



### D28 A Presentation of JLab: Restoring Selected Examples of Corrupt JPEG Data

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The goal of this presentation is to impart knowledge of a tool for the analysis of JPEG files and the restoration of corrupt JPEG data. Development of the JPEG toolbox named JLab was commissioned by Bundeskriminalamt, Germany, and it is distributed free of charge for police purposes.

This presentation will impact the forensic community and/or humanity by demonstrating that in special cases, the use of JLab will make it possible to recover pictorial evidence from digital data with little work, which before JLab was nearly impossible or would have required a great deal of effort.

Corrupted JPEG files that originated from investigative proceedings and reached the image enhancement service of the German Bundeskriminalamt (BKA) caused the BKA to commission the development of a software tool for the analysis and restoration of partially damaged JPEG files. This tool called JLab is now available for forensic applications. During this presentation the functionality and features, the structure, the input, and output, and the restrictions of JLab will be exemplified by means of selected sample images.

At the moment JLab's analysis and reconstruction capabilities are limited to JPEG/JFIF files (JPEG File Interchange Format) with DCT (Discrete Cosine Transform) and Huffman coding for practical reasons. This type of compression is by far the most commonly used at present. The program runs on computers with the MS Windows operating system. JLab combines the "viewer" and the "hexeditor" functions. In four sub-windows it displays three views of a JPEG data stream: a structural view, a hexadecimal view with a simultaneous ASCII interpretation, an image view and an additional preview which is especially useful while modifying large images. The views are linked together so that one can perform a combined analysis and/or restoration of structural elements and image areas.

The program can handle several JPEG data streams in a single file, e.g., a large JPEG image with a small JPEG thumbnail included, like those for instance, which Adobe® Photoshop® produces. Since JLab provides a detailed representation of the complete JPEG structure, one might be able to draw conclusions about the history of the image from both the comments and those inputs, normally not displayed, that are specific to applications involved before. Even if other viewers do not accept a JPEG file, JLab can recognize whether it contains any structures, which conform to JPEG and, at the least, can display the contents in the hexadecimal and ASCII formats.

The quantization tables and the Huffman tables are among the most important parameters of the compression procedure. Instead of faulty or missing tables, standard tables and tables from correct sample files may be used. Databases from different tables can easily be created and extended. Tables that are currently being analyzed can be compared with those from the database on the basis of a brief characterization, so that similar tables can be found quickly. The manual repair of tables and the restoration of damaged marker data require an exact knowledge of the JPEG standard.

The underlying principles and the handling of JLab will be discussed in detail during a live presentation showing examples from two categories:

- JPEG test images with artificially generated defects
- Damaged JPEG images from actual police investigations. Restrictions preventing JLab from a successful restoration normally

turn out to be due to extensively corrupted data like the lack of major parts of the Huffman table, the availability of only very small data fragments or some classes of errors that generally apply to the entire image data.

The outlook will give a statement about the possible future of JLab and present ideas about other developments, e.g. concerning the JPEG2000 standard.

#### **JPEG Images, Data Corruption, Image Data Analysis and Restoration**