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# Aerariumchain Project

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## Abstract.

The project aims to create an intelligent system that allows you to compare different 3D images, from scans in different periods, and that lets to understand changes to the artworks. A very high precision check-up system that allows you to intervene in time in the restoration of the artwork

## 1. Aerariumchain.com

The project aims to create an intelligent system that allows to compare different 3D images, from scans in different periods, and is capable of understanding changes to the artworks. A very high precision check-up system that allows the user to intervene in time in the restoration of the artwork.

Aerariumchain.com is a research project for the protection of cultural heritage. It is developed by the AerariumChain LTD start-up and incubated at Polihub.

In the team there are many different technical experts and archaeology researchers. Our solution is focused on preserving and enhancing cultural heritage (above all artistic and archaeological artworks), adopting digital technologies such as 3D Scan, blockchain and artificial intelligence. We allow artworks check-up, a fast return of the asset in case of theft and the recognition of the falsified works. The project foresees that in future the owner of a work of art can register it on our platform: the user will create a 3D image of the object and insert all the certificates concerning the object. Our platform will create a Unique Virtual Image (UVI) from the 3D scan and the certificates uploaded to it and will insert the Unique Virtual Image in a blockchain. Our algorithm will normalize all UVIs through a quality score that will depend on a rating of the 3D image quality, certificates and credentials of the subject (for example higher score for a museum and lower for an unknown owner). Our AI based algorithms will allow us to match the 3D images inside the platform, recognizing the possible fakes or, in case of theft recovered by the authorities, will permit to return it to the owners in a short time. The project intends to intercept the continuous growth trend of the use of 3D reconstruction systems, developing a sophisticated AI that allows comparison between these images.

### 1.1. 3D Scanning

We decided to use both digital photogrammetry and scanning in order to calibrate the platform and its AI algorithym at best. Until now we're working with a structured-light 3D scanner as "Scan in a Box FX by Faro" and "Artec Leo", a handheld 3D scanner. Scan in a Box is simple to use and it is a cost efficient product. The sets of points it generates define a 3D picture of each part of the object that has been framed and hit by the light pattern generated by the projector. The Scan in a box is used to record small and medium objects allowing them to reach a good precision level (1 micrometer) and for this reason it's more reliable compared to a close-range approach without structured-light, as digital photogrammetry is. Artec Leo, on the other hand, is designed for usability. Thanks to the 80 frames-



per-second 3D reconstruction rate and its wide field of view, it can 3D scan and process even large objects and scenes fast and accurately.

## 1.2. Unique Virtual Image (UVI)

In order to normalize 3D scans generated from different instruments and technologies, Aerariumchain produces a digital footprint with a fixed format that uniquely identifies each 3D scan. This footprint is called Unique Virtual Image (UVI) and is inserted inside a digital certificate issued in 2 parts: a private and a public one.

Working on the UVI and a digital certificate, it solves the problem of large files notarisation, like 3D scans are and allows some operation (like search and verification) on the certificates itself, without having to process the entire large files of 3d scans.

## 1.3. Blockchain technology

Aerariumchain uses blockchain technologies having to solve different prerequisites required in the art field:

- Notarisation of 3D scans (when they are stored);

- Making private and public data consistent;

- Allowing a restricted group of subjects to approve some transactions, eg. scientific method is not based simply on a majority system;

- Allowing operations directly on data stored on the blockchain;

- Provide a recognised notarisation system;

- Provide a solution not depending on blockchain daily computational costs;

- Allow automatic interactions if applications directly form distributed Apps on the blockchain.

After analysis and tests on technologies available the market, the Aerariumchain team has opted to build a solution based on multiple blockchain technologies to meet all the requirements:

- the IPFS (interplanetary file system) to publish the public part of the UVI certificate;

- IOTA blockchain to store different transactions (for every 3D scan including the updates);

- Private blockchain (Hyperledger or provisioned Ethereum both in test) to manage operations between restricted operators;

- Public Ethereum to notarize the state of the private blockchain.

## 1.4. Artificial intelligence

To better calibrate the AI algorithm, AEC's core business, we used spatial and chromatic information from both scanning methods, developing (obtaining) comparison models. The comparison is related to 3D scanning with a high precision rate deriving from the "Scan in a box".

There are many libraries and solutions available on the market for 2D images identification.

Less solutions are available for 3D image identification. The Aerariumchain team is focused now to work in this field, adopting comparison libraries that identify differences between different 3D scans and feeding AI algorithms directly with their results.

## 1.5. Summary

3D scanning, blockchain and artificial intelligence technologies create the basis for the creation of objective condition reports, to support the digitization and the restoration and maintenance processes of cultural heritage. In short:

The scan allows you to have a 3D model of the work, where everything visible is in evidence, allowing you to uniquely recognize the work and avoid running into theft.

The blockchain certifies the information acquired and acts as a guarantee to the buyer or lender of the work itself. It keeps track of historical information, which should be updated as time goes by.

Artificial intelligence limits the subjective sphere and human variables such as fatigue, inattention, and speed for editing. Monitor the state of the art over time. Helps prevent damage and highlight differences that may not be visible to the naked eye for scans made at different times.

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