

# New multispectral method for the analysis of documents and drawings

## Book2net has developed a new method for multispectral analysis of documents and drawings

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### General

The development of an innovative technology for multispectral analyzes in the range of 300 - 1300 nm was the task of our research project. At definable nm intervals, individual or series of scans can be performed. The scan results can be superimposed pixel by pixel and analyzed. The book2net method works without filter change (vibration-free) and without post-correction of sharpness and focus in the spectral ranges (i.e. pixel scale accurate). Pixel-accurate overlay, division, subtraction, and addition techniques can be applied to this database for image analysis and visualization of the desired information.

A systematic standardization of the scanning, light and imaging processes and deposition of profile structures enables comparability and repeatability. Profile structures allow the formation of classes or analysis groups.

### Special hardware components

The central hardware component is the X210 multi-spectral camera, characterized by a high-resolution CMOS sensor with a special architecture for multispectral analysis and special sensitivity down to the hyper-spectral range. The IR range can be extended over 1250 nm. Signals are evaluated in analog form and guarantee unprocessed original data generation. Special lenses allow the scanning of a wide spectral range without reductions in the UV and infrared segment. The self-developed LED light sources in the UV, visible and IR range enable homogeneous illumination and allow finely structured signal evaluations within respective spectral ranges.

### Applications

In the field of multispectral analysis of documents, the following special fields of application can be defined:

- A) The reconstruction of documents of different damage classes, each with specific analysis methods: fire damage, water damage, mold, aging damage or combinations of several damage classes.  
Examples: fire damage Anna Amalia Library Weimar, water damage Cologne city archive, adhesive residues and mold Weimar Klassik Stiftung
- B) Visualization of material structures and watermarks
- C) Visualization of information layers, p.e. signatures, shadow hatches, pentimenti, ledger lines
- D) Visualization of palimpsest, overrides and corrections
- E) Authentication of drawings  
Example: complete multispectral analysis of the Lucretia, Klassik Stiftung Weimar, Graphic Collections
- F) Material analysis in documents and drawings  
On the basis of self-created reference and test targets, comparative material considerations are carried out.  
e.g. Analysis of inks, ink, graphite pencil, lead handle, etc.  
e.g. Analysis of white "colors": lead white, lithipone, zinc white, rubber, white, gypsum, lime etc.

### Technical specifications of the solution – Overview

#### X210 Multispectral Camera

- High-resolution 70/100/150-megapixel CMOS sensor
- Especially developed for multispectral applications

- Innovative hyper spectral color sensor
- Spectral sensitivity: 350 nm – 1150 nm
- Native signal and information analysis for each spectral band LED Illumination
- 3 broadband LED light lines in the UV, visible and IR ranges
- Homogeneous illumination across the scan area

#### **MSP Filter Imager**

- Smart multispectral software filter
- Replaces optical filters and narrow band LED illumination
- Vibration-free image capture

#### **MSP Image Analyzer**

- Intelligent analyzing software
- Pixel-accurate overlay technique
- Detailed analysis of defined image areas across the different spectral bands
- Algorithms for analysis of material structure and properties

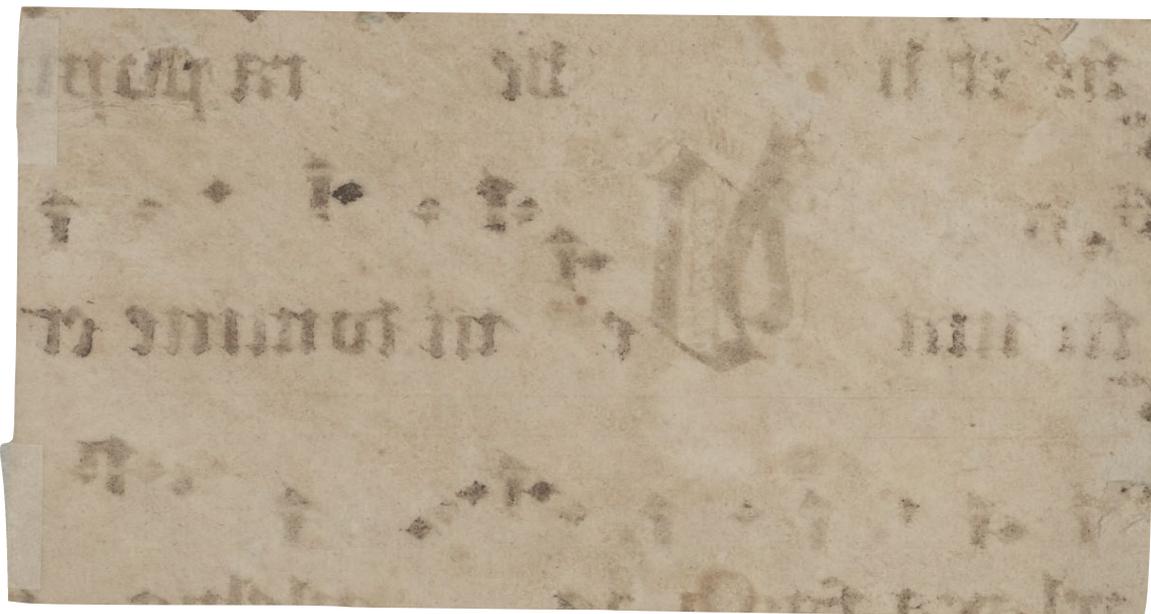
#### **Calibration**

- Specially developed white balance for improved differentiation of different white materials and types of pencils
- UV/ IR/ VIS balancing
- Black point correction
- Shadow correction

#### **Example 1: Fragments of sheet music, ink on paper**

The object is a copy of a music manuscript from the 15th century. This copy was formed unintentionally due to the reuse of the original music manuscript in a book cover. This early form of recycling was common practice, as materials were generally very valuable. Only with the dissolution of the cover, the fragment could be recovered.

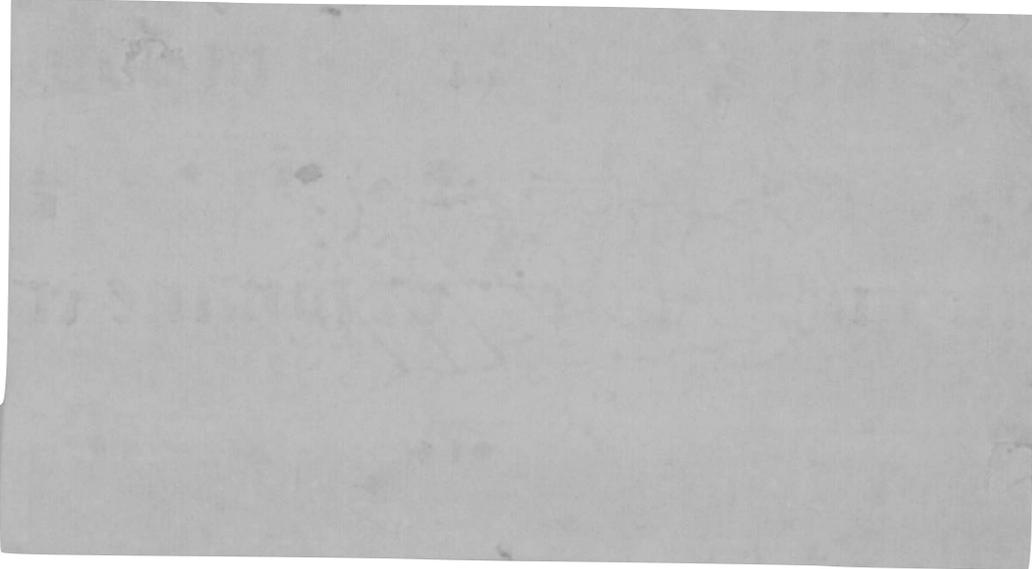
#### **Front side incident light:**



*Fig. 1. Unknown, Fragment of music (copy), c. 1470, Ink on paper, dimensions: 16,5 x 12,0 cm, private property*

**Front IR:**

Under infrared light at 1,100 nm, the ink almost completely disappears. Regardless of further analysis, it can be concluded that an iron gall ink is used.

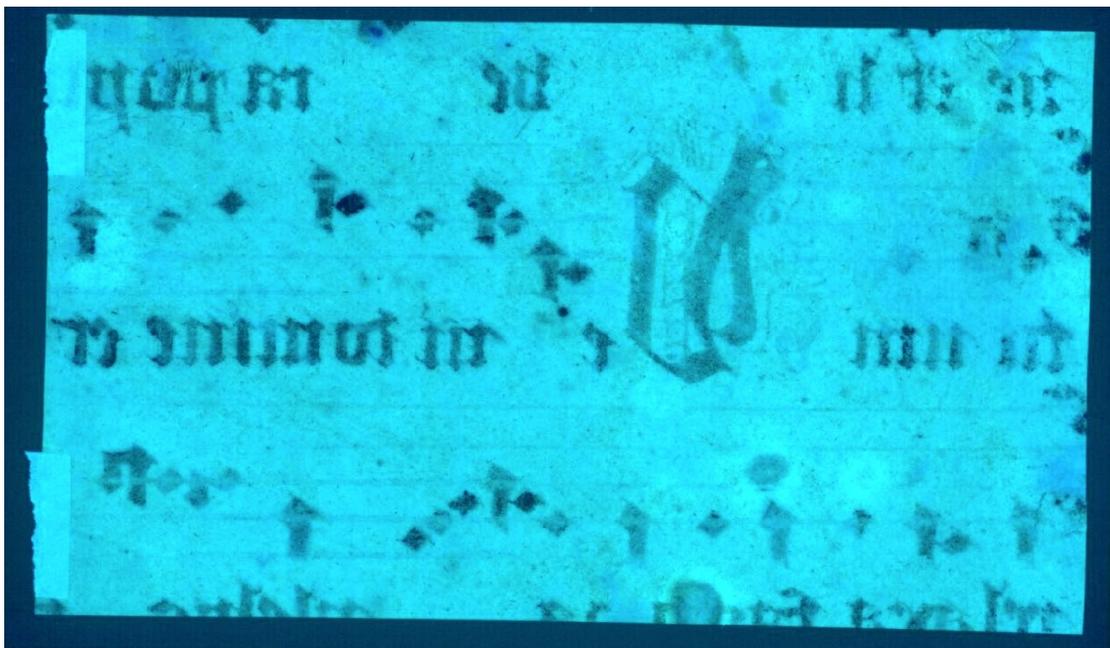


*Fig. 2. Unknown, Fragment of music (copy), c. 1470, Ink on paper, dimensions: 16,5 x 12,0 cm, private property*

**Front UV:**

Under ultraviolet light at 365 nm, notes and staves are significantly enhanced. This supports the assumption that iron gall ink has been used.

The enhanced contrast allows the visualization of information that is not visible in normal light.



*Fig. 3. Unknown, Fragment of music (copy), c. 1470, Ink on paper, dimensions: 16,5 x 12,0 cm, private property*

**Paper structure:**

Automatic image subtraction reveals paper texture and watermarks. Thus, all the information of the entire fragment is available for further analysis of the paper: The size of the watermark, the web distances and the number of ribs can be determined digitally..

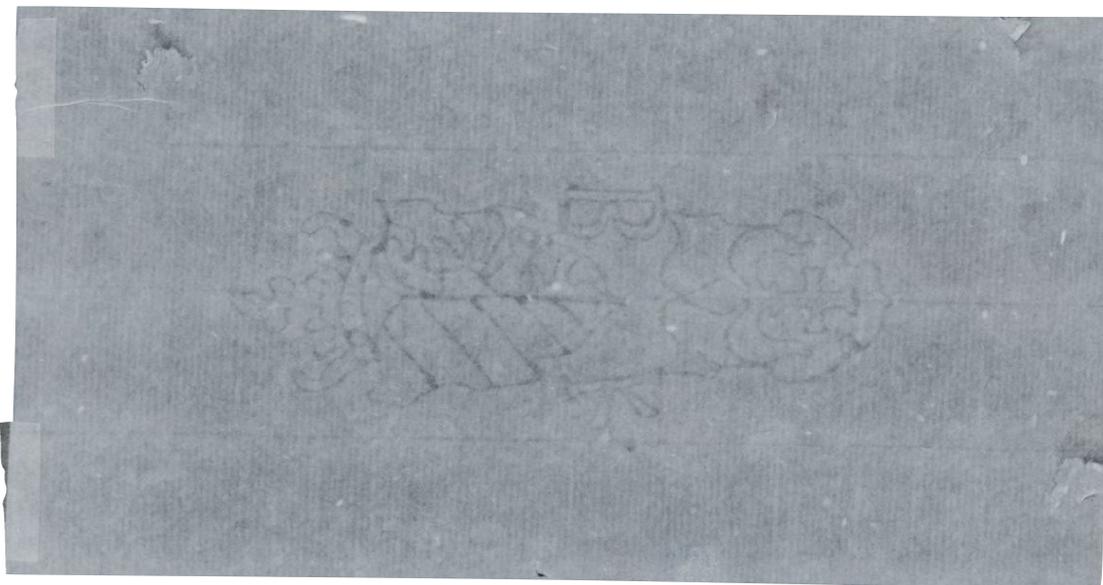


Fig. 4. Unknown, Fragment of music (copy), c. 1470, Ink on paper, dimensions: 16,5 x 12,0 cm, private property

**UV Spectral:**

The UV spectral recording allows the extensive visualization of all existing information, up to the remains of the formerly painted majuscule.

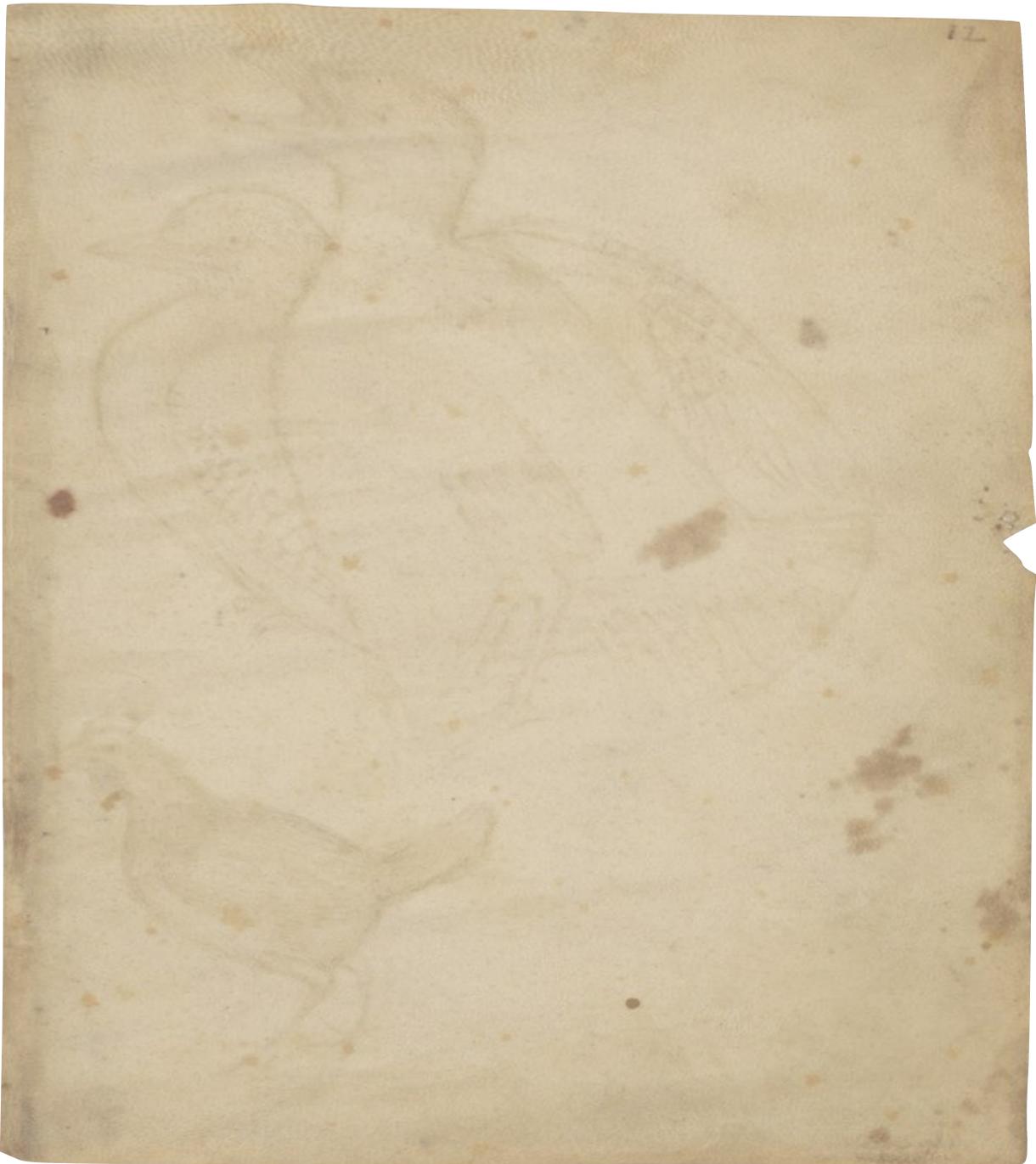


Fig. 5-7. Unknown, Fragment of music (copy), c. 1470, Ink on paper, dimensions: 16,5 x 12,0 cm, private property

## Example 2: Two partridges and a chicken

The animals are just delicately sketched with the silver point in a preliminary drawing, without the usual opaque, colored brush wash. As the drawing is lacking any specific artistic characteristics, the evaluation of graphical and content-related issues is very limited.

### Front side Incident light



*Fig. 1. Lombard painter, Two partridges and a chicken, about 1400, Technique: silver point on parchment, Dimensions: 16.5 x 12.0 cm, Klassik Stiftung Weimar, Graphic Collection*

### Front UV image

The UV image shows the performance of the system. Both the silver pen drawing and organic structures such as hair roots, veins and fluctuations in material thickness are significantly enhanced. The motif as a whole is just as recognizable as the line guidance and the detailed reproduction of the plumage structure.



*Fig. 2. Lombard painter, Two partridges and a chicken, about 1400, Technique: silver point on parchment, Dimensions: 16.5 x 12.0 cm, Klassik Stiftung Weimar, Graphic Collection*

### Example 3: Four birds

The animals are just delicately sketched with the silver point in a preliminary drawing, without the usual opaque, colored brush wash.

As the drawing is lacking any specific artistic characteristics, the evaluation of graphical and content-related issues is very limited.

- Lombard painter
- Four birds, about 1400
- Technique: silver point on parchment
- Dimensions: 16.5 x 11.9 cm
- Klassik Stiftung Weimar, Graphic Collection

#### Front VIS

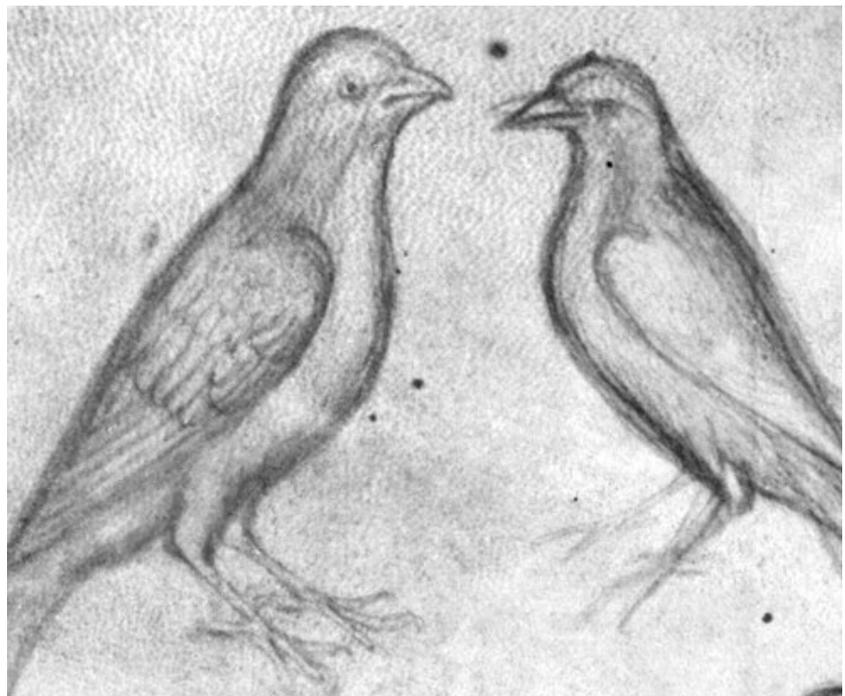


*Fig. 3. Lombard painter, Two partridges and a chicken, about 1400, Technique: silver point on parchment, Dimensions: 16.5 x 12.0 cm, Klassik Stiftung Weimar, Graphic Collection*

### Front UV image

The UV image shows the potential of the system: Both the silver pen drawing and organic structures, such as hairlines, veins and variations in material thickness, are significantly enhanced.

The motif as a whole is as recognizable as the strokes, the plumage structure and the occasional pentimenti.



*Fig. 4-5. Lombard painter, Two partridges and a chicken, about 1400, Technique: silver point on parchment, Dimensions: 16.5 x 12.0 cm, Klassik Stiftung Weimar, Graphic Collection*

## References

Klassik Stiftung Weimar - Graphic Collection