TOOLMARKS IDENTIFICATION USING SEM IMAGES IN OPTICAL CORRELATOR

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Optical correlator has wide applications in many different areas such as signs recognition(1), biophysics(2), or security(3). A new application referred to forensic science, using a system schematically shown in Fig. 1, is reported here.

Almost every tool has its characteristic damages and manufacturing marks, a kind of 'signature'. These characteristics enable one to compare a test mark made with the tool with the toolmark found at the crime scene and connect it with the used tool.(4) In our research, the cut end of the wire (*diameter* = 1 mm) left by a burglar was matched with the probe impression made by suspected pliers cutting blades in lead (*length* = 24 mm). The image of toolmarks at the trial cut end of the wire and the series of images of 24 slightly overlapping segments of the probe impression were obtained by scanning elecron microscope (SEM) at the same low magnification (Fig. 2. (a) and (b)). Each striation pattern of wire cut toolmark was characterized by the sequence of parallel fringes, grey level (0 – 255), for each point averaged over 10 pixels; three files were extracted to account for possible missalingment of the cut end of the wire. The fringe pattern for pliers was extracted in the same way from the image file created by merging 24 successive images. The prepared files are shown in Fig. 3.

To map the location of increased matching probability between the fringe patterns of the wire cut and the pliers impression, we performed numerical and optical correlations. Optical measurements are realized by using the correlator (Fig. 1) with a film transparency (for displaying input images), a liquid crystal display (for displaying phase-only filters), and a CCD camera (for detecting output correlations). The obtained results are normalized to emphasize the true correlation maximum (Figs. 4 and 5). Evidently, both correlation procedures give similar results.

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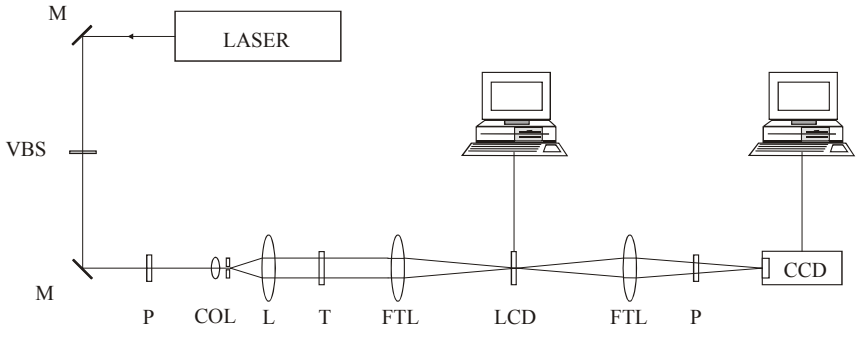

Fig. 1. Experimental setup for optical correlation: M – mirror, VBS – variable beam splitter, P – polarizer, COL – collimator, L – lens, T – transparency, FTL – Fourier transform lens, LCD – liquid crystal display

(a) (b)

Fig. 2. SEM images of (a) a segment of pliers cutting blade impression and (b) cut end of the wire.

(a)

(b)

Fig. 3. Fringe patterns obtained from the SEM images of complete pliers cutting blades impression (a), and the cut end of the wire (b).

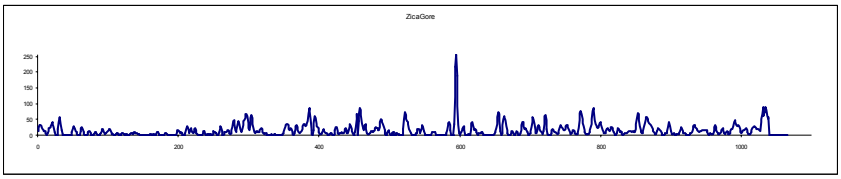

Fig. 4. A result of numerical correlation.

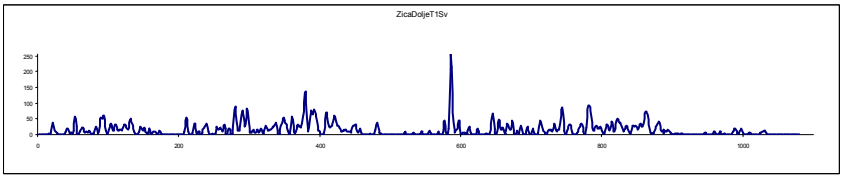

Fig. 5. The same result as in Fig. 4. obtained by optical correlation.

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