Institute for Spatial Information
and Surveying Technology
Mainz University of Applied Sciences

COLOR & SPACE IN
CULTURAL HERITAGE

Image processing techniques for crackle net analysis of old icons

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COST is supported by the EU Framework
Programme Horizon 2020

Outline

* Orthodox icons. Short historical overview.

* Addressed cultural heritage problem: Mapping of the Conservation Status.

* Crackle net structure and its analysis from VIS, UV and IR imaging.

* Image processing algorithm for crackle net structure visualization.

* Examples on several icons.

* About applications and benefits of the proposed image processing algorithm.

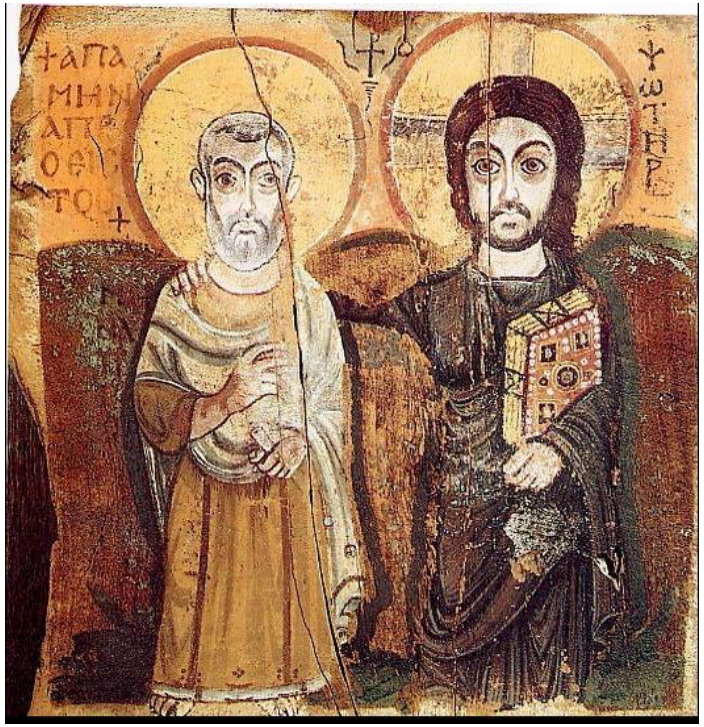
Icon is typically an easel painting, depicting Christian religious figures, especially venerated in Orthodox Christianity.

In Greek *eikōn*=image.

"The Ladder of Divine Ascent"
12th century icon
Saint Catherine Monastery, Mount Sinai.

Typical size of icons: 50cm x 70cm.

According to the legend, Pontius Pilat (Prefect of Judea 26-36 CE) had made an image/icon of Christ..



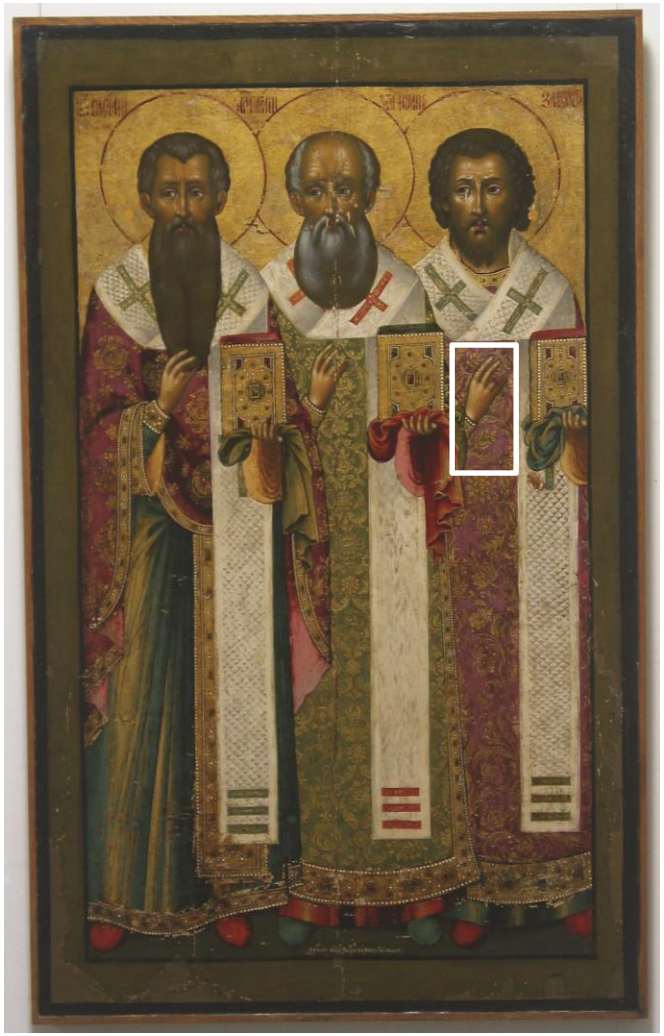
“Christ and Saint Menas”.
6th century Coptic icon, Egypt.

“Archangel Gabriel” from Novgorod, Russia.
12th century CE.

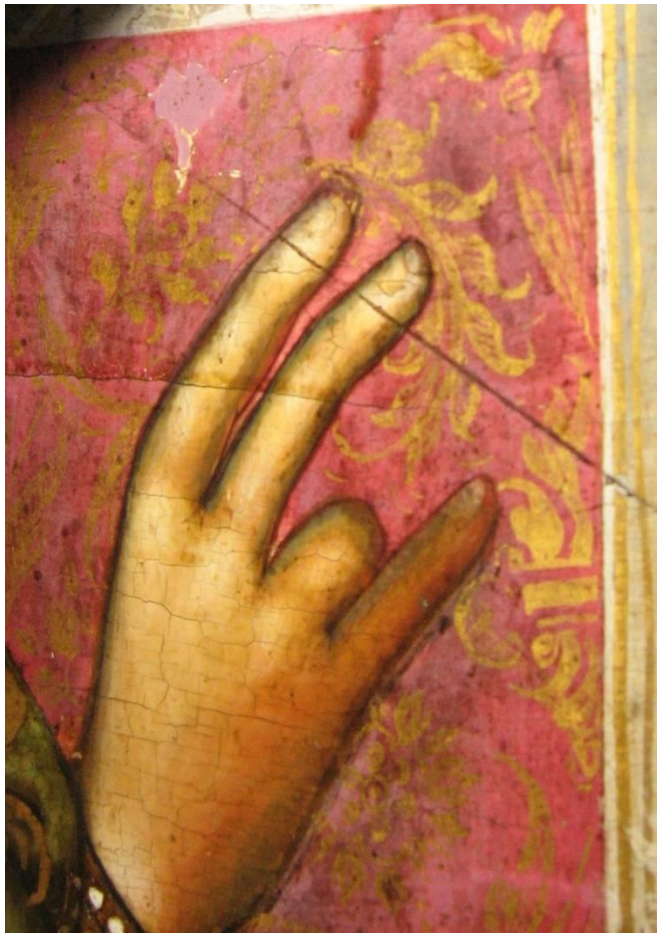
An icon is usually associated with "portrait" style images concentrating on one or two main figures.

"Annunciation to the Blessed Virgin Mary" 16th century, Monastery Krusedol, Serbia.

"Archangel Michael", 19th century, Greek Catholic iconostasis, Hungary.



“The Three Holy Hierarchs”,
1697,National Galery (GMS), Novi Sad, Serbia.



Crack damage, probably caused by human intervention.

Mapping of the conservation status (MCS) is the process of determining and documentation of damages, modifications and aging symptoms on cultural heritage (CH) artefacts, in our case icons.

MCS is necessary for restoration, scientific documentation and long term monitoring of the considered CH object.

Aging symptoms of icons:

- Anthropological factors (consequence of human presence)

- Natural factors
  * Physical (losses of protective and/or paint layer; **crackles net**)
  * Chemical (darkening or bleaching of the colors)

Typical icon intersection structure

We have the wooden icon panel with a canvas glued to its surface. First, several layers of powdered chalk mixed with glue must be applied over the canvas (pavoloka), and then be smoothed down to a mirror finish. This chalky surface is the levckas (Левкас) layer, it is the ground on which the actual icon image is painted. Even though LEVKAS is the term used in Russia for the gesso, it is actually originally a Greek word, *leukos*, meaning simply “white”.

Development of a crackle net as an aging process

Humidity exchange, via back side an borders of icon, with ambient causing specific deformations in the levkas layer. These deformations are discontinuities that first are microscopic size, but in time get deeper. In terms of hundred years, there form a well developed system of naturally branched **crackle net.**

Pattern or type of the crackle net of an icon depends on several factors. Typology depends on the type of a used wooden support, used materials for levkas, ambient conditions and the natural age of the icon. Due to this complexity, **it is very difficult to imitate them**.

Crackle net structure is like a signature..

Crackle net on the “Annunciation to the Blessed Virgin Mary”
16th century, Monastery Krusedol, Fruska Gora region, Serbia.

Different typologies of crackle net.

Illustration taken form: B. Slansky, The painting technique, Moscow, 1962.

Crackle typology is an important indicator for status of conservation.

Fields of application of crackle net analysis:

* Detecting status of conservation,

* Age detection,

* Fake investigation.

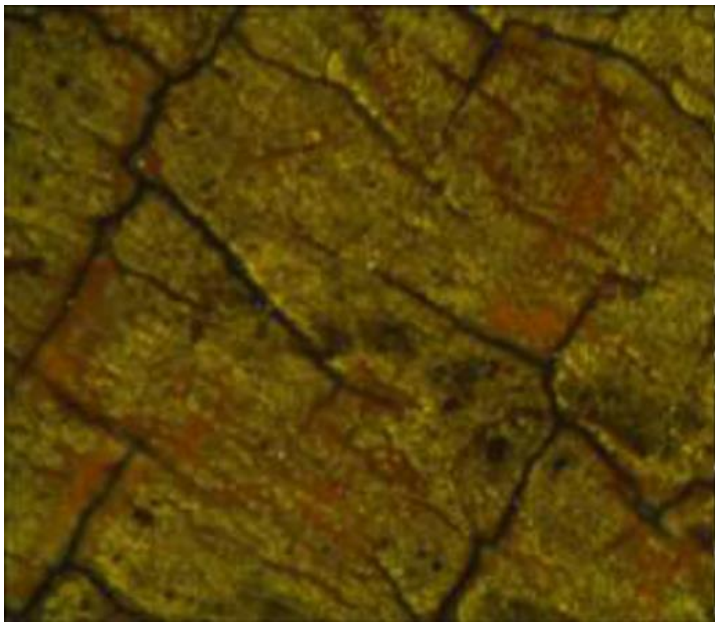
Application example: fake analysis of “Stroganov” icons in Russian Museum in Moscow, in 1980-ies.

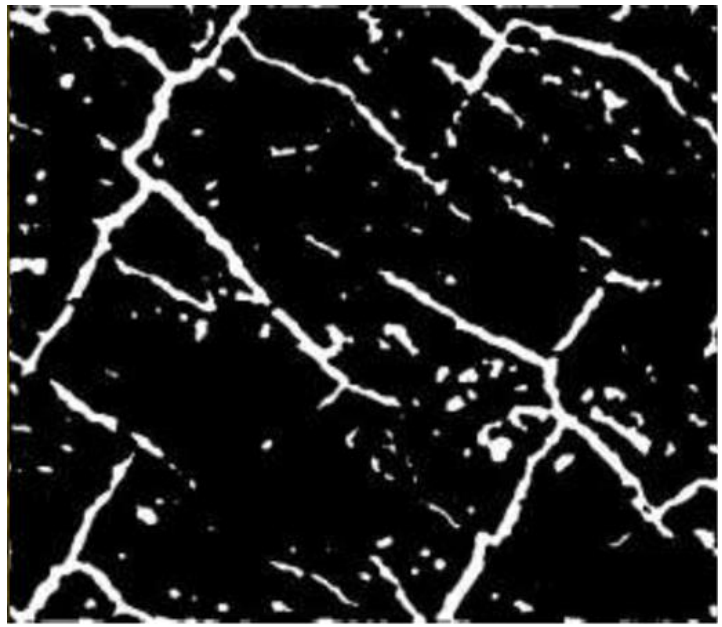
The proposed image processing algorithm

The algorithm is implemented in Matlab. Parameter settings..

"The Three Holy Hierarchs",
1697,National Galery (GMS), Novi Sad, Serbia.

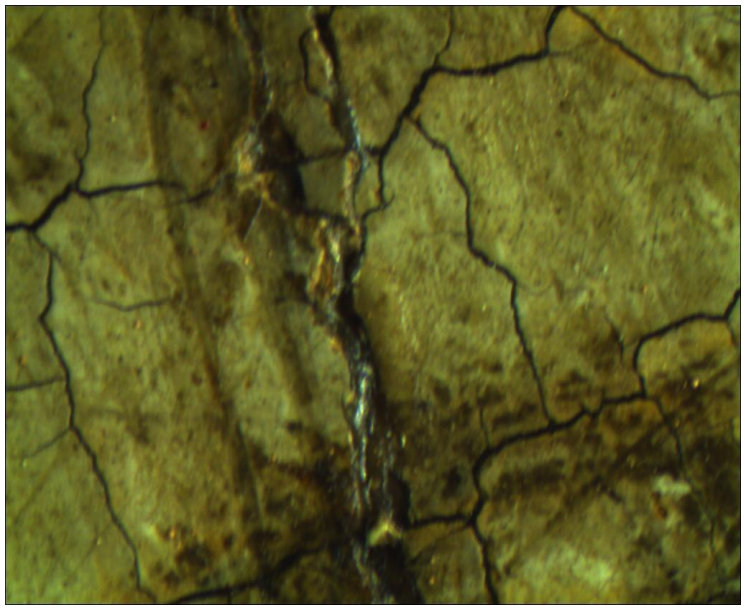
Binary segmented crackle net structure.

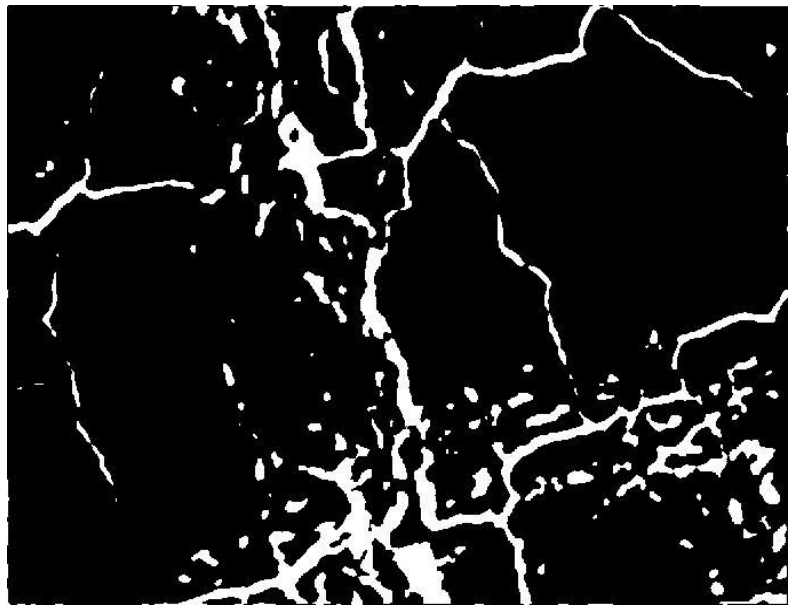




"Saint Theodore Trion and George"
1700(circa), GMS, Novi Sad, Serbia.

Binary segmented crackle net structure.





"Saint Theodore Trion and George"
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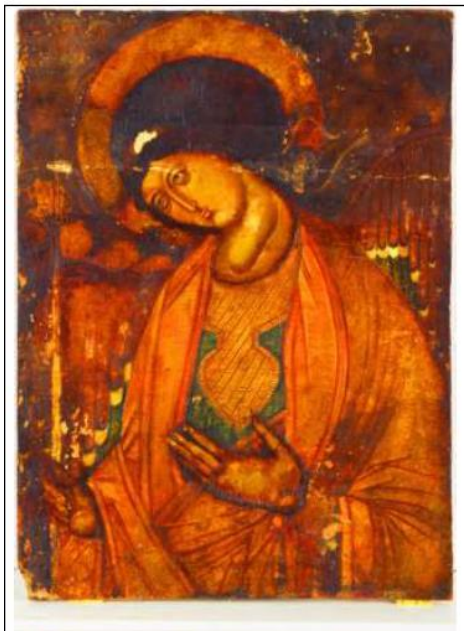
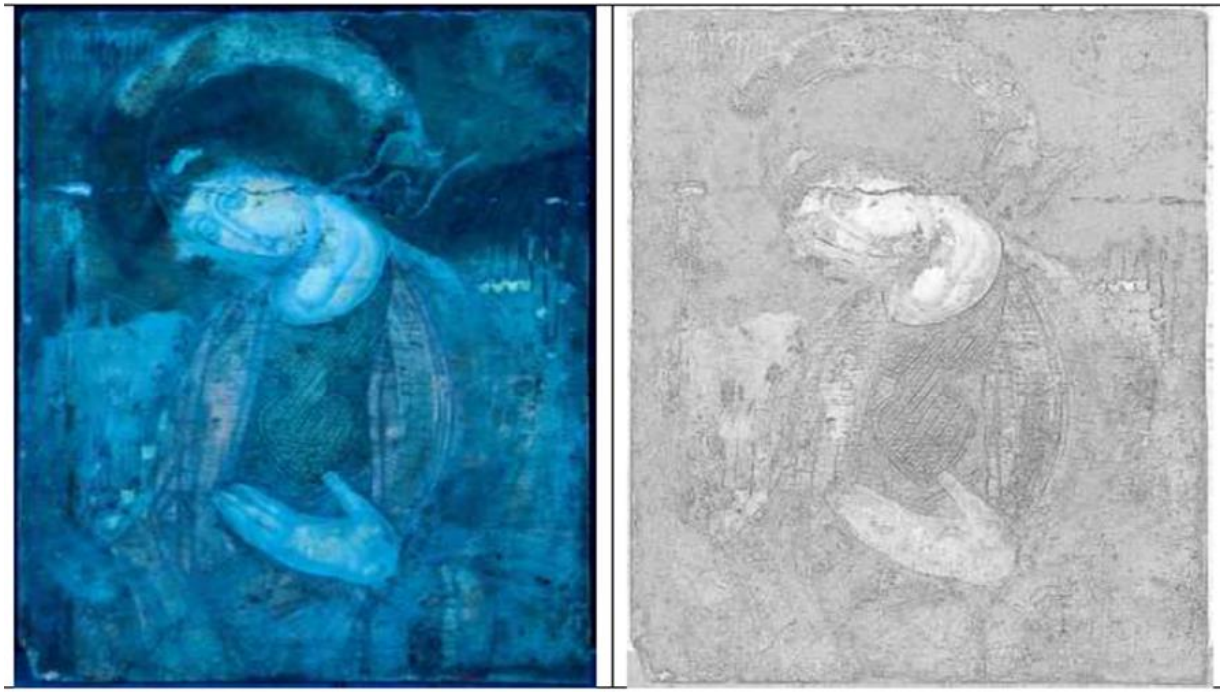
Binary segmented crackle net structure.

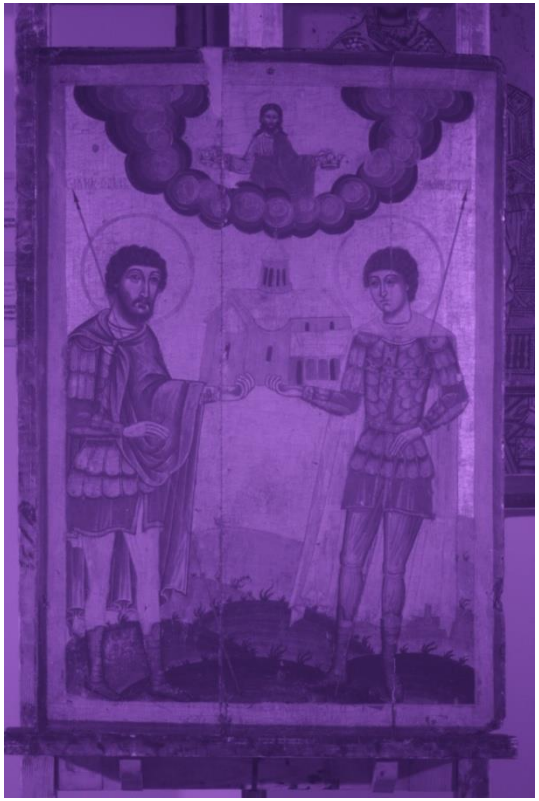
According to our experience, the best results are achieved by **adjusting/adapting the parameters of the method for each particular image**. This is due to the fact that each particular icon has specific image characteristics which are the consequences of several factors, for example, different origin, style, age, conditions of storage and also the diversity of the so far applied restoration techniques. However, our intention is that these **parameter adjustments should be a part of the "fine tuning" only**, but not to significantly affect the results.

UV imaging





IR imaging



“Saint Theodore Trion and George”
1700(circa), GMS, Novi Sad, Serbia.

Segmented crackle net structure

Future plans

-Integrate the already used approaches
for crackle net analysis with VIS macro image analysis, IR Reflectography and UV reflectography.

-Creation of crackle net data base.

-Crackle net segmentation algorithm based on
image processing methods.

Conclusion

-Binary image segmentation algorithm is developed for improving the visibility of the icons crackle net.

-Non-destructive approach.

-Applicable in mapping of conservation status, aging detection and fake detection of icons.

- Disadvantages: parameter settings and lack of training data base.

Literature

1) M. Stoyanova and T. Lukic, “Mapping the Conservation Status of Easel Painting. Craquelue Structure Visualization by Image Segmentation Approach”, Proceedings of DiPP2015, pp. 141-155, 2015.

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3) V.V. Filantov, “ Restoration of easel tempera painting”, in Russian, Moscow, 1986.

4) IB. Slansky, “The painting technique”, Moscow, in Russian, 1962.

5) Tibor Lukic and Jovisa Zunic, “A non-gradient-based energy minimization approach to image denoising problem, Inverse Problems”, Vol. 30 (095007), IOP Publishing, 2014. (publication prepared within COSCH STSM)

Thank You for Your attention!