

Gamification of NFT collections: Virtual NFT gallery

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Abstract

The rise of the popularity of Blockchain technologies, brought a cascade increase of interest for other Blockchain related products. The Non-Fungible Tokens (NFTs) represent a unique identification for digital assets present on a Blockchain system. The primary use of the NFTs are to represent digital images hosted on a dedicated web site. In most cases the environment or the visual interface for NFTs exhibition is a basic web page that is not interesting for the masses. The development of a virtual environment with increased details for the virtual reality, will leverage the overall experience of displaying and watching the NFTs collections to a level of exhibition in a gallery. In this paper we are proposing an on-chain cloudless semi-dynamic solution for virtual NFT gallery with increased security from theft, ransomware and inaccessibility of the content.

Keywords

Blockchain technology, NFT, Gamification, IPFS, Virtual Reality

1 Introduction

The main focus of the predecessor of Blockchain technologies is the media timestamping [1], which is an essential mechanism for obtaining and proving originality of a media in the legal process of Digital Right Management (DRM). With the introduction of Bitcoin [2], timestamping mechanism is used to prove the order of the transactions in the system.

A transaction in a Blockchain system is any kind of records, a static information written in the system or a digital asset transferred from one address to another. With the introduction of the Bitcoin, the first type of digital crypto asset is introduced, known as cryptocurrency. Beside the cryptocurrency, in 2012 the Mastercoin [3] Blockchain technology introduces the second most known crypto asset, known as token. The cryptocurrency is a digital alternative to the fiat currency, while the token can represent any digital substitution for a real asset. The token is a digital asset that can be used in security mechanisms, as a utility to incentivize the users or as a digital representation of a real asset.

There are two types of tokens: fungible and non-fungible tokens (NFTs). The fungible tokens are non-unique tokens representing an asset similar to a currency, used to pay for a good purchased inside the frame of the Blockchain technology where it exists. On the other hand, the non-fungible tokens are unique tokens associated with either a digital asset or real-life asset. The NFTs are of limited quantity, thus representing a unique piece of digital asset, which gives the token significant value. Thus it is feasible to connect a NFT with any type of art, media or other item from collectibles. The Quantum non-fungible token [4] released on the Namecoin Blockchain [5] in 2014, was the first digital art (image) created on a Blockchain platform. The introduction of NFT completely solves the problems of media timestamping from [1].

With the introduction of the Ethereum Blockchain technology [6] and the first implementation of smart contracts, there is a mechanism to leverage the use of tokens. Some of the most important projects related to

the NFTs are the Terra Nullius [7], Peperium [8], CryptoPunks [9], CryptoKitties [10]. The success of CryptoPunks is a motivation for the development of smart contract standard ERC-721 [11]. The standard was delivered in the early 2018, which brings steep rise of the interest for developing NFTs, especially in the gaming industry.

In 2018 the NFT marketplace started to grow and web based platforms like OpenSea [12], SuperRare [13], KnownOrigin [14] started to offer public space to trade and show-off NFTs. In late 2018, the web-based platform Maecenas [15] started to tokenize fine art paintings from Andy Warhol which was the first time that a real asset was traded on the Blockchain as NFT.

To enhance the experience of NFT collectible exhibition, the companies are going beyond the traditional web based platforms and are offering commercial platforms for creating virtual galleries for NFT exhibition. Several companies are offering proprietary solutions of Metaverse-based virtual galleries to create the three-dimensional (3D) or virtual environment for NFT galleries. Some of them are Spatial [16], Cryptovoxels [17] and Decentraland [18]. The developers are going even beyond the concept of simple galleries for exhibition of digital art and are building public on-chain places for NFT trading like Christie's 3.0 [19].

2 Virtual NFT gallery application architecture and code structure

General approach of the platforms for NFT management is to use on-chain storage of simple and lightweight data like wallet addresses and transactions, and off-chain (mainly cloud-based) storage for NFT and virtual environment storage. This approach is partially centralized and is prone to potential security threats like theft, ransomware or inaccessibility of the content. In order to overcome these potential problems, in this paper we are proposing an architecture that is completely on-chain cloudless semi-dynamic virtual environment for NFT exhibition.

The proposed architecture for the virtual NFT gallery (see Figure 1) offers a complete on-chain online solution where the user can exhibit the personal NFT collection. The simple architecture of the application uses the IPFS (InterPlanetary File System) [20] storage and Polygon Blockchain technology [21] in order to adopt the on-chain cloudless approach for building decentralized application.

In order to generate the virtual reality environment (the 3D space), the application uses the A-frame web framework [22]. A-frame defines the virtual reality environment inside an HTML file of the application, by specifying the sources for the textures, location of the elements in the scene, lighting of the scene and other components of the 3D scene. All segments of the A-frame virtual environment definitions are part of the HTML code. Beside the A-frame framework, the application uses the Web3 JavaScript libraries [23] to define the interaction between the Blockchain and the application interface.

The whole application code is set in a single index.html file containing a definition for the Cascading Style Sheets (CSS) design script of the web interface, the Web3 functions that are defining the interaction between the Blockchain and the web page, a single event listener definition for "load" event and two asynchronous function definitions for fetching and displaying the NFTs. The code also consists of A-frame scene assets initialization with definition for 10 NFT placeholder positions. The application shows the NFTs possessed by the user at the moment of application opening. If the user sells or buys new NFT, the application has to be manually refreshed in order to display the new collection. The application is completely uploaded to IPFS, and accessible through the following link

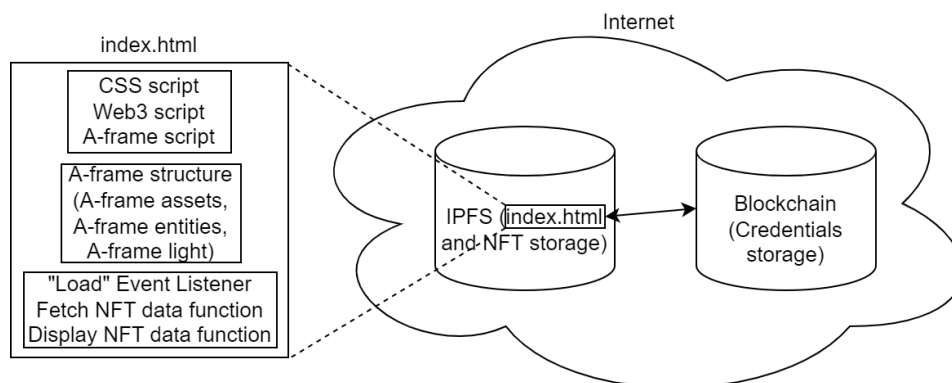


Figure 1. Architecture of the application

Figure 2 shows the simplified HTML code of the index.html file.²

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <!-- metadata and title -->
    <style>
      /* style definition */
    </style>
    <script src="https://aframe.io/releases/1.0.4/aframe.min.js"></script>
    <script src="https://cdn.jsdelivr.net/npm/web3@1.5.2/web3.min.js"></script>
  </head>
  <body>
    <a-scene>
      <a-assets>
        <!-- definition of the assets in the scene -->
      </a-assets>
      <!-- loading the references from a-assets -->
      <a-entity>
        <!-- setting up placeholder for the header text -->
      </a-entity>
      <!-- setting up 10 placeholders for the NFTs -->
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <a-entity id="nftWall" class="nft-wall" position="0 1 -4"></a-entity>
      <!-- setting up the light of the scene -->
      <a-light type="point" intensity="2" position="2 4 4"></a-light>
    </a-scene>
    <script>
      window.addEventListener("load", async () => {
        /* setting up the event trigger */
      });
      async function fetchNFTData(tokenId) {
        /* content of the function */
      }
      async function displayNFTs(connectedAddress) {
        /* content of the function */
      }
    </script>
  </body>
</html>
```

Figure 2. Simplified HTML code of the index.html file

The application requires Metamask [24] browser extension to interact with the Blockchain. After the initial authentication in the Metamask wallet, the user can see the NFTs that are available in the wallet. Figure 3 shows an example of the NFT gallery with NFT artwork present in a user's wallet. The user can navigate through the 3D space by use of WASD or arrow keyboard buttons. A better perspective of the artwork with additional information about it, is available by approaching closer to the desired artwork.

The current implementation of the application exists on the Mumbai testnet. It is accessible by setting up the following parameters in the Metamask extension:

- Network Name: Mumbai Testnet
- New RPC URL: <https://rpc-mumbai.maticvigil.com/>
- Chain ID: 80001
- Currency Symbol: MATIC
- Block Explorer URL: <https://polygonscan.com/>

² <https://fleek.ipfs.io/ipfs/QmU6sYcP3qPhPaEw14yzg54xEAyWLx8kwUigy6bT8RAsc8/>

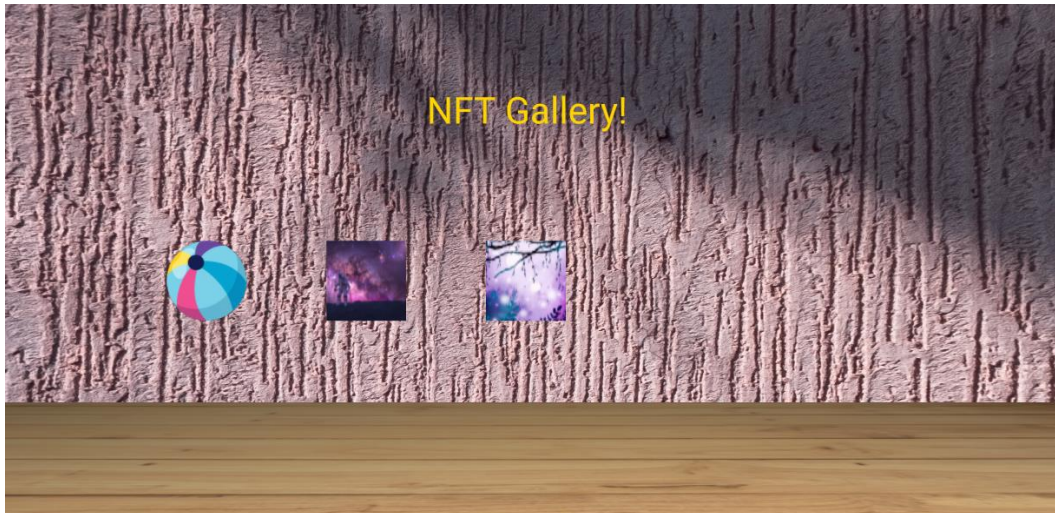


Figure 3. Example of artwork presented in the NFT gallery

The application uses the Polygon Blockchain, which is Ethereum layer 2 scaling solution that inherits the standardization procedures for writing smart contracts of the Ethereum Blockchain. The smart contract implements the ERC-721 standard for Non-Fungible Tokens, written in Solidity 0.8. The application uses the OpenZeppelin [25] templates in order to provide compatibility with the guidance and common standards for smart contract writing. Appropriate modification to the templates is conducted in order to add additional functionalities. The smart contract of the application is publicly available on the following link³.

The smart contract role is to manage the credentials of the users and allow them to mint, buy and sell NFTs. The current version of the application uses public free service nft.storage [26] (see Figure 4) to upload the artwork to the IPFS storage. Every change of NFT ownership can be updated by manually refreshing the page which gives the semi-dynamic nature of the application.

The user can interact with the smart contract and the functions defined inside the scope of the smart contract, through the Polygonscan [27] interface. Figure 5 shows an example for selling an image from the NFT collection. To proceed with selling of an artwork, the user implements the function transferFrom() where he inputs the owner's wallet address, the recipient's wallet address and the token ID for selling.

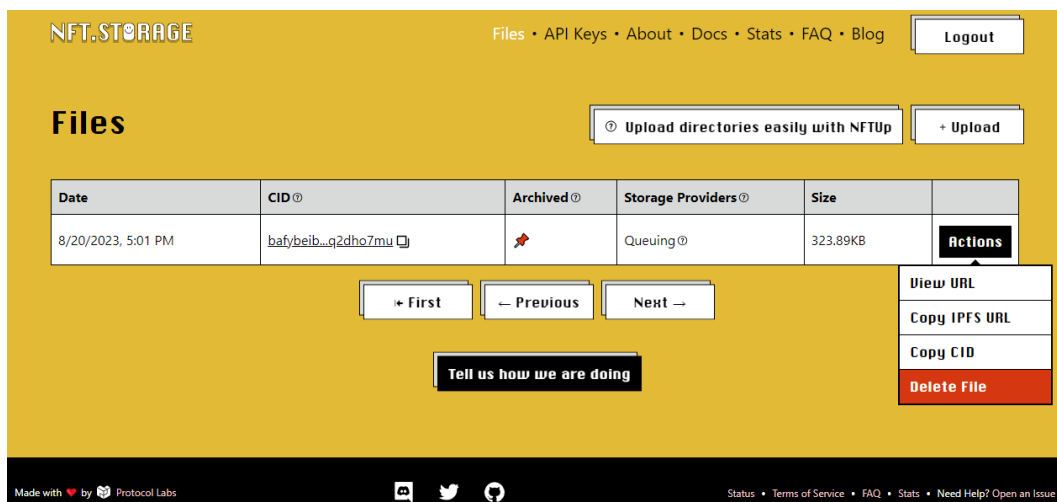


Figure 4. The uploading process of an image through nft.storage page

³ <https://mumbai.polygonscan.com/address/0x3f003e7285873e06f70ab2e5fa1c78a010de6a9e>

7. transferFrom (0x23b872dd)

from (address)

0x556AF8b766a28696028F9a397c511C0178B02b3e

to (address)

0x75F65C3253c0ca8ef49a78CA8216F9a724F78889

tokenId (uint256)

1

Write

Figure 5. Calling a smart contract function through Polygonscan

3 Advantages and disadvantages

The main advantage of using a virtual NFT gallery is the enhanced experience of the visitor, and better visibility and availability of the collectibles. Additionally, the proposed architecture has an enhanced security against theft, ransomware and inaccessibility of the artwork.

The example from Figure 3 is a simplified view of the application. The virtual environment can be enhanced in a direction to show the real environment of an actual museum or gallery. By tokenization of the art exhibited in these museums/galleries with NFTs, they can be sold as a regular digital art. This tokenization can further increase the income of the museums and galleries from selling art or selling virtual tours with virtual reality/augmented reality experience.

The main disadvantage of the proposed architecture is a result of the IPFS protocol limitations. Due to the static content addressing in the IPFS, the NFT gallery 3D space can be initiated only with a predefined number of art positions and static virtual environment definitions. Although this can be enhanced and improved by using more sophisticated frameworks and technologies, yet compromises have to be made and some kind of refreshing mechanism has to exist. Also if we want to make design changes, changes to the environment or update the code, the hash of the web-site is going to change after a push in the code, so there will be a different URL. This limitation accompanied with the requirement for manual page refresh after NFT collection modification, gives the semi-dynamic nature of the virtual environment.

4 Conclusion

The proposed architecture offers enhanced experience for the NFT collectible exhibition. The enhanced security through complete on-chain integration and cloudless mechanisms, allows the content to be theft-proof, automated, ransomware-proof and accessible at any time from everywhere. The semi-dynamic nature of the virtual environment enables the users to initialize the application with sufficient number of image positions depending on their needs. This limitation is the only disadvantage that can hinder massive adoption of this application architecture.

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