Tracking down the Perpetrator

High-Resolution USB Cameras in Action at State
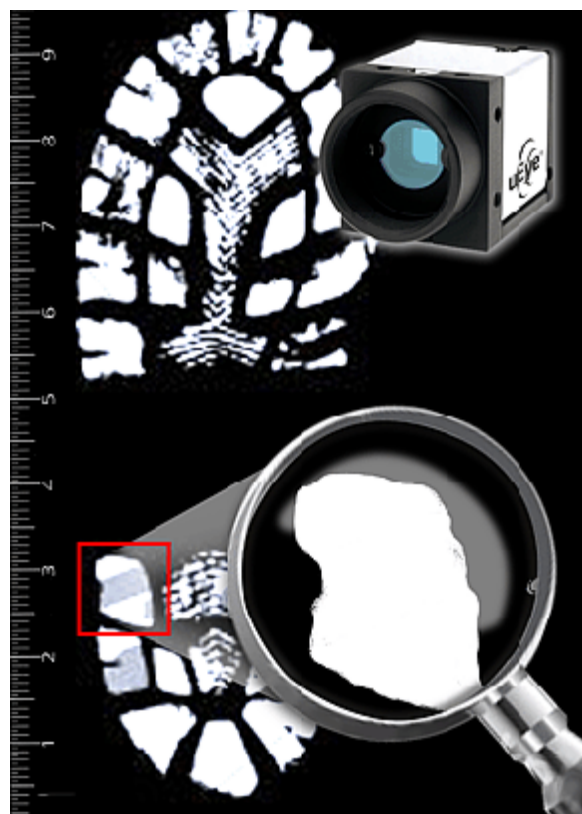Criminal Police Office in Baden-Württemberg

There is no perfect crime, as every criminal leaves traces at the crime scene. These can be not only fingerprints, microparticles or DNA material, but also shoe prints. Particularly the latter are very difficult to avoid, e.g. for burglars. Therefore they often play an important part in solving property offenses, providing not only the key to difficult cases, but also substantive evidence. To ensure a successful and efficient search for clues, the crime scene incvestigators use state-of-the-art computer technology: Images of shoe tread and outsole prints are collected in a central database, where they can be immediately queried and matched to crime scene prints. The procedure of entering all the tread patterns (prints as well as reference samples) in the system is crucial in this connection. Image acquisition and processing must be very precise, fast and efficient. For this purpose the LKA Baden-Württemberg, which is the State Criminal Police Office in the German State of Baden-Württemberg, uses the high-resolution cameras of the uEye® series from IDS.

The USB cameras can be found here in a rather unusual application area. At repro stations they take images of plaster casts or of the 2-D photos of shoe print fragments made at the scene of crime. These 2-D photos can be provided as black film, transparent film or black-on-white comparison prints of shoe treads.

In contrast to scanners, for example, the repro systems allow highly individual lighting. By using a camera, they also offer an excellent depth of field. All the settings of the repro station are optimized directly with the live image until the resulting image shows the appropriate level of detail for on-screen comparison. It can then be stored in the central shoe print database at the push of a button. This allows matching the tread pattern of a footprint lifted at the crime scene to the state-wide database contents, which comprise not only crime scene prints, but also a comprehensive reference collection of many common tread and outsole patterns.

In the course of its "lifetime," every shoe sole develops a unique structure caused by a multitude of different factors, such as age and wear, the owner's motion characteristics, foreign material (e.g. gravel, grit, etc.), and much more. If such individual structures of a shoe sole show in a footprint, the footprint was definitely made by precisely that shoe—and no other shoe of the same tread and size. A shoe print thus has a substantial probative force, provided that the wearer of the shoe can be determined without doubt.

The system is used at five data entry stations: Department 614 of the "Kriminaltechnisches Institut" at the LKA Baden-Württemberg as well as the forensic departments in Freiburg, Karlsruhe, Tübingen and Stuttgart. In the early 1990s the LKA Baden-Württemberg started using analog cameras with framegrabber cards - already then supplied by IDS — for machine vision and image processing. Technological changes also in forensic science as well as the purchase of more powerful IT systems resulted in a need to invest in a more advanced camera solution.

To be able to continue using the existing ISASPro® image database software, it was essential that the camera's control software could be adapted individually and with little effort.

The LKA Baden-Württemberg decided on the USB cameras of the uEye® series from IDS. With this series the machine vision specialist, which is also located in Baden-Württemberg, offers way over 100 camera models in a vast variety of versions for almost any application: with USB or Gigabit Ethernet interface, plastic or metal housing, CCD or CMOS sensor, cost-effective or extremely robust, etc. And if any wishes still remain unfulfilled, IDS can develop and manufacture special customized and project-related solutions beyond the standard. That was not necessary in this case, however, because the models of the standard line were optimally suited for the repro stations. Featuring CCD and CMOS sensors, monochrome and color technology (Bayer mosaic color conversion) as well as rolling and global shutters, these cameras cover a very wide area of applications. Depending on the model the resolution ranges from 640 x 480 pixels to 2560 x 1920 pixels, i.e. 5 megapixels. The frame rate is 10 to 75 frames per second in full-frame mode; far higher frame rates can be achieved in the area-of-interest mode (AOI). A 4 MB memory capacity is optionally available and allows synchronously acquiring images from multiple cameras, which can be buffered and asynchronously read out.

All models have a universal, opto-decoupled trigger input as well as a universal, opto-decoupled output e.g. for operating a flash. They also provide a C-mount lens connector and mounting holes on all four sides of the housing. Two different USB 2.0 ports are offered for the standard line: The standard mini-B type known from digital cameras, or a screw-on micro D-sub version, which is also used for the trigger signal and flash/strobe control and is suitable particularly for use in industrial environments.

The repro systems use a camera with a light-sensitive ½" CMOS sensor and a 2048 x 1536 pixel resolution. This model of the uEye® standard line achieves a frame rate of 11 frames per second and is very small and compact, with a size of only 34 x 32 x 27.4 mm and a weight of only 62 g.

"It's so easy" - true to the camera manufacturer's corporate motto, the cameras provided exactly what the LKA was looking for: ease of use and fast integration. Thanks to the USB 2.0 port, the cameras need no additional hardware and allow instant connection to any PC or notebook. Power supply to the camera is also via the USB cable. With a maximum bandwidth of 480 MB/s the bus can simultaneously acquire and display the images from multiple cameras on the computer without any problems. The permissible cable length of up to 5 meters is sufficient for many optical test systems. If necessary, longer distances can easily be covered using USB hubs.

A key aspect in the crime scene investigators' choice was the extensive software package, which comes with all the uEye® cameras. It comprises free software for the current Windows operating systems and Linux as well as a software development kit (SDK), a TWAIN driver, an ActiveX component, a DirectShow (WDM) driver, and more. Also available are direct interfaces for many other current machine vision programs, such as ActivVision Tools, Common Vision Blox, HALCON, NeuroCheck or LabVIEW.

The easy customization of the camera software on the basis of demo programs from the SDK was a deciding factor for the LKA Baden-Württemberg. These programs for image acquisition and analysis are provided complete with the corresponding source code. The source code is written in C/C++ and can be quickly adapted to the specific requirements and integrated into other applications. Implementing the camera at the LKA Baden-Württemberg thus required little time and effort. And time is of the essence, particularly for the police. For the new solution is to help track down perpetrators even more quickly in the future…