Lab 1 – Art Guardian Product Description

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1.   Introduction

Non-fungible Tokens (NFTs) exploded in popularity and market value around Q1 2021, resulting in a year over year growth in volume within NFT marketplaces from less than $100 million in Q1 2020 to $1.5 billion in Q1 2021. (Chang, 2021) This growth sustained throughout all of 2021, as volume within NFT marketplaces reached around $41 billion towards the end of the year. (Collins, 2021) NFTs have no doubt changed the digital art landscape throughout this period of growth; they have become infamously known to counterfeit digital art and sell them for high value. DeviantArt, a well-known art platform, reported that there were 90,000 possible thefts of digital art in December 2021, which was an increase of 300% from November 2021. (Beckett, 2022) Adding on to this, roughly 50% of all NFT sales were over $200 at the beginning of 2022. (Dailey, 2022)

Although more and more digital artwork is being stolen from artists and sold on these NFT marketplaces for profit, there are currently not many solutions that address the needs of these artists. To find out whether their artwork has been stolen, they must manually search on NFT Marketplaces. After they discover that their artwork has been stolen, they then must file Digital Millennium Copy Act (DMCA) takedown requests through the NFT marketplace; a tedious process which needs to be done for each piece of stolen art. Artists then have to manually track the statuses of their takedown requests, along with any information that they contain. This entire process is cumbersome for artists and takes up a lot of time, but Art Guardian provides a solution which aims to automate this process. As the world of NFTs continues to grow and subsequently cause increasing counterfeiting issues, Art Guardian gives artists a way to safeguard their art from being stolen and sold.

2.   Art Guardian Product Description

The overall goals of Art Guardian are to streamline and automate the process of removing stolen art from NFT marketplaces for artists. The first objective is to provide artists with a product that automatically searches for artwork that has been stolen and minted on NFT marketplaces. The second objective is to provide artists with an automated process that creates DMCA takedown requests and sends them to NFT marketplaces on their behalf. Finally, the last objective of Art Guardian is to give artists detailed up-to-date information on all their DMCA takedown requests, which includes a record of all DMCA takedown requests sent and their status. Additional features that Art Guardian aims to provide to artists are whitelisting capabilities which remove artwork from the automated stolen art search, and helpful advice to prevent artwork from being stolen and minted as NFTs.

2.1 Key Product Features and Capabilities

The user interface for Art Guardian is a progressive web application. This type of application is compatible with both mobile and desktop devices, regardless of operating system. This gives artists the ability to upload artwork into a secure database through either option. Art Guardian will then use the uploaded artwork to automatically search for stolen art on NFT marketplaces. This search is done on an interval basis, and each piece of uploaded art is searched once every 30 days. If the user chooses to do so, they can whitelist pieces of their uploaded art from the automatic search. This can be done by selecting which specific uploaded artwork they want to whitelist within the user interface.

 If stolen art was found on an NFT marketplace, then Art Guardian will utilize an image matcher to compare stolen art and the artist's artwork. When the image matcher detects a match, Art Guardian will then notify the artists for additional confirmation on whether the stolen art

found is their artwork. Additional confirmation is required to prevent any mismatches from the

image matcher. Artwork that has been whitelisted will never invoke this process. Artists can then

choose to warrant legal action, which prompts Art Guardian to automatically generate a DMCA

takedown request for that piece of stolen art using legal information provided during sign up.

This will then require an e-signature from the artist for liability reasons and prevents people from

abusing the system. Once the e-signature has been received, Art Guardian will send the DMCA

takedown request to the NFT marketplace on the artist's behalf, which will be monitored and

cataloged as an item that the artist can investigate for additional details.

As an additional feature, helpful hints and advice are also provided to the artist. This

includes information such as how the NFT minting process works, how certain NFT

marketplaces handle stolen artwork, etc. Most of the helpful hints will focus on providing the

artist information on how to protect their art from being stolen and minted as NFTs. For instance,

Art Guardian will suggest how to create effective watermarks. Another example would be that

Art Guardian will inform the artist on methods that stolen art minters may try to use to spoof

image matching algorithms and other stolen art detection software, and how to prevent that from

happening.

2.2 Major Components (Hardware/Software)

Users can access features of Art Guardian using a device that has Internet connection and

can run a web standards compliant browser. The mobile and desktop applications both

communicate with the Art Guardian Web Server, which is shown at the center of Figure 1.

Artists must make an account first, which requires them to upload legal identification in the form

of a photo that will then be validated via the Stripe Identity API. After registering an account, the

User will be able to upload their art, change profile settings, and check for any notifications.

Account Information is stored on the Amazon RDS database. Image matching confirmations and

electronic signature requirements on DMCA Takedowns are two important notifications that the

Artist will receive.

Figure 1

Art Guardian Major Functional Component Diagram
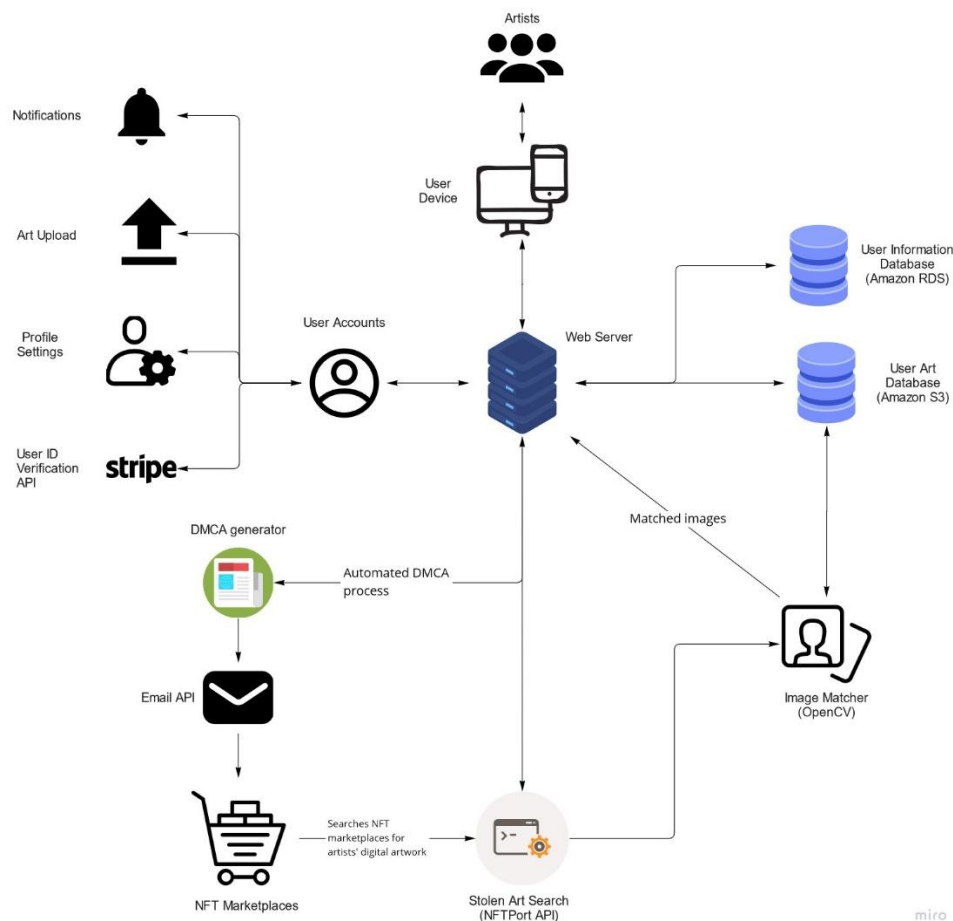
The flow of the Artist's experience is as follows. First, as mentioned before, the Artist

must register an account with Art Guardian and provide a photo of legal identification which will

be verified using the external Stripe Identity API. After the account is created, the Artist will

upload images of their digital art into the system, which will start the image matching process.

This art is stored on the User Art Database. The database is powered by an Amazon S3 instance. Each piece of art uploaded by the Artist will be searched on NFT Marketplaces using an external API provided by NFTPort. Searches for each piece of art will be conducted once every 30 days due to rate limits of NFTPort.

NFTPort returns the most similar NFT that matches the art uploaded by the Artist. Art Guardian's Image Matcher will then compare the art uploaded by the Artist and the returned image. If the matcher determines that the two images are similar, then a notification is sent to the Artist, which they will manually confirm or deny whether the two images match. After they confirm, information about the stolen art or NFT will be stored into the S3 instance, and the automated DMCA process will start. Once the DMCA Generator has created a takedown notice, a notification requiring an E-signature from the Artist is sent. Signing the E-signature prompts the Takedown to be sent to the offending NFT Marketplace via the external Gmail API.

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3   Identification of Case Study

Art Guardian is a solution developed specifically for commissioned artists, aiming to prevent their artwork from being stolen and minted as NFTs, and subsequently sold for profits. Art Guardian will allow commissioned artists to upload their artwork into a secure database, which will be used to automatically search for stolen artwork on NFT marketplaces. Image matching, along with confirmation from the commissioned artist, will be used to certify that the searched artwork is stolen. A DMCA generator will be used to automatically fill out DMCA takedown requests using the legal information provided by commissioned artists during sign up and will be sent via email on the Artist's behalf.

ODU undergraduate art students are the selected case study group for Art Guardian. Aside from providing general feedback on user interface and functionality, Students will also upload art from either their personal projects or from school assignments. These pieces of art will be used for two tests. The first test modifies artwork uploaded by the students, such as applying negative inversion, and records whether the image matching algorithm can detect a match between the modified artwork and the original artwork. The second test involves uploading student artwork as NFTs, or identifying known open NFTs, on to NFT marketplaces. Afterwards, image copies of these NFTs will be used to test the functionality of the NFTPort search API, DMCA Generator, and whitelisting.

The future goals of Art Guardian involve including any digital artist who would use it as a solution against their art being stolen and minted as NFTs for sale. This also includes major art platforms that are interested in using the product as a way of safeguarding artists and their artwork on their platforms. Another possible future customer would be NFT marketplaces themselves, as they also require a solution to prevent stolen art from being sold as NFTs.

4   Art Guardian Prototype Description

The purpose of Art Guardian will be to develop a software tool which provides digital artists with an automatic system that identifies copyrighted artwork minted as NFTs and initiates legal proceedings to remove them from NFT marketplaces. The prototype implements proof-of-concept demonstrations of several key features of Art Guardian to showcase its capabilities from a viability perspective. The prototype does not to plan implement every feature that will be present in the real-world product of Art Guardian as it serves to only provide an assessment on the validity of Art Guardian feasibilities during development. However, the prototype will fulfill the key objective features of Art Guardian which allows it to operate under a limited capacity in a specialized environment.

4.1 Prototype Architecture (Hardware/Software)

The Art Guardian prototype follows a similar architecture to the real-world implementation, with slight differences between the two. The prototype will still include all the user interface (UI) elements, image searching and analysis, and DMCA takedown processing. The prototype product will still be a progressive web application, ensuring a native cross-compatible experience for Art Guardian. The user interface will not face any major changes, but there will be minor adjustments due to other differences within the prototype architecture and features. Like the real-world implementation, the prototype will use the React framework of JavaScript to develop the user interface, and Python will be used as the main programming language for image analysis. The major functional component diagram detailing the key architecture of the prototype is shown in Figure 2.

Figure 2

Art Guardian Prototype Major Functional Component Diagram
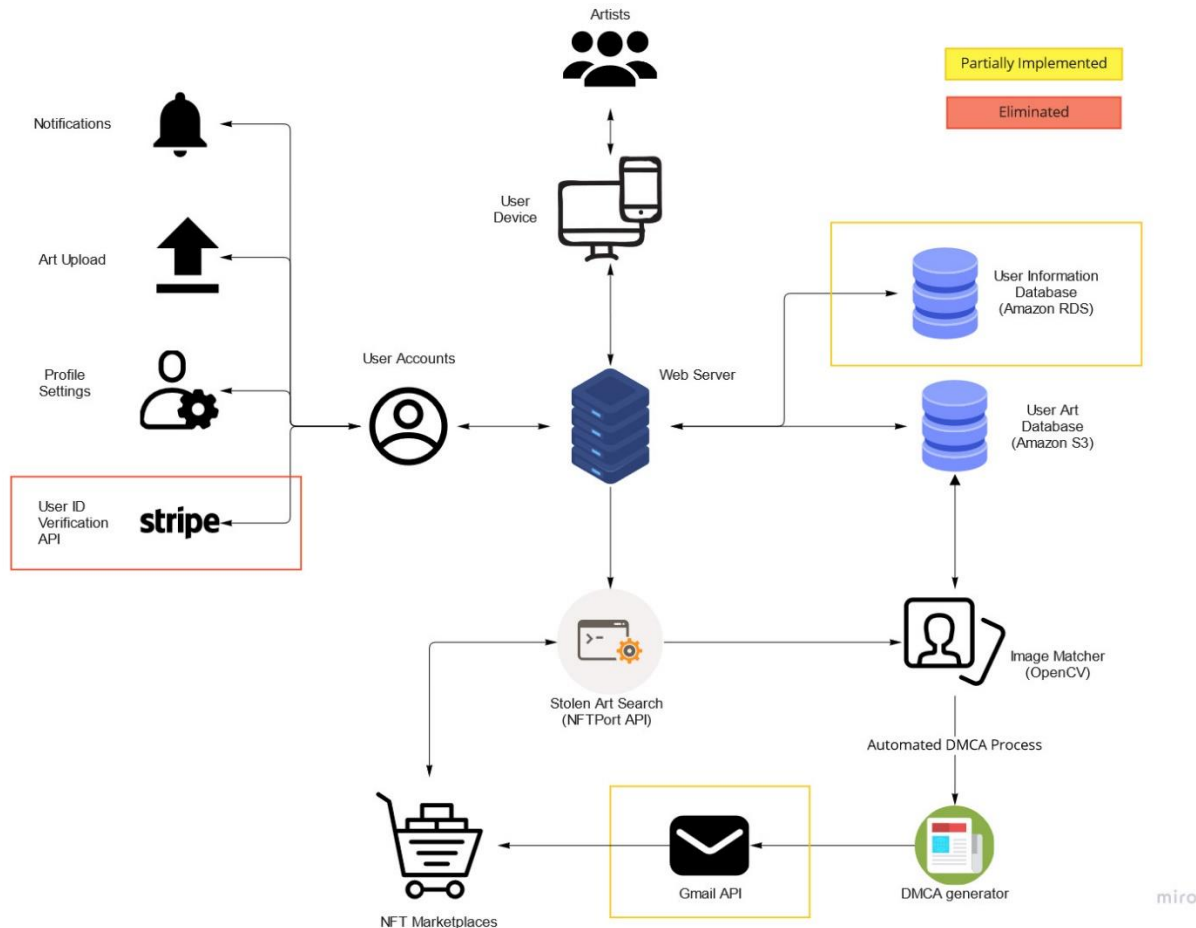
There are three differences between the major functional component diagram of the real-world implementation and the prototype. The first affected component will be the User Identity Verification API powered by Stripe. This component will be eliminated from prototype development as there will be no collection of personally identifying legal documents. The second affected component will be the Gmail API. This component will only be partially developed as the prototype will not send any real DMCA takedown notices to any NFT marketplace, because there will be no actual users for the prototype. The third affected component will be the User Information Database, which will not contain any real personal information of users as it will not

be collected during prototype development. The collection of personal information and

implementation of actual users will not be planned for the prototype as the ethicality of such

aspects must be reviewed and approved by an ethical review board.

4.2 Prototype Features and Capabilities

Many of the key features planned for the real-world implementation will remain within

the prototype, aside from a couple that will be partially implemented or eliminated. The full list

of features that will be applied within the prototype is visualized in Table 1.

Table 1

Art Guardian RWP vs Prototype

Art Guardian	RWP	Prototype
Account Creation	Fully Implemented	Fully Implemented
User Verification	Fully Implemented	Eliminated: Mock data
Art Upload	Fully Implemented	Fully Implemented
Image Library	Fully Implemented	Fully Implemented
Whitelisting	Fully Implemented	Fully Implemented
Marketplace Monitoring	Fully Implemented	Fully Implemented
Image Matching	Fully Implemented	Fully Implemented
Stolen Art Alert	Fully Implemented	Fully Implemented
DMCA Generation	Fully Implemented	Fully Implemented
DMCA Filing	Fully Implemented	Partially Implemented: Send to testing email
DMCA Cataloging	Fully Implemented	Fully Implemented
DMCA Tracking	Fully Implemented	Eliminated: Simulated Data

As shown, the UI features will be fully integrated into the prototype, such as the Image

Library, Art Uploading, Stolen Art Alert, and Helpful Advice. Key processing features such as

Searching for Counterfeit NFTs, Marketplace Monitoring, and Image Matching will also be fully

developed by the end of the prototype phase. DMCA Generation and Cataloguing will be

implemented but Filing DMCAs will only be implemented partially as the prototype does not

plan on sending actual DMCAs to NFT marketplaces. Instead, a test email will receive all the

filed DMCA takedown requests, which will verify its functionality. DMCA tracking also will

also not be integrated because no real DMCAs will be sent; instead, DMCA tracking will be

simulated. All features involving account management will be developed except for the User

Verification, which relies on legal documents containing personal information.

4.3 Prototype Development Challenges

Developing the prototype for Art Guardian will come with several kinds of challenges, as

the product connects multiple software technologies and different concepts, all of which must

remain foolproof given that the Art Guardian solution will hold heavy real-world legal

implications. The most challenging task for prototype development will be the learning curve.

Because several disciplinary concepts must be studied, such as learning how manage databases

or understanding how to develop an image matching algorithm that will be reliable and

consistent, there will be a steep learning curve over the course of the prototype phase. The best

way to mitigate this issue will be by adopting a divide and conquer approach. This relies on

breaking down tasks into manageable parts, along with group coordination and effective

communication.

Another challenge will be understanding how to bound the scope of development when

necessary. For example, one of the goals of Art Guardian will be to monitor multiple NFT

marketplaces, which will be a difficult task to accomplish given the volume. In such cases where

the task may be too difficult, the proper mitigation would be to reduce the scope of that task. For

instance, in the case of monitoring NFT marketplaces, one solution will be to reduce the amount of NFT marketplaces to monitor. This will be beneficial as it keeps priorities on schedule and alleviates unnecessary workload. It will also be necessary to make sure that the task continues fulfilling necessary proof-of-concepts after reducing the scope.

One final challenging aspect of prototype development are time constraints. Some of the priorities planned for the prototype may not be fulfilled by the end of the phase. Mitigating this challenge would require either scope bounding or adopting a divide and conquer approach, but overall, it will be inevitable that some features may not be fully developed. Given enough time however, aspects of the prototype will be improved upon, such as a fleshed Helpful Advice feature and the speed or effectiveness of the Image Matcher.

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5   Glossary

- **NFT**: Non-Fungible Token.

    - Non-fungible means unique, indivisible, and irreplaceable.

    - NFTs are a certificate of ownership stored on a blockchain that links to a file.

- **Blockchain**: A decentralized, immutable, public ledger that anyone can validate.

- **Minting**: The process in which the files become part of the blockchain.

- **NFT Marketplace**: An online platform in which NFTs are minted, sold, and collected.

- **DMCA (Digital Millennium Copyright Act) Takedown**: A process in which the owner of copyrighted content requests the removal of the infringing content from the internet or platform.

- **Art Platform**: A website in which users can publish and share their digital art.

- **AWS (Amazon Web Services)**: Largest provider of various cloud computing services.

- **AWS Amplify:** An AWS service for building full-stack web applications.

- **Amazon RDS (Relational Database Service)**: A cloud-hosted relational database service provided by AWS.

- **NFTPort API**: A programming interface used to search popular blockchains and NFT marketplaces.

- **Stripe Identity API**: A programming interface that is used to process and verify identities through legal documents.

- **React**: Open-source, front-end JavaScript library used for creating web applications and mobile apps with modern user interfaces.

- **OpenCV**: An open-source computer vision library with a Python branch.

- **Gmail API**: Programming interface used for generating and sending emails.

- **MySQL**: A relational database management system.

- **Git**: Version control system for tracking software changes.

- **GitHub**: Online host of the git version control system.

- **JavaScript**: A general purpose functional programming language often used for web development.

- **HTML**: Markup language used for displaying documents in the web browser.

- **CSS**: Style sheet language that specifies the style and layout of how documents are displayed in a web browser.

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