St. Nicholas of Myra: Reconstruction of the Face between Canon and AI

Marinella Arena
Gianluca Lax

Abstract

This study is an ideal continuation of the one presented at REAACH-ID 2021. The results therein obtained are in fact the starting point for new evaluations and for the development of a protocol for the reconstruction of the missing parts in the Byzantine frescoes of St. Nicholas.
The research in question aims to carry out, thanks to Artificial Intelligence, digital restorations useful both for the formal and symbolic analysis of Byzantine iconography and for its communication to a wide audience. Four phases describe the research strategy: 1) choice of the case study and the field of investigation; 2) identification of the formal parameters in the processing of the paintings: canon; 3) definition of the work-flow relating to the work of artificial intelligence; 4) application of the study to a specific case and analysis of the obtained results.

Keywords
byzantine frescoes, effigies, inpainting, pyton, torch.

	CAPELL	TESTA	TESTA	CAPE	vertice s	vertice s	CAPE	TESTA	sopr occh	sopr occh	sopr occhi	sopr occhi	sopr		barba	occh	occh	occhi	occhi	barba	occhi	occhi	narici	narice s		naso		
SANTO	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	27b	28	29	30	31	32	33	34	35	38	39	40	41
6 a San Nicola Mottola	-1	-1,5	1,59	1,2	0,5	-0,61	-1,1	-1,5	1,1	0,5	0,1	-0,1	/	/	2	1,15	0,8	0,2	/	/	-1,1	-1,4	0,5	/	0,3	-0,3	1,08	0,83	0	-0,8
	1,08	1,08	0,52	0,5	0,52	0,44	0,5	0,52	0,2	0,2	0,2	0,17	/	/	0	0	0	0	/	/	0	0	-0,2	/	-0,8	0,75		-1	-1	
6 b San Nicola Mottola	-0,85	-1,1	1,47	1,3	0,5	-0,57	-1,1	-1,3	0,9	0,5	0,2	-0,1	-0,5	-0,84	2	1,15	0,8	0,2	-0,2	-0,74	-1	-0,2	0,5	-0,5	0,18	-0,2		0	-0,7	
	0,98	0,98	0,31	0,3	0,31	0,34	0,3	0,31	0	0,1	0,1	0	0,1	0,07	0	0	0	0	0	-0,07	0	0	-0,2	-0,1	-0,7	-0,7		-0,7		
7 San Nicola dei Greci, Matera	-1,01	-1,5	1,77	1,2	0,62	-0,5	-1,1	-1,6	1,1	0,5	0,1	0	-0,5	-0,94	2	1,27	0,9	0,3	-0,16	-0,8	-1,1	-1,6	0,5	-0,5	0,23	-0,2		0	0,19	
	1,13	1,13	0,46	0,5	0,46	0,52	0,5	0,46	0,2	0,1	0,2	0,16	0,15	0,14	0	0	-0	-0,1	-0,03	-0,05	0	0	-0,2	-0,2	-1	-1		-1	-1,1	
8 San Lorenzo, Fasano	-1,15	-1,4	1,41	1,1	0,58	-0,5	-0	-1,2	0,9	0,5	0,1	-0,1	-0,5	-1,02	1	1,06	0,7	0,2	-0,26	-0,84	-1	-1,4	0,5	-0,5	0,22	-0,3		0	-0,7	
	1,21	1,21	0,4	0,4	0,4	0,36	0,4	0,4	0,2	0,1	0,1	0,04	0,11	0,05	0	0	-0,1	-0,1	0	-0,09	0	0	-0,2	-0,2	-0,7	-0,7		-0,7	-0,8	
13 San Vito Gravina, Lecce	-1,26	-1,5	1,47	1,1	0,5	-0,5	-1,1	-1,5	0,9	0,5	0,2	-0,1	-0,5	-0,84	1	1,09	0,8	0,3	-0,19	-0,73	-1	-1,4	0,5	-0,5	0,28	-0,2		0	-0,1	
	1,36	1,36	0,47	0,5	0,42	0,47	0,5	0,47	0,3	0,1	0,1	0,1	0,14	0,21	0	0	-0,1	-0	-0,03	-0,1	0	0	-0,2	-0,2	-0,8	-0,7		-0,7	-1	
16 S. Maria degli Angeli, Poggia	-0,98	-1,2	1,14	0,9	0,5	-0,5	-0,9	-1,3	0,8	0,5	0,1	-0,1	-0,5	-0,8	1	0,9	0,7	0,2	-0,32	-0,8	-1	-1,2	0,5	-0,5	0,22	-0,3		0	-0,8	
	1	1	0,31	0,3	0,33	0,31	0,3	0,31	0,2	0,1	0,1	0,06	0,11	0,16	0	0	0	-0,1	-0,05	-0,06	0	0	-0,1	-0,2	-0,6	-0,7		-0,7	-0,8	
22 San Nicola, Derme, Antalia	-1,08	-1,3	1,4	1	0,5	-0,5	-0,9	-1,3	0,9	-0,8					1	0,95				-0,9	-1				0,26	-0,3		0	-0,6	
	1,43	1,43	0,37	0,4	0,37	0,37	0,4	0,37	0,3	0,3					0	0									-0,8	-0,8		-0,8		
1, Chiesa del Crocifisso Lentini	-1,21	-1,6	1,68	1,3	0,64	-0,5	-1,3	-1,7	1	0,5	0,2	-0,1	-0,5	-0,89	2	1,25	0,9	0,2	-0,18	-0,84	-1,3	-1,6	0,5	-0,5	0,27	-0,4		0	-0,8	
	1,05	1,05	0,5	0,5	0,5	0,5	0,5	0,5	0,3	0,1	0,2	0,11	0,11	0,22	0	0	-0,1	-0,1	-0,05	-0,09	0	0	-0,2	-0,2	-1,2	-1,2		-1,4		
2, Chiesa dello Spedale,Scalea	-0,88	-1,3	1,28	1	0,5	-0,5	-0,9	-1,3	0,8	0,5	0,2	-0,2	-0,5	-0,79	1	0,87	0,8	0,3	-0,29	-0,77	-1,0	-1,2	0,5	-0,5	0,22	-0,2		0	-0,7	
	0,9	0,9	0,37	0,4	0,37	0,37	0,4	0,37	0,2	0,1	0,2	0,16	0,37	0,22	0	0	0	-0,1	-0,06	-0,05	0	0	-0,1	-0,2	-0,7	-0,7		-0,7	-0,8	
6 c Chiesa San Nicola, Mottola	-1,14	-1,5	1,67	1,3	0,66	-0,5	-1,2	-1,6	1,1	0,5	0,2	-0,1	-0,5	-0,9	1	1,27	0,9	0,3	-0,18	-0,77	-1,1	-1,4	0,5	-0,5					-0,8	
	1,18	1,18	0,4	0,4	0,49	0,4	0,4	0,4	0,2	0,1	0,2	0,15	0,15	0,12	0	0	0	0	0	0	0	0	-0,1	-0,1					-1	
35 S. Marina, Muro Leccese, Lec					0,5	-0,5				0,5	0,2	-0	-0,5	-0,82			0,9	0,3	-0,14	-0,81	-1	-1,1	0,5	-0,5	0,34	-0,2	1,17	1,03	0,08	-0,7
					0,37	0,4				0,1	0,2	0,19	0,11	0,16			-0,1	-0,1	-0,04	-0,05	0	0	-0,2	-0,2	-0,6	-0,6		-0,8	-0,8	
2b chiesa dello Spedale, Scalea	-1,14	-1,5	1,79	1,2	0,78	-0,56	-1,3	-1,8	1,1	0,5	0,2	-0,2	-0,5	-1,01	1	1,14	0,8	0,3	-0,23	-0,85	-1,2	-1,2	0,5	-0,5					-1	
	1,14	1,14	0,48	0,5	0,48	0,48	0,5	0,48	0,2	0,1	0,2	0,2	0,13	0,25	0	0	0	-0	-0,07	-0,1	0	0	-0,1	-0,1					-1,1	
14 Cripta del Crocifisso, Ugento,	-0,85	-1,2	1,53	1,2	0,68	-0,56	-1	-1,4	/	0,5			-0,5	-0,93	2	1,14	0,8	0,3	-0,17	-0,7	-1	-1,3	0,5	-0,5	0,22	-0,2		0	-0,9	
	1	1	0,46	0,5	0,37	0,46	0,5	0,46	/	0,1			0,13	0,21	0	0	-0	-0	-0,04	-0,1	0	0	-0,1	0,11	-0,9	-0,9		-1,1	-1,1	
15 Chiesa SS. Marina e Cristina,	-0,82	-1	0,95	0,8	0,5	-0,56	-0,8	-1	0,7	0,5	0,2	-0,1	-0,5	-0,77	1	0,84	0,7	0,2	-0,31	-0,74	-0,9	-1	0,5	-0,5	0,13	-0,3		0	-0,6	
	0,76	0,76	0,43	0,4	0,43	0,43	0,4	0,43	0,2	0,1	0,3	0,33	0,13	0,27	0	0	-0,1	-0,2	-0,03	-0,06	0	0	-0,2	-0,1	-0,7	-0,7	-0,9	-0,9	-0,9	-0,9
18 Chiesa Boyana, Sophia	-0,84	-1,2	1,7	1,1	0,56	-0,56	-0,9	-1,3	1	0,5	0,1	-0,2	-0,54	-0,89	2	1,14	/	0,3	-0,29	-0,78	-1	-1,3	0,5	-0,5	0,22	-0,3		0	-0,7	
	1,2	1,2	0,35	0,4	0,4	0,35	0,4	0,35	0,2	0,1	0,2	0,21	0,09	0,22	0	0	/	-0	-0,05	0	0	0	-0,1	-0,1	-0,6	-0,7		-0,8	-0,8	
31 Chiesa San Nicola, Steyis, Cyp	-1,13	-1,4	1,37	1	0,68	-0,56	-1,1	-1,5	0,9	0,6	0,2	-0,1	-0,5	-0,9	1	1,02	0,9	0,3	-0,17	-0,78	-1,1	-1,3	0,5	-0,5	0,33	-0,3		0	-0,7	
	1,29	1,29	0,41	0,4	0,41	0,41	0,4	0,41	0,2	0,1	0,2	0,25	0,13	0,08	0	0	-0	-0	0	0	0	-0,2	-0,2	-0,8	-0,5		-0,9	-0,9	
32 san Nicola Bolnicki, Macedon	-1,05	-1,5	1,94	1,3	0,5	-0,5	-1,2	-1,6	0,9	0,6	0,1	-0,2	-0,5	-0,94	2	1,22	0,7	0,2	-0,22	-0,84	-1,1	-1,5	0,5	-0,5	0,22	-0,4		0	-1	
	1,36	1,36	0,36	0,4	0,36	0,36	0,4	0,36	0,3	0,1	0,2	0,22	0,13	0,21	0	0	0	-0,1	-0,02	0,05	0	0	-0,1	-0,2	-0,5	-0,6	-0,8	-0,8	-0,8	-0,8
34 MONASTERO Eski Gumus, Tur	-0,94	-1,3	1,44	1	0,61	-0,5	-1,1	-1,5	0,9	0,5	0,1	-0,2	-0,5	-0,93	1	1,01	0,8	0,2	-0,26	-0,8	-1,1	-1,5	0,5	-0,5	0,22	-0,4	0,94	0,74	-0,1	-0,9
	0,89	0,89	0,4	0,4	0,44	0,4	0,4	0,4	0,1	0,2	0,2	0,22	0,13	0,27	0	0,1	-0,1	-0	-0,03	-0,1	0	0	-0,1	-0,2	-0,6	-0,7	-0,8	-0,8	-0,8	-0,8
30 Chiesa di San Giorgio, Sophia	-1,1	-1,5	1,31	1	0,53	-0,5	-1,1	-1,4	0,8	0,5	0,2	-0	-0,5	-0,84	1	0,91	0,7	0,3	-0,26	-0,77	-1	-1,2	0,5	-0,5	0,39	-0,2	0,97	0,74	0,13	-0,8
	1,05	1,05	0,4	0,4	0,37	0,4	0,4	0,4	0	0,2	0,1	0,06	0,13	0,05	0	0	-0	-0	-0,03	0	0	0	-0,1	-0,1	-0,6	-0,6	-0,9	-0,9	-0,9	-0,9

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Introduction

This study is an ideal continuation of the one presented at REAACH-ID 2021. The results therein obtained are in fact the starting point for new evaluations and for the development of a protocol for the reconstruction of the missing parts in the Byzantine frescoes of St. Nicholas.
The research is based on some preliminary considerations relating to the intrinsic qualities of Byzantine painting, its widespread diffusion in the Mediterranean basin, and the often unexpressed potential of the sites that host them. The iconographic structure of the Byzantine frescoes is strongly codified, it is in fact a perfect example of syncretism between the oriental aniconic matrix, centred on the decorative and calligraphic apparatus, and the western, Latin and figurative one. The Byzantine culture, spread throughout the Mediterranean basin, is one of the founding elements of our culture. Currently much of the religious and formal message underlying the Byzantine iconography is invisible, the causes, of course, are both physical and cultural. In fact, the state of conservation of the paintings prevents an evaluation while the absence of adequate cultural preparation does not allow the occasional user to appreciate the formal and symbolic contents of the works. The research in question aims to carry out, thanks to Artificial Intelligence, digital restorations useful both for the formal and symbolic analysis of Byzantine iconography and for its communication to a wide audience.
Four phases describe the research strategy: 1) choice of the case study and the field of investigation; 2) identification of the formal parameters in the processing of the paintings: canon; 3) definition of the work-flow relating to the work of artificial intelligence; 4) application of the study to a specific case and analysis of the obtained results.

Fig. 1. St. Nicholas of Myra: the scheme of 'three circle'.

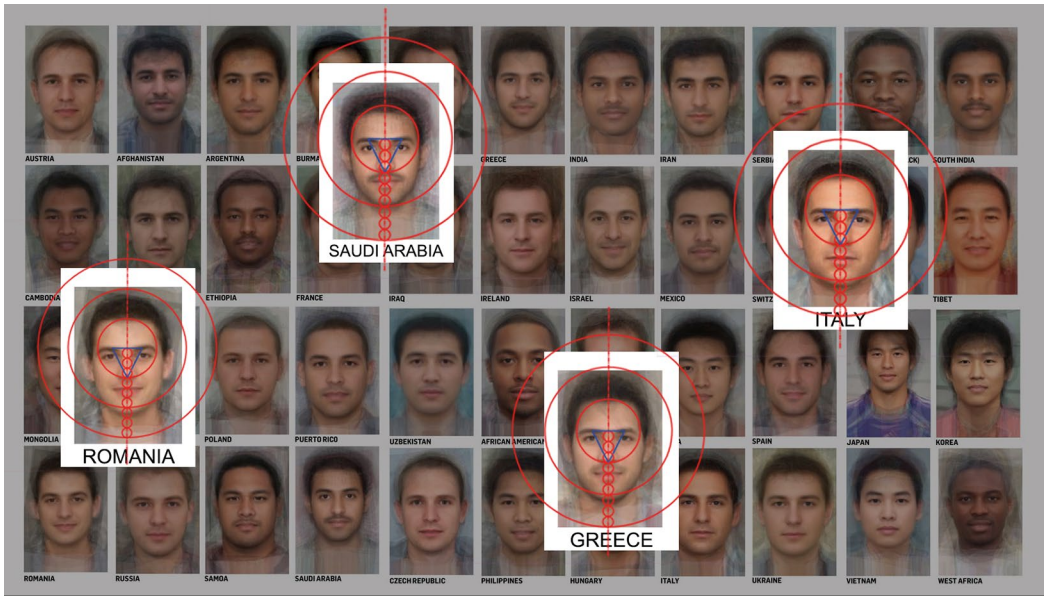

Fig. 2. Superimposition of the scheme of the 'three circles' to *The Face of Tomorrow* by Mike Mike.

The Case Study

The case study is the effigy of St. Nicholas of Myra, widespread throughout southern Italy. The iconography of the Saint, which is very repetitive and codified, lends itself well to an analytical investigation that involves the cross-comparison with omogeneous frescoes, in terms of technique and dating, belonging to the entire Mediterranean basin. The faces of the saints in Byzantine sacred iconography are rigidly defined by simple geometric figures and predefined proportional ratios. Using the results of the previous research we try to verify if the analysed examples respect the established canons, and if the latter can be used for the reconstruction of the missing parts.

Canon: the Formal Parameter

The search for a canon in the proportions of the human figure runs through the entire history of visual art even if, in various eras and in different cultures, it has taken on very different connotations. In fact, the canon can trivially express the search for anthropometry, or indicate the metaphysical structure, invisible and immanent, in the proportions of the human body; finally, the canon could be a simple technical support for the artist: a regulatory layout. In ancient Greece, the canon aimed at identifying the ideal dimensions of the human figure. The first of which we know is that of Polykleitos, Κάνον, elaborated in 450 BC, which had an enormous resonance in Western classical art and of which we have traces only from hints in later works. The Canon of Polykleitos while aspiring to verisimilitude, to the profound mimesis of human features, left room for the artist to freely compose its work by offering a system of proportional relationships based on ordinary fractions.
The practical theory of proportions, in the Renaissance, recovers the classical notions of Polykleitos and Vitruvius and makes them the rational foundation for the search for beauty. The canon in this historical period combines microcosm and macrocosm, geometry and matter. Finally, the canon can be aimed at the 'technical' realization of the work, in this case it is a structure that simplifies the tracing operations and gives a guide to the artist. An exemplary case is the grid that the Egyptians made before tracing the work. The grid, which divided the human figure into 18 or 22 modules, was used to construct the representation by giving the right proportional ratios to the parts. In the Middle Ages, the theory of Byzantine proportions abandoned anthropometry and mimesis while not completely denying classical art. Proportional schemes are no longer expressed as ordinary fractions and complex relationships

between the whole and the parts but with a schematic system of modules or the so-called 'system of unity'. The relationships between the parts of the body, or of the face, are defined by a rigid system based on a single module repeated a whole number of times. Sacred Byzantine art, more than the others, follows strict protocols in the tracing of the figures, probably to mark the separation between the real and the divine and to respect the multiple canons deliberated in the councils. Sacred icons, in fact, are intended as images of the Image, types of the Archetype, do not aspire to mimesis but are proposed as a gateway to the divine. The identification of the rules underlying the 'Byzantine canon', among the scholars of the sector, is the philosopher's stone of knowledge, capable of extracting the 'truth' about the morphology and meanings of Byzantine painting. For this reason, over time, many scholars have been dazzled by manuals and texts of dubious origin. One of the most striking cases is that of Adolphe Napoléon Didron who accepted as authentic, that is, as a rewriting of a twelfth century text, the nineteenth-century manual of the painter Dionisio da Furnà [1]. Panofsky was one of the first scholars to highlight the rigid formal-symbolic and geometric rules underlying the creation of the icons and, in the famous text The meaning of the visual arts [Panofsky 1999], takes up the theories of Furnà and the so-called 'scheme of the three circle'. The scholar identifies a concentric structure based on the size of the nose [2]. The construction tested on some examples provides the length of the nose as a unit of reference, which is divided into three parts and is the module of the entire composition. The smaller circumference at the base of the nose envelops the face with the exception of the lips. The second circumference, twice the size of the first, marks the size of the head and laps the chin. The third defines the nimbus (halo) and the position of the dimple at the base of the neck.

Panofsky in a note [Panofsky 1999, p. 84] underlines how the scheme is sometime applied in a partial way and that it is often generated by circumferences with a ratio equal to 1/1 ½ / 2 ½. In many cases the outermost circumference, the one that defines the nimbus, is not concentric to the others and wraps around the beard.

Before applying the canons identified by Panofsky, and then taken up by many other scholars, it seems interesting to us to check whether the proportions identified, for example, respect the anthropometry of a human face. After all, Vitruvius in his De Architectura already encodes the proportions of the human face and divides the height of the face into three equal parts marked by the length of the nose: "For the height of the face itself, however, it is one third from the tip of the chin up to the lower part of the nose, likewise measure the nose from its lower end to the end in the centre of the eyebrows; from this end to the lowest roots of the hair, where the forehead is formed, it is likewise a third" [3].

The sharing of data, in recent years, has made possible the morphological analysis of faces and, through artificial intelligence, automatic recognition. We can superimpose the 'three circles' pattern on the 'average face' of the different nationalities [4] and verify that the division of the face into three parts is the norm. Instead the second circle rarely describes the ridge of the head, even if a certain coincidence is noted in the Greek and Romanian faces; the outermost circle identifies, in the examples cited, also the dimple at the base of the neck.

The 'Byzantine Canon' is all too rigid and in fact it is denied by Panofsky himself who, in a note, underlines how the scheme he has taken up is often disregarded or applied in a partial way. In fact, circumferences often have a ratio of 3/4 ½ / 6 ½.

In many cases the outermost circumference, the one that defines the nimbus, is not concentric to the others.

By superimposing the scheme of the 'three circles' on the effigies of St. Nicholas (Fig. 3) we can verify that there is not a perfect correspondence but that most of the paintings oscillate, with variations equal to half a module, around the Canon: graphs marked in red, blue and yellow. The effigies characterized by the graphs in green have the second circle very close to the first with a ratio of 3/5/8. Finally, the effigies with the gray graphics are missing by some circumferences.

The verification carried out by superimposing the results of the division into clusters [5] on the rule of the three circles shows a certain persistence of the effigies analysed in cluster 1. Furthermore, the division into clusters is shown in Fig. 5 where the rule of 'three circles' is further verified by exemplifying the faces through the control points used for recognition.

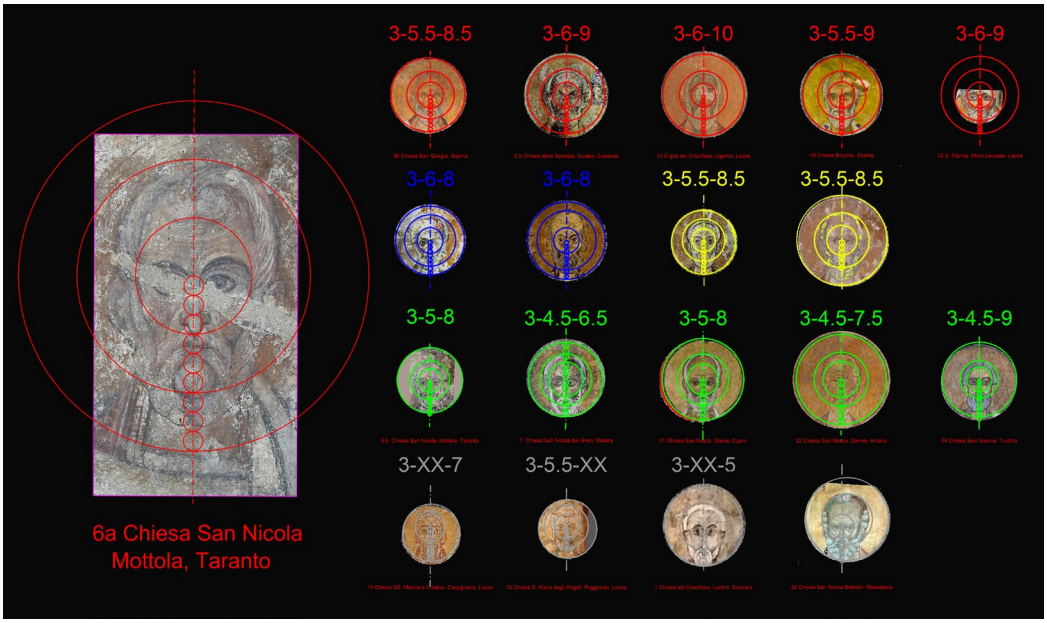

Fig. 3. Superimposition of the scheme of the 'three circles' to *the AI Data*.

The AI restore

The approach we use to restore the digital representation of the effigies of Saint Nicholas is inspired by generative adversarial networks.
In machine learning, a generative adversarial network (GAN) is a technique in which two neural networks are competitively trained to reach a goal. One neural network is named generator, the other is named discriminator. The goal of the generator is to produce new samples to fool the discriminator, whereas the discriminator needs to detect if a sample is real or generated by the generator. This technique was first introduced in *Generative adversarial nets* [Goodfellow 2014] where the models of both the generator and the discriminator were multilayer perceptron.
The training procedure of the generative model aimed to maximize the probability of deceiving the discriminative model, which is equivalent to minimizing the likelihood that the discriminator performs correctly. The training procedure of the discriminative model aimed at maximizing the probability of distinguishing real data from generated samples. At each iteration, the generator knows the classification done by the discriminator and uses this result to produce new samples. A schema of how a generative adversarial network works is reported in Fig. 6.
Generative adversarial networks are used in many application contexts such as image dataset enrichment, generation of human faces or cartoon characters, text-to-image translation, face aging.

AI Workflow

The artificial-intelligence-based technique used to restore the digital representation of the effigies of Saint Nicholas has been implemented in Python and exploits Torch [http://torch.ch/], an open-source library for machine learning.
The limited number of effigies of Saint Nicholas available in our study does not allow us to train a model. For this reason, we decided to start with a pre-trained model for human faces, then we customized it with the effigies of Saint Nicholas. Since the model works with low-resolution images, another AI-based post-processing task was exploited to increase image resolution. Specifically, the adopted workflow is composed of the following steps.

1. Input management. The available set of images of San Nicholas to be used as input is shown in Fig. 7. The set is composed of eighteen 1690x1690 pixel images having the same size. Among these images, we have selected those that have very limited parts to be restored and these images are used to customize the generative model.
Moreover, we selected the image in the worst state of conservation and used it as the input of the process of restoring. The image to be restored is reported in Fig. 8 a along with the "mask" to be used for restoring, which is a 2-color bitmap image having the same size as the other inputs and black pixels in correspondence of the parts of the image to be restored (see Fig. 8 b).
2. Generation. The limited size of the input images is not sufficient to train the generative model. For this reason, we used a standard approach consisting in finding a model already trained for the same purpose and then customizing it for the specific scenarios with the available effigies of Saint Nicholas. The model we used in this phase is generated by a deep fusion network [Hong 2019] and requires two inputs: the image to be restored and the mask (Fig. 8 c).
3. Upscaling. Training a model with high-resolution images takes a lot of time, thus the model training has been carried out by 512x512 pixel images. As a consequence, the generated output has the same (low) resolution as the input. In this step, we use a deep convolutional neural network trained on a large set of general images (i.e., different from the effigies of Saint Nicholas). At the end of this step, the size of the generated image is the same as the initial input, and the result of the elaboration is reported in Fig. 8 c.

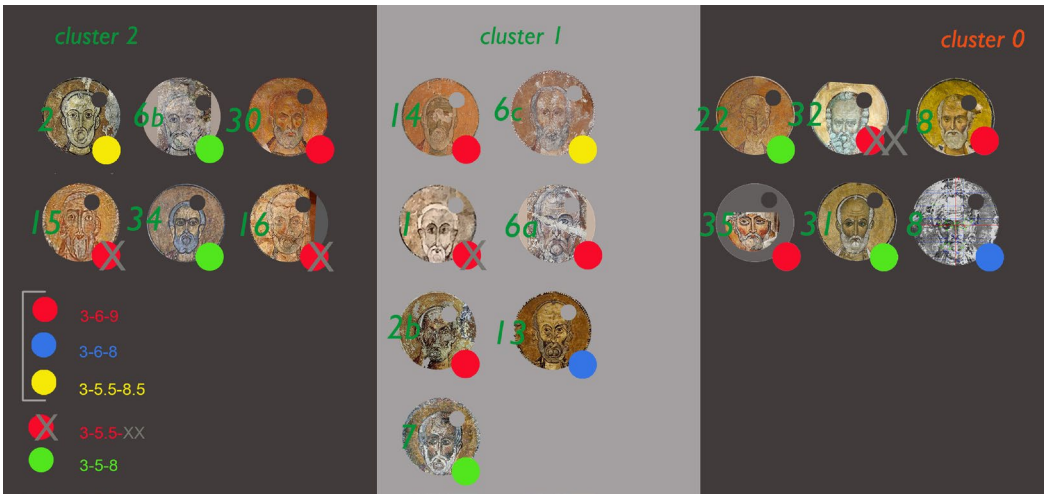

Fig. 4. The rule of the three circles superimposed to the division into clusters.

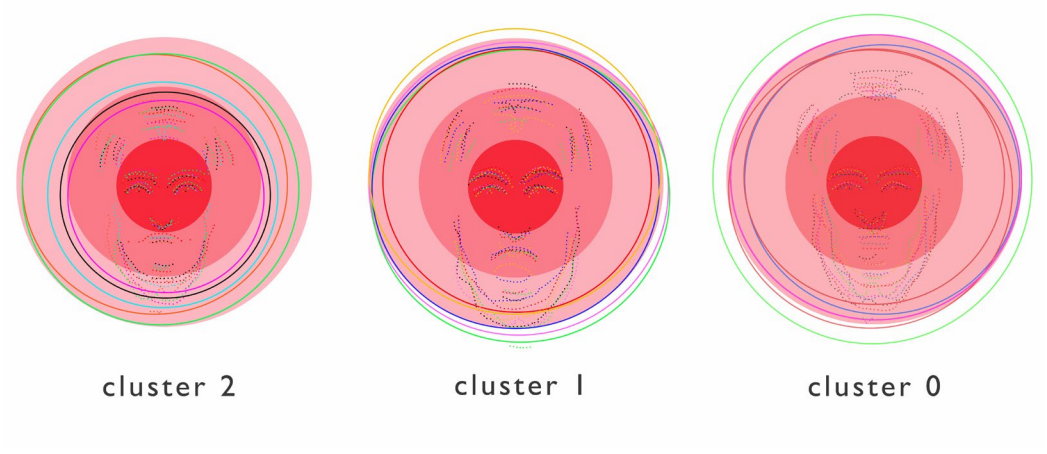

Fig. 5. The rule of 'three circles' verified by exemplifying the faces through the control points.

Conclusion

The comparison between the original effigies and the restored one shows a great improvement. In particular, the small missing part on the top of Fig. 8 b has been completely restored. The large strip in the middle of the effigies has been partially restored, in particular in proximity of the missing eye. However, large parts missing are much more complex to be restored than smaller ones.

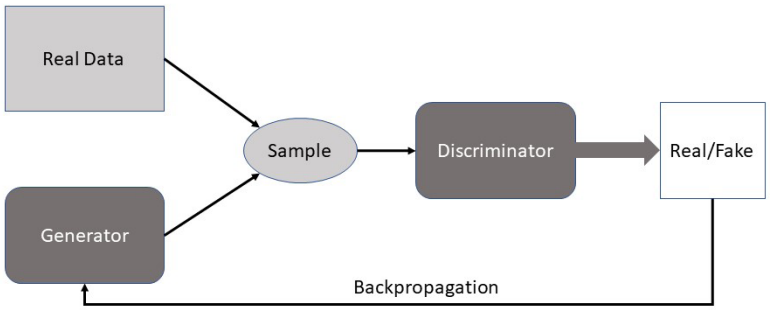

Fig. 6. AI workflow.

Fig. 7. The available set of images of San Nicholas used as input.

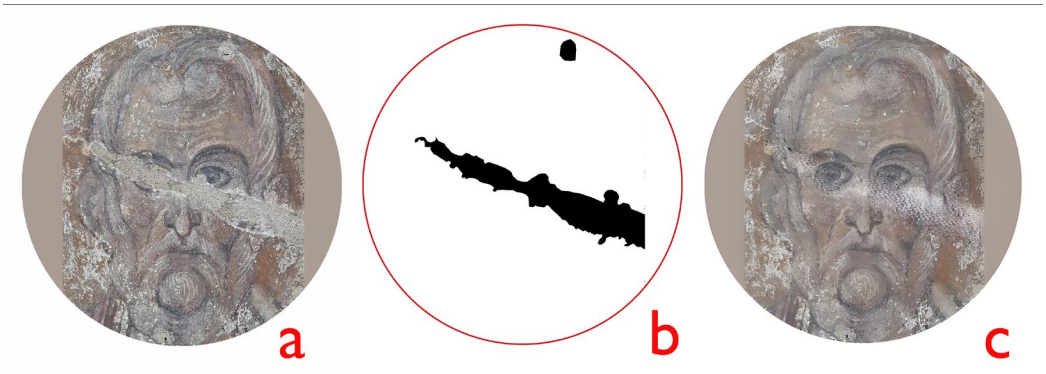

Fig. 8. The reconstruction of the face of St. Nicholas of Myra through the AI.

The model obtained with AI could show the missing parts of the saint's faces and be of support for the reconstruction of other effigies not belonging to this research. The results of the reconstruction may be useful for the creation of a database for enriching the documentation of the Byzantine iconographic heritage and for the development of content for new media. The enhancement of the asset, in fact, always rests on a double track: on the one hand the philological and scientific reconstruction of the iconography and on the other the communication of the underlying cultural and formal matrices.

Notes

[1] This is the story of a false medieval Byzantine manuscript, recognized as such since the beginning of the 1900s and which even today some people persist in passing off as true. In 1839 Adolphe Napoléon Didron went to Greece to study the works of art of the Byzantine age. And there, wandering among the monasteries of Mount Athos, he was able to observe a guide to artistic making, whose author (the painter Dionisio da Furnà) provided indications on the technical measures to be followed and on the iconographic characteristics to be respected. Didron believed he had come across a manuscript which, although compiled in the century XV or later, it reported rules and behaviours from a much older period, dating back – as the monks of the place claimed – to the 10th or 11th century, that is, to an age that has recently emerged from the well-known controversies on the lawfulness of the use of images. (See Dionisio da Furnà, Hermeneutics of painting, Edited by Giovanna Donato Grasso Introduction by Sergio Bettini, Fiorentino publisher, 1971)

[2] The circular structure is an aid for the artist without being the necessary condition of the design. In the end though, the structure shows itself as the mysterious ground of the icon's harmony. […] the first circle which has the radius of the length of the nose creates the space for the eyes and the forehead. The circle whose radius is two lengths of the nose determines the volume of the head. The halo, by contrast, does not correspond to the third circle but is displaced toward the bottom because it encircles both the beard and the hair and must be inscribed in the format of the icon.

[3] VITRUVIO, De Architectura libri decem, (curator Curt Fensterbusch), Darmstadt 1996, III pp. 91-92.

[4] The base image of Figure 2 is taken from the 2011 project "The Face of Tomorrow" by South African Photographer Mike Mike who collected the faces of people from various cities for a studio at Goldsmith University in London.
In 2004, the Korean artist Atta Kim in his ON-AIR Project, Self-Portrait Series, 100 Countries / 100 Men had already created the image of an average face.
Effectively, in 1880 Sir Francis Galton, cousin of Charles Darwin, was the first to create the image of the "middle face" by superimposing multiple portraits of individuals.

[5] The subdivisions into 'clusters' referred to in this paper refer to the results obtained with the research carried out in the context of the REAACH-ID 2020 conference [Arena Lax 2021].

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Authors
Marinella Arena, Dept. of Architecture and Territory, dArTe, University of Reggio Calabria, marinella.arena@unirc.it
Gianluca Lax, Dept. of Information Engineering, Infrastructure and Sustainable Energy, University of Reggio Calabria, lax@unirc.it

 Isbn 9788835141945