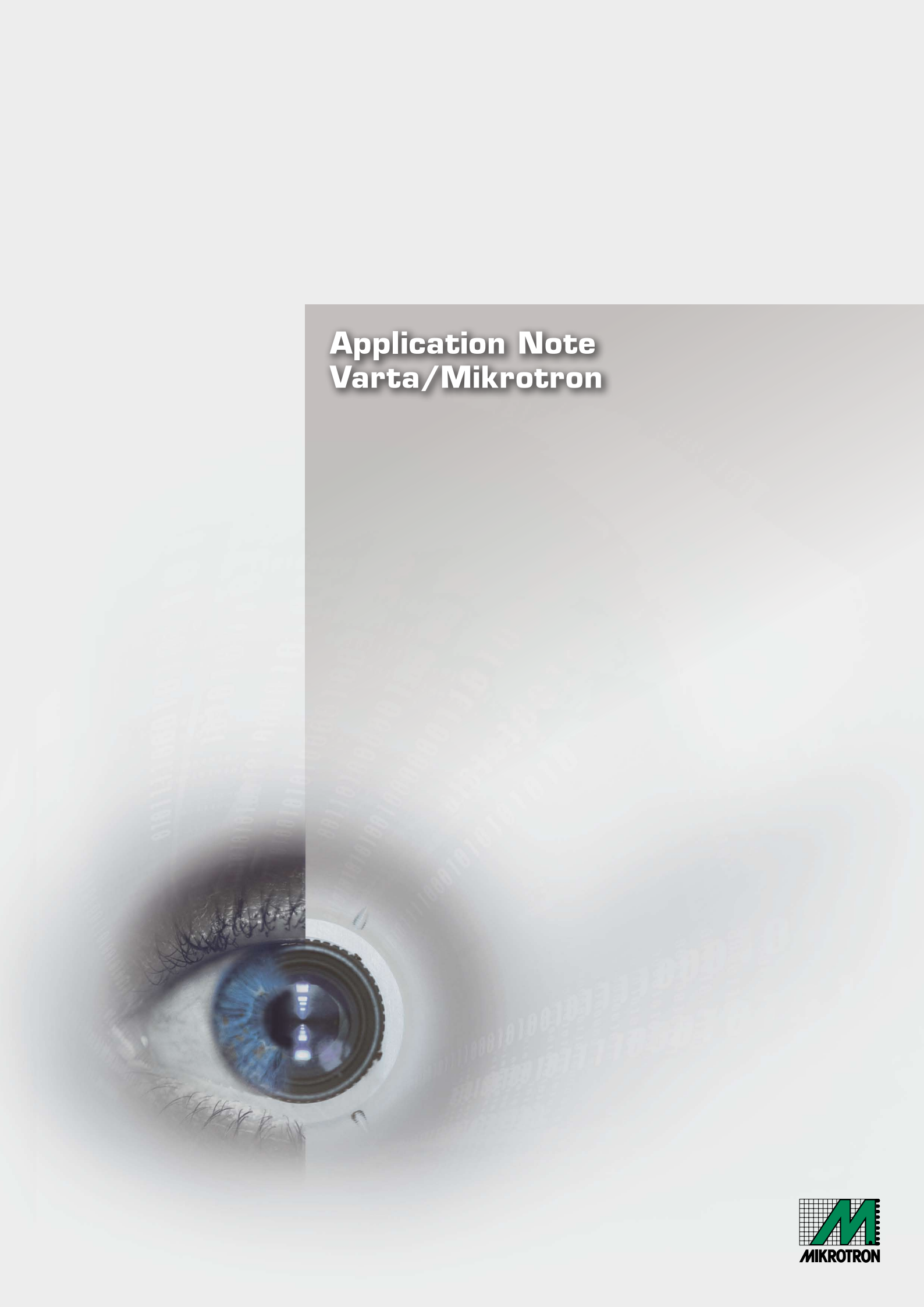
Application Note
Varta/Mikrotron



MIKROTRON

Secure fault analysis with high-speed video

Complete process optimisation

The early prevention of fault sources in the production process increases product quality, optimises process flow and reduces costs. For battery manufacturer Varta, the MotionBlitz® Cube2 high-speed camera has proven itself to be an extremely efficient tool for this ongoing strategy.

Digital high-speed cameras provide immediate insight into fast running processes which elude the human eye. A growing number of companies are using this analysis technique in both the development process, as well as in existing production lines, for accelerated causal research and for the ongoing optimisation of products, systems and processes.

At Varta Consumer Batteries in Dischingen, one of the largest battery producers in the world, the MotionBLITZ® Cube2 compact camera from Mikrotron GmbH in Unterschleissheim has proven to be an extremely useful technology in many phases of production. It has made it possible to identify and correct many totally different problems and fault causes in system and process planning, as well as in maintenance and servicing, and has led to the optimisation of process efficiency through better 'insight'.

Problem identified – fault eliminated

At process cycle rates of up to 600 per minute, it is simply impossible for staff at the Dischingen battery plant to clearly identify the cause of a fault during production with the naked eye alone. Only slow-motion technology with modern, digital high-speed video systems can deliver unambiguous findings about hidden causes and their metrologically detectable details. In high-speed rotary transfer systems, increased process quality not only yields cost savings, but rather ultimately serves to improve a company's image with its customers and consumers through product quality.

For this reason, the responsible staff at the Dischingen plant made the decision in 2006 to invest in a high-speed video system. There were plausible reasons behind the quick decision for the MotionBlitz® Cube system, as emphasised by Otto Hessel, technical director in Dischingen:

"We decided to invest in a Mikrotron MotionBLITZ® Cube2 due to the fact that we were able to accurately identify one of our most important process problems during the course of a 15 minute product demonstration." The recording speed, image quality and especially the remarkably simple operation of the device meet all of the requirements for everyday use in production and in the commissioning of systems. Moreover, Varta was quite pleased to be able to work together with an experienced German manufacturer, as they could take advantage of a strategy that was close to home.

Capture events on the spot

The compact and robust product family of MotionBLITZ® Cube high-speed cameras offers unique capabilities and covers a very wide spectrum of research and industrial applications. A standard gigabit Ethernet interface (GigE) with an extremely fast data transfer rate enables the camera to be operated from any laptop. Stand-alone operation is also possible with the Cube. This ensures remarkably mobile and quick use, even under cramped and inaccessible conditions. Thanks to the intuitive, windows-based software, even untrained users are able to quickly obtain very good results.

The 1280 x 1024 image resolution provided by the MotionBLITZ® Cube2 unlocks the potential to analyse details within a very small measurement range. At this maximum resolution, a recording speed of up to 500 frames per second is possible. Even faster frame rates of up to 45,000 fps can be achieved by reducing the resolution. The display window (RoI = Region of Interest), and thus the resolution, can be moved or resized on the monitor as needed by simply dragging it with the mouse. In doing so, the corresponding maximum frame rate is automatically set (it can, however, also be adjusted manually).

In record mode, newly captured images are continuously recorded over the previously captured images in the internal ring buffer of the camera until the recording is stopped by a trigger signal. A freely-definable number of images captured before and after the trigger event are then saved in the ring buffer. The memory, which is optionally available in two sizes, provides a recording time of up to 3 to 6 seconds at maximum speed and resolution. At Varta, the built-in ImageBLITZ® Auto-Trigger proved to be particularly advantageous. An adjustable (size and position) sensor window within the area of exposure functions as a light barrier or signal generator by reacting to any changes in brightness. This results in a very simple, incredibly sensitive and adjustable trigger mechanism with an extremely short reaction time which can be used in many applications to replace expensive external triggering devices such as light barriers and sensors.

Precision injection process

Varta, a brand-name subsidiary of the US consumer product group Spectrum Brands, stands for premium batteries within the group. The staff at the Dischingen plant are specialised in all types of dry batteries, from single cell to micro cell (type AAA). All assembly, fitting and filling processes are developed in Dischingen based on the formulation requirements specified by headquarters in the US. Every step of the manufacturing process takes place in this plant, including the labelling and packaging of the finished product. Every day approximately 3 million cells move through rotary transfer systems, conveyor lines, test equipment and packaging machines to their final destination in the dispatch bay. However, not all batteries are labelled with one of the company's two brand names. Several trading partners are also supplied with high-quality microcell batteries.

Otto Hessel elaborates: “In terms of quality and price, we must be able to compete in the global market. Not only with ‘real’ competitors, but also with other production sites within the group.” Consequently, they are always under a lot of pressure. Consistent goals are high system availability and optimum production processes at the lowest possible cost.

According to Otto Hessel, Varta’s newest generation of batteries performs significantly better than the competition. The increased performance is the result of a specially formulated electrolyte which is injected into the battery casing. However, this requires precise dosing in an environment where only a few hundredths of a second are available for the filling process.

In the past, this production step caused two problems:
First, there were always problems with the system being contaminated. Increased downtime for maintenance reduced system availability, thus lowering production rates. The contamination also had a negative impact on the external composition of the batteries. Second, problems with the electrolyte filling process resulted in fluctuations in the performance of individual batteries that were greater than what was permitted, and what the formulation theoretically allowed.

“The very first high-speed video recordings enabled us to make significant advancements” explains Josef Graule, the project engineer who specialises in working with the camera. “After making only a few high-speed recordings, we could select the filling jets in such a way that the filling process ran without any more troublesome splashes.” The far-reaching impact of the systems and machines being contaminated with the aggressive electrolyte was finally overcome. After conducting slow-motion studies, process parameters were quickly adjusted so that the high quality requirements could be met while maintaining a very short cycle time.

In the past, staff had to wait on time-consuming trial-and-error processes after each reconfiguration of the system until the finished product could be tested. Now the effect of control parameters can be determined immediately while the production process is running.
As a result, staff are now capable of evaluating systems and active processes better than they ever were before.

Fast amortisation

Previously, the investigation of running production lines was unsatisfactory because the process speed had to be slowed down significantly. Then, on top of that, the machines usually ran without any problems since the faults only occurred while running at full capacity.

Now the high-speed camera makes it possible to determine where problems arise even while running at maximum production speeds. Graule elaborates: “Now the MotionBLITZ® Cube2 provides us with information we can use to constantly reduce bottlenecks in the flow of production.”

Within the first year, investigations of more than 20 points in the battery cell production process have been carried out with the Mikrotron Camera. The results led to a substantial number of optimisations. The desire expressed at the time the MotionBLITZ® Cube2 was purchased was that this system would pay for itself within a period of one year. For any production manager, however, the idea of one hour of downtime on a production line is just as critical as it is dreaded. With this in mind, today’s conclusion that the camera has paid for itself in less than one year is an almost laughable understatement.

There are other less obvious advantages, which are not directly factored into the economic equation. For example, the human reaction of machine operators. When there is a recurring problem in the production line and the responsible person cannot identify and correct the cause, this leads to frustration. If the cause of the problem is known, personnel can – and want to – correct the fault, and the interaction between man and machine is a harmonious one. Working morale is improved, which in turn has a beneficial effect on costs and quality.

The MotionBLITZ® Cube2 also enabled clear improvements to be made in the battery labelling process. When the battery cells are fitted with wrap-around labels, it has to be done very quickly and with a high degree of precision, as the machine runs at a speed of 900 to 1000 parts per minute. Each individual label has to be precisely applied to the rotating cell at the same band speed, because any slippage in the transport of the labels or insufficient adhesion to the cell leads to problems with the next cell. Improperly labelled batteries result in unnecessary rejects and material loss. Any jams in the labelling process must be rectified and thus cause machine downtime, which can add up over the course of a shift.

The use high-speed video for conducting a failure analysis on this machine would not have been possible without the same concurrently high image resolution. As it is necessary to record this process from the side, the contour of label is only perceived as a very thin line. Nevertheless, even under these circumstances the problem could be thoroughly analysed and progress was made towards rectifying the fault. Machine downtime and other disadvantages were able to be substantially reduced, thus optimising this production step as well.

Another example is the setup and configuration of a continuous measurement inspection point using the MotionBLITZ® Cube2. A new laser measuring system for quality control purposes could be precisely mounted for the first time, only because slow-motion video revealed the exact point at which the measurement was to be made on the batteries, and at which point the most accurate measurement could be obtained with the system running at full capacity. The camera's integrated time-stamp function, which is applied to each individual frame, proved to be extremely advantageous for this task. It enables processes to be calibrated to the millisecond. Even small delays in process control can be recognised, and processes can be much more precisely harmonised with one another. "The additional integration of control signals in the high-speed recording process provides even more valuable information for the optimisation of the process, as multiple process steps must often be coordinated with each other on a single machine," explains Josef Graule.

Ongoing process optimisation

In Dischingen, staff see even more untapped potential for the use of high-speed video as an optimisation tool. Preventative system optimisation based on clear information obtained from slow-motion video is seen as an effective means of improving productivity even more in the long run. This would not only be a decisive step towards maximum process and quality control, but it would ultimately serve to unlock additional capacity reserves in production with the same machines. Graule: "I'm quite sure that we will practice even more prevention in the future. The MotionBLITZ® Cube2 provides precisely the information needed for that."

Author: Kamillo Weiß

MIKROTRON GmbH of Unterschleissheim (near Munich) develops, manufactures and distributes systems and components for industrial image processing. Our core competence lies in the production of high-speed video systems, vision cameras and analogue/digital frame grabbers for production, research and development, as well as turnkey systems for industrial electronics.

Mikrotron GmbH
Landshuter Str. 20–22
85716 Unterschleissheim
Phone +49-89-72 63 42-00

info@mikrotron.de · www.mikrotron.de