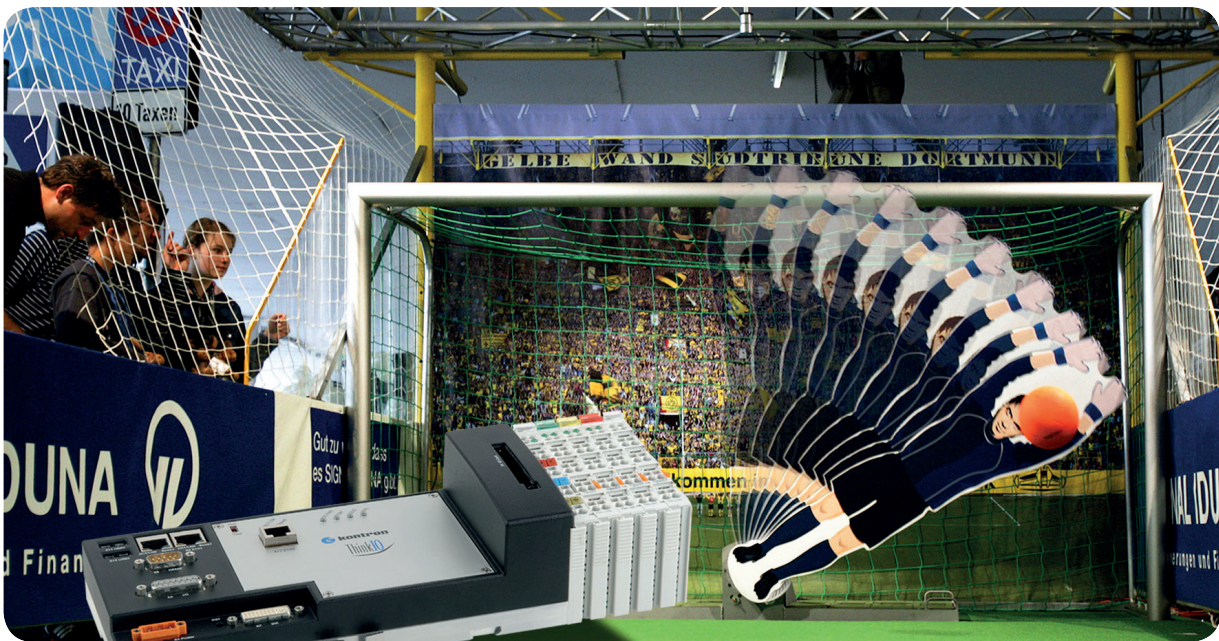# » Application Story «

ThinkIO in Automation

Soccer player versus machine

Kontron ThinkIO-Duo Embedded IPC with multi-core performance delivers ultra-fast image processing for industrial vision control applications

The Fraunhofer Institute for Material Flow and Logistics (IML) in Dortmund, Germany has developed a robot goalkeeper with lightning fast reflexes that is a match for even the best professional footballers. RoboKeeper's brain is the ThinkIO Embedded IPC from Kontron that offers dual-core processing performance as well as a range of standard PC and industrial interfaces for easy and cost-effective implementation of industrial vision control applications.

The 1.96 m goalie made from foam with an aluminium "backbone" may not look nimble, but the RoboKeeper developed by the Fraunhofer Institute (IML) in Germany has lightning fast reflexes and can stop almost any shot from the penalty spot, even banana shots. Even though RoboKeeper is an entertainment attraction, it is an impressive benchmark for multi-core, vision-based measurement and control applications: Image processing software calculates exactly where the ball will cross the goal line and provides an angle value to the servomotor that tilts the goal keeper to either the left or right in order to parry the shot wide of the goal. A ball travelling at 100 km/h from the penalty spot reaches the goal in 300 msec, so RoboKeeper has to react fast. The Kontron ThinkIO-Duo Embedded IPC equipped with an Intel® Core™ Duo processor provides 2 x 1.2 GHz processing power. A powerful servomotor and transmission typically found in avionics applications accelerate the goal keeper at up to 212 m/s2 – 17 times faster than a Formula 1 racing car – to leave even professional footballers dumbfounded.

Parallel processing for lightning fast reactions

Two digital cameras mounted behind the goal line each take around 40 pictures per second. This enables the system to follow the flight curve of the ball from the moment it is struck. Each camera has its own connection to one of the ThinkIO-Duo's two Gigabit Ethernet ports. Using separate ports avoids packet collisions and enables two images to be transmitted simultaneously using the fast GigE Vision™ standard. With each color picture consisting of 640 x 480 pixels and 2 bytes per pixel (614,400 bytes per picture), the
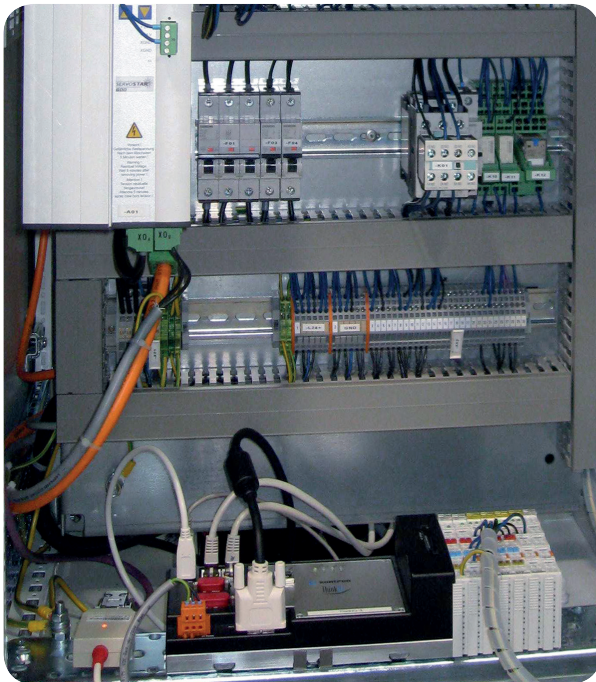

Figure 1: The Kontron ThinkIO-Duo provides standard PC connectivity as well as industrial fieldbus and industrial Ethernet interfaces in a single, ultra-compact unit.

cameras deliver a total of 47 Mbytes of uncompressed information every second (2x 40 x 614.400).

The sophisticated image processing software written in C++ by IML runs on the ThinkIO-Duo under Linux 2.6.23.1 (SMP) with Fedora Core 8 and ThinkIO extensions. It takes full advantage of the parallel processing capabilities of the ThinkIO-Duo by assigning the respective pictures from each camera to one of the two processing cores for Symmetric Multi-Processing (SMP). The software identifies surfaces, so-called blobs (Binary Large Objects), and classifies them according to size, color and shape. When it finds two appropriate blobs, it calculates the 3-D position of the ball. The speed of the ball is found by comparing its position in two consecutive pictures. Once the position and speed are known, it is possible to calculate where the ball will cross the goal line. The calculation even takes the flight curve of the ball into account, enabling RoboKeeper to cope with curling shots. In just 1-2 msec, the ThinkIO has calculated the angle through which RoboKeeper has to move in order to intercept the ball and sends this value to the motor controller via the ThinkIO-Duo's CAN interface.

Cost-effective parallel processing

Parallel processing is necessary for achieving the required processing speed. Initial trials with a single core processor ran into trouble since images arriving from the cameras could not be read from the network buffer fast enough, resulting in the loss of individual pictures. In order to implement the system with single-core embedded processors, IML would have required at least three separate CPU boards – two for parallel processing of the image data and another for load balancing – as well as additional I/O cards for fieldbus connections. This would have meant a customized rack mount system and a considerable amount of integration and programming work. The ThinkIO-Duo, on the other hand, offers dual-core performance with no significant increase in thermal design power as well as standard PC and industrial interfaces in a single, ultra compact off-the-shelf system for easy implementation and faster project implementation.

"The Kontron ThinkIO-Duo offered exactly what we needed - dual-core performance for fast image processing together with all the required PC and industrial interfaces, "declares Thomas Albrecht, head of control systems at IML. "Since there was no need for extra expansion cards, implementation was straightforward and cost-effective."

From soccer to industrial applications

RoboKeeper is a reference project for industrial vision-based applications that require fast image processing combined with a range of standard PC and industrial interfaces. Typical examples are robotic systems that use complex object recognition algorithms to identify and locate the position of goods, for example, on fast moving conveyor belts and

deliver output commands to servo motors. Since the dual-core ThinkIO-Duo is fast enough to calculate the changing position of objects in non-linear motion, it enables implementation of machine vision systems on both straight and curved sections of industrial processing lines.

In the RoboKeeper application, the standard PC interfaces are used to connect the digital cameras (Ethernet) and HMI (DVI) that is required for setting up the system at different venues. The industrial interfaces are for connecting the servomotor (CAN) and adjusting RoboKeeper's speed: To give everybody a fair chance of scoring a goal, RoboKeeper has 7 speed settings – from novice to professional. These are adjusted using a handheld controller directly connected to the ThinkIO's modular I/O system. Since there is no need for extra PCMCIA cards, implementation is fast, easy and cost effective.

For industrial applications that require complex PLC operations, the optional IEC 61131-3 SoftPLC package available for OEM configurations includes editors for developing controller application nodes, integrated compilers for generating native application codes for the controller and numerous diagnostic and commissioning functions. All I/O nodes are configurable on the software side, making all I/O clamps plug & play. Using an optionally available third party OPC server reduces programming time even further by providing full API support for the transfer of plant data and operating commands between automation equipment and a company's IT infrastructure (e.g. ERP and database systems).

On tour

With its robust stainless steel housing, maintenance free design and up to 2 GBytes of onboard Compact Flash instead of rotating media, the rugged and fanless Kontron ThinkIO-Duo also provides the shock and vibration resistance to cope with harsh environments. This enables it to easily cope with the frequent mounting, dismounting and transportation as RoboKeeper moves from venue to venue as well as in industrial environments. More information about the project as well as tour dates can be found at: www.robokeeper.de
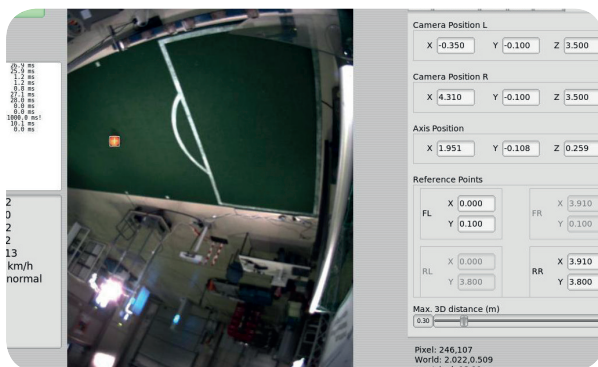

Figure 2: The HMI connected via the ThinkIO-Duo's DVI port enables technicians to adjust parameters according to environmental conditions

The Kontron ThinkIO-Duo Embedded IPC

The extremely compact Kontron ThinkIO-Duo (70mm deep / 35mm slot level) is equipped with an Intel® Core™ Duo U2500 processor with a clock rate of 2x 1.2 GHz and 512MB or 1GB of RAM. The Kontron ThinkIODuo achieves exceptional performance in an ultra compact unit. The Embedded IPC for DIN rail mounting combines Intel® Core™ Duo performance and standard PC connectivity with a rugged design, which is also suitable for applications in harsh environments. Two independent processor cores allow for parallel computing. Therefore, the ThinkIO-Duo meets the requirements for demanding control and visualization tasks as well as web server and firewall applications. The system is designed to decrease the total cost of ownership for OEMs through a very reliable architecture and long term availability. The completely integrated platform significantly reduces time to market, allowing customers to focus on software development and system integration. Optional WAGO 750/753 I/O clamps can be directly connected as well as Profinet, Profibus or CANopen fieldbus devices.

Along with high computing performance and industrial Ethernet connectivity, this passively-cooled IPC offers internal Flash (512MB/2GB), a CompactFlash socket for data storage or backups/updates, 512kB non-volatile memory and all standard PC interfaces (2 x USB 2.0, RS232, DVI-I). Three LAN interfaces make it simple to connect a variety of media such as cameras or a WLAN router. Users can also implement an Ethernet-based 'software' field bus. The ThinkIO-Duo also enables remote access/monitoring and control as well as connection to MES and ERP systems. There are also interrupt-capable onboard inputs which can be used for rapid reaction to external events, such as activation of a cut-off switch.

The Kontron ThinkIO platform can be customized in various ways according to OEMs' individual requirements, e.g. with Windows XP Embedded, embedded real-time Linux (OSADL - Open Source Automaton Development Lab, www.osadl.org) or an IEC61131-3 software package.

About Kontron

Kontron is a global leader in embedded computing technology. With more than 40% of its employees in research and development, Kontron creates many of the standards that drive the world's embedded computing platforms. Kontron's product longevity, local engineering and support, and value-added services, helps create a sustainable and viable embedded solution for OEMs and system integrators.

Kontron works closely with its customers on their embedded application-ready platforms and custom solutions, enabling them to focus on their core competencies. The result is an accelerated time-to-market, reduced total-cost-of-ownership and an improved overall application with leading-edge, highly-reliable embedded technology.

Kontron is listed on the German TecDAX stock exchanges under the symbol "KBC". For more information, please visit: **www.kontron.com**

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