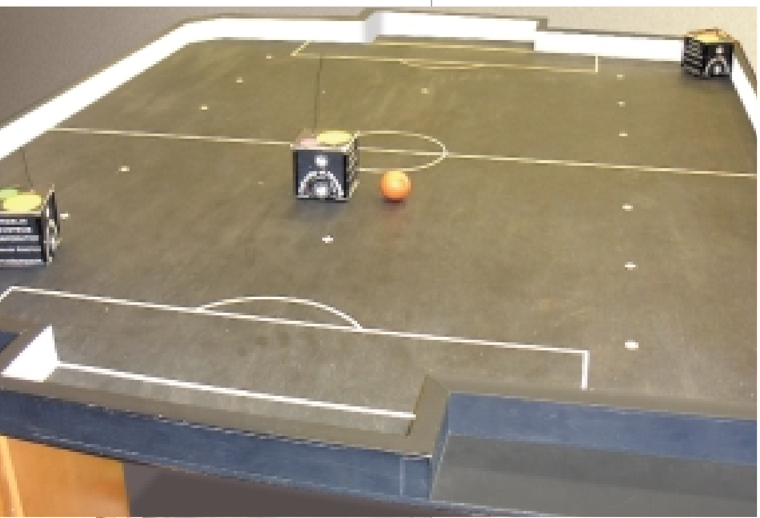
MATROX IMAGING

Robotic football with a vision

Matrox Meteor-II frame grabber used in UK team robots

By Peter Gallon/Kelly Davis

If the idea of robots playing football sounds a little far-fetched and frivolous, a discussion with the man behind the UK's leading robot football team will convince you of the serious purpose behind the on-field antics of six cuboid robots.



For Paul Robinson, robot football is not only a means of motivating students at Plymouth University but it also provides a solid foundation for developing "more serious" robotics technology.

For Paul Robinson of Plymouth University, not only is robot football a means of motivating students but it is also an excellent foundation for developing robotics technology.

"The pool from which suitably qualified students can be drawn – in particular those who have studied Physics, Mathematics and Chemistry – has shrunk alarmingly since the 1980s, leading to an over-provision of engineering course places in the UK," says Robinson. "Many such courses are very traditional and I feel this has been a key element in deterring potential students."

In response to this problem, Robinson established the first dedicated undergraduate robotics programme in the UK – the BEng (Hons) degree in Robotics and Automated Systems – in 1993. "The technology and transferable skills that the students learn through robotics hardware and software are effectively the gateway to a vast number of fields," he says. "The comprehensive range of skills with which the course equips students means that our graduates have the highest employment level of any engineering course at the university."

Enter robot football

Until about six years ago, the three critical technologies at the heart of robot football – real-time vision recognition, artificial intelligence and micro-robotics – tended to exist as separate disciplines. It became widely recognised that the new, evolving, information-centred industrial revolution would be largely dependent upon these technologies.

Consequently, in the early 1990s, SONY's research laboratories in Japan decided to use robot football as a vehicle for accelerating research in these strategically important technologies. SONY created an organisation called Robocup to establish the ground rules and organise international robot football competitions. This was soon followed by the creation of Mirosot (Micro Robot Soccer Tournament) at KAIST (the Korean Advanced Institute of Science Technology) for smaller robot footballers. Robocup is concerned with robots from 15cm cube upwards whereas Mirosot deals with robots 8cm cube and smaller.

In the UK, the first institution to become involved in robot football was the Open University, thanks to Dr. Jeff Johnson, a senior research fellow. In 1997, Johnson met Robinson and the two decided to work together on developing teams of 8cm cube, football-playing Mirosot robots.

How it works

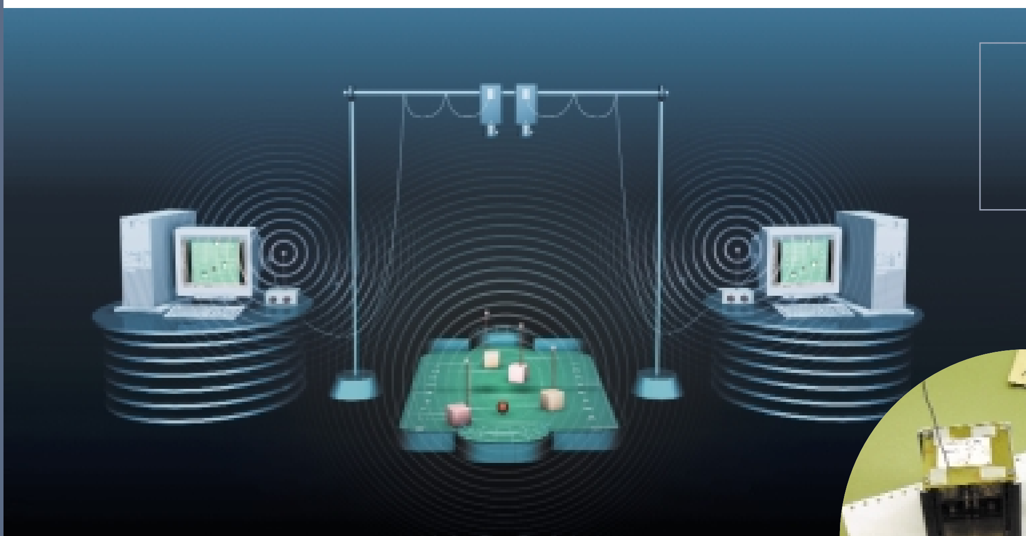
Each Mirosot team set-up consists of four robots – two outfield players, a goalkeeper and a substitute. On a gantry over the specially marked 150cm x 130cm pitch is a video camera connected to a host PC for each team. Plymouth uses a Matrox Meteor-II board to grab the video stream. Plymouth's software, which is currently written in "C" to operate under Windows NT 4, analyses the images and determines the position and orientation of the three robots plus the position of the orange golf ball which is used as the game ball. This positional information is passed on to a strategy section of the controlling programme in order to decide the players' next move. Movement orders are then transmitted from the PC to the robots via a UHF communications link.

There are rules limiting the options. For example, the goalkeeper cannot move outside the 'six yard' box and a defender may not enter the box. The basic strategy currently employed by Plymouth's team is that the outfield robot closest to the ball positions itself behind the ball, in-line with the ball and the opposing team's goal. It then attempts to 'run' with the ball towards the opposition's goal. In the meantime, the goalkeeper moves to the X coordinate value of the ball (X being the width of the pitch and Y the length). Movement instructions are downloaded to the transmitter, which transmits the relevant commands. As all three robots receive the same signal, identification codes for the robots are included within the transmission, so that each robot only responds to its intended instructions. The UHF radio link operates at either 418MHz or 433MHz. In order to avoid radio interference, opposing teams are required to transmit at different frequencies. Thus, closed-loop control is achieved.

The camera continues to monitor movement on the pitch and the cycle is repeated until a goal is scored. Cycle time is a critical factor in the success of a team. The team that can minimise the time of the full control cycle possesses an enormous advantage and will invariably play best – all other factors being equal. Currently, the University of Plymouth's cycle time is <500mS and the objective is to decrease this time by a factor of 10.

All teams must have two sets of 'shirts' – the coloured targets stuck to the top of the robots that allow the controlling PCs to identify the position and orientation of the players. Colours for the shirts are usually yellow, blue or green in order to simplify colour resolution for the camera. The only colour not allowed is orange. Orange is reserved as the ball colour. Robinson says they are researching the possibility of combining colour and pattern recognition for improved accuracy in the future.

The robots themselves are manufactured by a local company, Merlin Systems, which also has its own robot football team. Merlin Systems provides useful local competition to the university team and in turn, the university makes both its software and hardware developments available to the company. The robot design is now in its sixth generation, having started as a Lego model, and is a modular design of approximately 7.5cm cubed. These robots are easily dismantled for repair or modification. The on-board ATMEL microprocessor, FM receiver, power electronics and interfacing have been shrunk down to a single, small card about 7cm square. Robinson believes this card is of significant commercial value in its own right.



Lights, camera, recognition

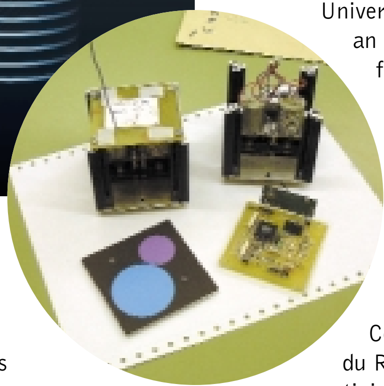
The video camera requires a telephoto lens, since its height above the pitch is not fixed and can vary as much as 500mm either way. Such a lens introduces distortions, i.e. spherical aberration, which must be removed in the software to obtain a rectangular image of the pitch. Before the game starts, the camera must be calibrated to the ambient light conditions that vary considerably both from venue to venue and during a game. Plymouth has written calibration software which scans the pitch and identifies the colours within it – from the players, the ball and the pitch itself. It has nevertheless proven preferable to play under artificial lights and away from open windows. If calibration is successful, then recognition confidence is high – in excess of 90%.

The recognition process involves seven pieces of data – the position of three robots, their orientation and the position of the ball. The image is currently 640 x 480 pixels and is scanned into memory for pixel identification. Not all pixels need to be recognised, however. Depending on the size of the object and the pixel size, it may only be necessary to recognise every fourth or sixth pixel. For example, if the robots are wearing yellow 'shirts' the camera will scan across the pitch until a yellow circle is located by the identification of a yellow pixel. The area around the yellow pixel is then scanned to locate the second small circle which identifies the individual robot and also provides orientation information. This is repeated for the other two players and the ball is located to complete the data set.

Currently, the system does not take into account the locations of opposing robots.

Software filters can have their parameters altered manually to cope with ambient light changes, but Robinson is already looking forward to adaptive filtration that would measure the ambient light level independently of the colour, analyse the spectral content and adjust the filters accordingly. While there are numerous other innovations waiting in the wings for when the necessary resources become available, Robinson states that his team – some 12 people on-site and another 3-4 elsewhere – has made enormous strides in the past two or three years.

The components of a Mirosot robotic football player (below) and game set-up (left).



World Cup

Plymouth and the Open University put together an English team for the 1998 Robot World Cup in Paris, held concurrent with the FIFA World Cup competition. The 1998 Coupes de Monde du Robots was a prestigious event held at the Cité de Science de l'Industrie. Matches were screened on French TV between the human games of the World Cup. Approximately 40 teams took part in the robot football competition with all five continents represented. It was immediately after the Robot World Cup that Robinson and his team began to think seriously about the vision system components they had developed. Although they reached the quarter finals in the Mirosot category, they returned from Paris disappointed at how far behind they were from the best of the rest of the world – particularly the Japanese, Koreans and Americans. A lack of effective machine vision was identified as the key shortcoming. The ability of the system to identify the players, the ball and their positions on the pitch – at the highest possible frame rate – was essential to play the game effectively.

At that point, the team began looking for new image capture cards. "We wanted a board that could theoretically deliver a high frame rate – ideally 50 frames per second – with direct memory addressing, either RGB or Chrominance/Luminance-based colour, and reasonable definition, of course," says Robinson. He was able to raise sufficient funds to purchase cameras and cards, deciding on Matrox Meteor-II frame grabbers.

Robinson is sure that European co-operation will be essential to compete effectively against the USA and Japan, which is where the serious purpose of Mirosot becomes apparent. Therefore, he and other European colleagues in December 1999 set up the European Federation of Co-operative Robotics. The federation will use robot football as a demonstration platform for the three strategic technologies. As he says, robotic football is one of the few areas of high-technology research where a complete amateur can decide who is best.

Creators and coaches: members of the Plymouth Mirosot robotic football team.

The future

Research is ongoing at Plymouth University with the goal of creating an intelligent, autonomous group of robots. For this they will need sensing ability (principally vision), their own power supplies, actuation and all the computing power they need to operate autonomously. Control systems could be varied, for example neural networks to improve recognition heuristically over time as they played successive games. Stereoscopic vision would be required for more accurate gauging of distances. The robots would also be able to reach strategic decisions between themselves and so would need transceivers rather than receivers. Robinson expects that the football-playing robots will be able to talk to each other within 18 months, if only in a simple capacity to prove the technology.

Looking ahead, Robinson anticipates that within the next year there could be six to eight UK universities fielding Mirosot teams – including Wales, Oxford, Salford, Reading and Essex. He believes that if a UK league can be established, the momentum created by a core of committed universities will grow rapidly as engineering institutions like the Engineering Council and the Royal Academy of Engineering latch on to an application area with mass appeal.

Interestingly, he also believes that the next generation of robots will be 'soft' robots, primarily in the service industries and driven not by motors but by such innovations as air muscles. As robots become more complex, their sensing abilities become critical, which is where vision comes in. Robinson is convinced that if the sensing problems can be overcome, huge benefits can be accrued. He cites the food industry, where contamination by human operatives is a major problem and one he believes suitable robots can solve.

Robinson's ambitions for the team are considerable, which is justified given the media interest the 'sport' regularly attracts. Earlier this year, BBC2 invited Plymouth University and Merlin Systems Corporation to take part in an international Mirosot competition in the Millennium Dome, located in London. This was considered a home fixture after Plymouth had beaten the European Mirosot champions, Austria, 12-2 in a competition shown on German television in December 1999. The focus was on the England/Germany clash. This match, plus much accompanying hype, was broadcast during prime time viewing on a Friday evening. On this occasion, the German team was beaten, although Robinson admits sheepishly that the win owed more to the German team's technical problems than to the home team's dazzling ball-play.

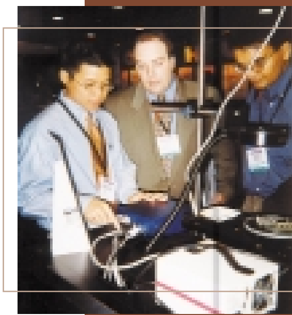
Eyes firmly set with evangelical zeal on the next World Cup in Japan in 2002, Robinson is confident about where his team is going - just as long as he can keep their eyes on the ball and their sights set on the future!

For more info, go to:

www.tech.plym.ac.uk/robofoot
www.merlinsystemscorp.com

It's show time!

See Matrox Imaging and our representatives at the following trade shows...



The Vision Show (AIA)
San Jose, California
October 3-5, 2000

FinnTec
Helsinki, Finland
October 3-6, 2000

Vision '00
Stuttgart, Germany
October 18-20, 2000

Kemia
Helsinki, Finland
November 15-17, 2000

RSNA
Chicago, Illinois
November 26-December 1, 2000

APEX 2001
San Diego, CA
January 16-18, 2001

IPOT 2001
Birmingham, England
February 16-17, 2001

Need Tickets?

To receive complimentary trade show passes, please contact:

European shows
Matrox VITE Limited
+44 (0) 1753 665511

North American shows
Matrox Imaging Marketing
+1 (514) 685-2630 ext. 7638

For more information on these shows, head to our website at:

http://www.matrox.com/imgweb/whatnew/trade.htm

Latest MIL Benchmarks

MIL Guide updated to reflect 6.1 release

The recently updated, comprehensive 50-page guide to the award-winning Matrox Imaging Library (MIL) includes an overview of the latest release of the software – MIL 6.1 and ActiveMIL 2.1 – plus up-to-date benchmarks (see below), a listing and quick-reference description of each library command, plus real-world programming examples.

Go to: **www.matrox.com/imaging/prod/mil/mil_guide_sections.htm** to download the entire MIL Guide (in .pdf format) or select individual sections of the guide to download (also in .pdf format).

The following benchmarks provide a performance overview for a range of imaging operations. The benchmarks listed below have been validated on a variety of the latest platforms. A brief description of all functions, parameters and images used are also included. Note that the benchmarks assume full CPU and memory bandwidth (i.e., no other system activity) and include system overhead.

Image Processing Operations	Pentium® III @ 1 GHz/ 133 MHz FSB	Athlon™ @ 1 GHz/ 100 MHz FSB	Pentium® III @ 800 MHz/ 100 MHz FSB	Celeron® @ 500 MHz/ 66 MHz FSB
Point-to-point Add two 8-bit images and store results in an 8-bit destination image.	1.4 ms	1.3 ms	1.5 ms	3.2 ms
Edge Detection (sobel) Perform an edge detection (sobel) on an 8-bit source image and store results in an 8-bit destination image.	3.2 ms	2.0 ms	3.6 ms	6.0 ms
Convolution (3 x 3) Perform a general 3 x 3 convolution with arbitrary coefficients on an 8-bit source image and store results in an 8-bit destination image. Results are saturated.	3.6 ms	2.4 ms	4.1 ms	7.0 ms
Convolution (5 x 5) Same as above except with a 5 x 5 kernel.	7.3 ms	6.5 ms	8.9 ms	14.5 ms
Convolution (11 x 11) Same as above except with a 11 x 11 kernel.	34.8 ms	31.2 ms	38.7 ms	69.6 ms
Erosion/Dilation (3 x 3, predefined, binary) Perform a binary erosion/dilation on a 1-bit source image using a predefined 3 x 3 structuring element and store results in a 1-bit destination image.	134 μs	150.6 μs	164.8 μs	460.1 μs
Erosion/Dilation (3 x 3, predefined, grayscale) Same as above except perform a grayscale operation.	2.7 ms	1.9 ms	2.9 ms	5.3 ms
Erosion/Dilation (3 x 3, user-defined, binary) Perform a binary erosion/dilation on a 1-bit source image using an arbitrary 3 x 3 structuring element and store results in a 1-bit destination image.	496 μs	458.2 μs	619.6 μs	1.2 ms
Erosion/Dilation (3 x 3, user-defined, grayscale) Same as above except perform a grayscale erosion/dilation operation.	4.0 ms	3.3 ms	4.3 ms	7.7 ms
Erosion/Dilation (5 x 5, user-defined, binary) Perform a binary erosion/dilation on a 1-bit source image using an arbitrary 5 x 5 structuring element and store results in a 1-bit destination image.	2.0 ms	1.8 ms	2.5 ms	4.3 ms
Erosion/Dilation (5 x 5, user-defined, grayscale) Same as above except perform a grayscale erosion/dilation.	9.0 ms	9.4 ms	10.6 ms	17.5 ms
Histogram Calculate the histogram of an 8-bit source image and store result in a 32-bit buffer.	1.9 ms	1.3 ms	2.3 ms	4.4 ms
LUT map Perform a point-to-point LUT mapping operation for an 8-bit source image and store results in an 8-bit destination image.	2.1 m	1.9 ms	2.3 ms	3.9 ms
Lossless JPEG Compression Perform lossless JPEG compression on an 8-bit source image and store results in an 8-bit destination image.	7.4 ms	10.7 ms	8.9 ms	14.8 ms
Lossy JPEG Compression Same as above except perform lossy JPEG compression.	5.9 ms	5.8 ms	7.3 ms	12.3 ms
Rotate (55°) Rotate by 55° an 8-bit source image and store results in an 8-bit destination image.	5.9 ms	6.5 ms	7.1 ms	12.0 ms
Warp Polynomial Warping using a first-order polynomial mapping on an 8-bit source image and store results in an 8-bit destination image.	8.9 ms	10.5 ms	10.9 ms	17.2 ms

Note: Operations executed on 512 x 512 images. Benchmarks performed under Windows NT.

MIL Benchmarks continued...

	Pentium® III @ 1 GHz/ 133 MHz FSB	Athlon™ @ 1 GHz/ 100 MHz FSB	Pentium® III @ 800 MHz/ 100 MHz FSB	Celeron® @ 500 MHz/ 66 MHz FSB
Pattern Matching [1, 2]				
Normalized Grayscale Correlation (128 x 128, non-rotated) Perform a pattern match of a 128 x 128 model in an 8-bit grayscale image. The whole image is searched and the model position is located with 0.1 pixel accuracy.	2.0 ms	1.8 ms	2.2 ms	4.0 ms
Normalized Grayscale Correlation (32 x 32, non-rotated) As above except perform a pattern match of a 32 x 32 model.	6.5 ms	6.1 ms	7.2 ms	14.1 ms
Normalized Grayscale Correlation (128 x 128, -5° to +5°) Perform a pattern match of a 128 x 128 model located at 0° in an 8-bit grayscale image. The whole image is searched with a range of -5° to +5° and the model is located with a 0.1 pixel accuracy and ±0.1° accuracy.	5.2 ms	5.2 ms	5.8 ms	10.7 ms
Normalized Grayscale Correlation (32 x 32, -5° to +5°) As above except perform a pattern match of a 32 x 32 model.	14.1 ms	13.1 ms	14.8 ms	26.9 ms
Normalized Grayscale Correlation (128 x 128, -180° to +180°) Perform a pattern match of a 128 x 128 model located at 30° in an 8-bit grayscale image. The whole image is searched with a range of -180° and +180° and the model is located with a 0.1 pixel accuracy and ±0.1° accuracy.	24.7 ms	23.2 ms	28.3 ms	48.1 ms
Normalized Grayscale Correlation (32 x 32, -180° to +180°) As above except perform a pattern match of a 32 x 32 model.	334.0 ms	268.1 ms	381.0 ms	587.0 ms
Blob Analysis (Blobs in image occupy approximately 25% of area.)				
Calculate Area (100 blobs)	1.2 ms	1.1 ms	1.5 ms	2.4 ms
Calculate Area + Binary Center of Gravity (100 blobs)	1.4 ms	1.3 ms	1.7 ms	2.8 ms
Calculate Area + Grayscale Center of Gravity (100 blobs)	3.5 ms	2.8 ms	4.0 ms	7.0 ms
Gauging & Measurement				
Find an Edge Locate an edge in a 16 x 4 measurement region.	60.8 µs	73.6 µs	75.4 µs	172.5 µs
Find Multiple Edges Locate 24 edges in a 128 x 16 measurement region.	268.8 µs	272.9 µs	297.3 µs	626.1 µs
OCR				
OCR Reading Read an unknown string of 12 SEMI font characters (33 x 21) within a 404 x 54 image region.	51.9 ms	47.0 ms	64.3 ms	112.6 ms
Verification Verify that a known string of 12 SEMI font characters (33 x 21) within a 404 x 54 image region can be read properly.	6.7 ms	7.2 ms	7.5 ms	14.9 ms
Bar and Matrix Code Recognition				
Bar Code Reading Read a EAN13 bar code (no rotation).	3.8 ms	3.8 ms	4.4 ms	57.6 ms
DataMatrix Reading Read a DataMatrix code.	8.0 ms	7.7 ms	9.0 ms	21.1 ms

1 Faster search speeds can be obtained by reducing positional/rotational accuracy.
2 Search speeds will vary with image content.

Corporate headquarters:

Canada and U.S.A.
Matrox Electronic Systems Ltd.
1055 St. Regis Blvd.
Dorval, Quebec H9P 2T4
Canada
Tel: +1 (514) 685-2630
Fax: +1 (514) 822-6273

Offices:

Europe, Middle East & Africa
Matrox VITE Limited
Sefton Park
Stoke Poges
Buckinghamshire
SL2 4JS
U.K.
Tel: +44 (0) 1753 665500
Fax: +44 (0) 1753 665599

France
Matrox France SARL
2, rue de la Couture,
Silic 225
94528 Rungis Cedex
Tel: (0) 1 45-60-62-00
Fax: (0) 1 45-60-62-05

Germany
Matrox Electronic Systems GmbH
Inselkammerstr. 8
D-82008 Unterhaching
Germany
Tel: 089/614 4740
Fax: 089/614 9743

Asia Pacific
Matrox Asia Ltd.
12F
Guangdong Investment Tower
148 Connaught Road Central
Sheung Wan
Hong Kong
Tel: 852.2281.5700
Fax: 852.2537.9530

Printed in Canada
SIE-5177-B