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Rebirth of Ceramic Art in The Digital Age: Transformation Journey from 3D Modeling to NFT

Dijital Çağda Seramik Sanatının Yeniden Doğuşu: 3D Modellemeden NFT'ye Dönüşüm Yolculuğu

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ABSTRACT

This research paper thoroughly addresses the processes of digitizing ceramic art and offering it as Non-fungible Tokens (NFTs) for sale. It examines the effects of transitioning from traditional ceramic molding methods to modern 3D printing and Stereolithography (SLA) technologies on the digital transfer of ceramic works. A case study on the use of porcelain highlights thanks to white color the impact of material choice on aesthetics and functionality. The rise of digitalization and NFTs introduces new mechanisms for preserving the originality and ownership rights of works, while also discussing the technical challenges and ethical issues this process entails. The article evaluates the place and future of ceramic art in the digital age from both technical and cultural perspectives. Our research posits that the digitization of ceramic works opens new avenues for the preservation, dissemination, and commerce of art, and that this process could have profound effects on the future of ceramic art. This process attempts to determine how ceramic works gain presence in the digital realm and their position in the NFT market. However, this study is one of the first to cover the entire process of ceramic art digitization and to address stage with academic rigor. The process from the creation of the work to its digitization, NFT registration, and sale, is detailed in this study. Our work demonstrates that the process of digitizing ceramic art and offering it as NFTs can have significant impacts on the future of art. It sheds light on the future of ceramic art by presenting both the opportunities brought by digitalization and the challenges encountered, as well as potential solutions. Furthermore, it emphasizes the importance and potential of ceramic art in the digital age and aims to fill the gaps in this field.

Keywords: Digitalization, Ceramics, NFT, Blender 3D, Metamask, Opensea, 3D printing

ÖZ

Bu araştırma makalesi, seramik sanatının dijitalleştirilmesi ve Non-fungible Token (NFT) olarak satışa sunulması süreçlerini detaylı bir şekilde ele almaktadır. Geleneksel seramik kalıplama yöntemlerinden başlayıp, modern 3D baskı ve Stereolitografi (SLA) teknolojilerine geçişin, seramik eserlerin dijital ortama aktarılmasındaki etkilerini incelemektedir. Beyaz renginden dolayı porselen kullanımı üzerine yapılan bir vaka çalışması, malzeme seçiminin estetik ve işlevsellik üzerindeki etkisini gözler önüne sermeyi planlamaktadır. Dijitalleşme ve NFT'lerin yükselişi, eserlerin özgünlüğünü ve mülkiyet haklarını koruma konusunda yeni mekanizmalar sunarken, bu sürecin teknik zorluklarını ve etik sorunlarını da tartışmaktadır. Makale, seramik sanatının dijital çağdaki yerini ve geleceğini hem teknik hem de kültürel perspektiflerden değerlendirmektedir. Bu araştırma, seramik eserlerin dijitalleştirilmesinin, sanatın korunması, yayılması ve ticaretine yeni yollar açtığını ve bu sürecin, seramik sanatının geleceği üzerinde derin etkiler yaratabileceğini öne sürmektedir. Bu süreç, seramik eserlerin dijital ortamda nasıl bir varlık kazandığını ve NFT pazarındaki yerini belirlemeye çalışmaktadır. Ancak, bu çalışma, seramik sanatının dijitalleştirilmesi sürecini uçtan uca kapsayan ve bu sürecin aşamalarını akademik bir titizlikle ele alan ilk örneklerden biridir. Eserin yaratılmasından, dijitalleştirilmesine, NFT olarak tescillenmesinden, satışa sunulmasına kadar olan süreç, bu çalışmada ayrıntılı bir şekilde incelenmektedir. Araştırma, seramik sanatının dijitalleştirilmesi ve NFT olarak satışa sunulması sürecinin, sanatın geleceği üzerinde önemli etkileri olabileceğini göstermiştir. Sanatın dijitalleşmesinin getirdiği olanaklar kadar, karşılaşılan zorlukları ve çözüm yollarını da sunarak, seramik sanatının geleceğine ışık tutmuştur. Ayrıca, seramik sanatının dijital çağdaki önemini ve potansiyelini vurgulamakta ve bu alandaki boşlukları doldurmayı hedeflemektedir.

Anahtar Kelimeler: Dijitalleşme, Seramik, NFT, Blender 3D, Metamask, Opensea, 3D baskı

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Introduction

The digital age has fundamentally transformed the forms of expression and dissemination of art. The transfer of traditional artworks to the digital medium and their registration through blockchain technology are opening new horizons for the preservation, sharing, and trading of art (Vargün, 2023). This transformation, especially in art forms that require craftsmanship such as ceramics, manifests itself in the digitalization of works and their sale as Non-fungible Tokens (NFTs). The digitalization of art not only enhances the global reach of the works but also enables creators to present their works to a broader audience and generate economic value (Kılıç & Şener, 2022). However, this process also has its shortcomings and challenges. The digitalization and NFT creation processes require technical knowledge and bring new questions regarding the preservation of the originality of art (Kıvrak & Özkartal, 2022). Additionally, there are not yet fully established standards for evaluating and preserving artworks in the digital environment. In addition to the digitalization and blockchain-driven transformation of art, advancements in 3D printing technologies such as Stereolithography (SLA) are opening new horizons in art production and expression. SLA technology has made it possible to produce highly detailed and intricate objects, which are crucial for art forms that require precision, such as ceramics. Artists and designers like Neri Oxman, known for her work in material ecology and biodesign, have used SLA technology to create biomimetic structures that bridge the gap between art, design, and technology (Oxman, n.d.). Similarly, artists like Anouk Wipprecht, who integrates fashion design with technology, have utilized 3D printing to create wearable art that merges the digital and physical worlds (Wipprecht, 2007). Additionally, Joshua Harker, a pioneer in the use of SLA technology for intricate sculptures, has pushed the boundaries of 3D printing with his 'Crania Anatomica Filigre' series, demonstrating the potential for creating highly complex and detailed forms that challenge traditional artistic methods (Harker, n.d.). These examples illustrate how SLA technology transforms artistic creation, enabling new forms of expression and interaction. These examples illustrate how SLA technology is transforming artistic creation, enabling new forms of expression and interaction.

This study thoroughly addresses the process of digitizing ceramic art and offering it as NFTs, aiming to remedy the deficiencies in this area. Examining a broad spectrum from 3D modeling to SLA printing technologies, from traditional ceramic molding methods to the digital art market, the study showcases the potential evolution of ceramic art in the digital age. Similar research efforts are attempting to determine how ceramic works gain presence in the digital space and their position in the NFT market. Material experts from the University of Leicester have received a grant of £18.3 million for using innovative computer modeling techniques to shape the future of technical ceramics. This research aims to create a 'digital twin' of the sintering process of technical ceramics and to precisely control this process through computer simulation and in-process monitoring. The project monitors complex manufacturing processes to precisely control the dimensions and properties of ceramic components, especially for high-tech applications such as the aerospace industry (University of Leicester, 2021). Fraunhofer IWM conducts research centered around material information and data. Through the digitalization of materials, they make significant contributions to integrating processed materials into digitally consistent and interconnected value chains. This approach aims to create a materials data space that allows for the digital management of material information, automatic access, and reconfiguration according to their properties and lifecycle conditions (Fraunhofer IWM, n.d.). Another pioneering example of digital transformation is "Everydays: The First 5000 Days" by Mike Winkelmann (Christie's, n.d.). This project, which began in 2007 with a commitment to create a digital picture every day, has pushed the boundaries of digital art as a product of 13 years of effort and has added a new dimension to the ownership and trade of artworks through NFT technology. Beeple's "Everydays" series has redefined the concept of collecting in digital art, emphasizing the unique and non-replicable nature of the works. This effort has challenged the traditional valuation criteria in the art market by combining artworks with verifiable ownership and provenance information in the digital realm through the use of NFTs. The "Everydays" series symbolizes the new paradigms in the evaluation of digital art pieces and showcases the potential of Blockchain technology in the art world. Beeple's work has been recorded as a turning point that redefines the material value and the concept of collecting in digital art, securing its place in art history (Christie's, n.d.). Similarly, the CryptoPunks collection is considered one of the early examples of digital art and NFTs, revealing the legal and economic dynamics in this field. CryptoPunks is a project that emphasizes the uniqueness of digital assets and the concept of ownership, and in this context, it has been examined in academic studies (Lee, 2021). Refik Anadol has notably drawn attention with his work "Machine Hallucinations- Nature Dreams: AI Data Sculpture 2021 1/1," created using artificial intelligence and data visualization. This piece has achieved significant sales success in the NFT space by transforming complex data sets into aesthetic and meaningful visual artworks. Anadol's work, sold for 300.6 Ethereum (approximately 1.2 million dollars), has proven his impact and success in the field of digital art (Anadol, 2021). Tarık Tolunay's artwork titled "Pandemi" is also a work that reflects the atmosphere of

Istanbul during the pandemic process and has been offered for sale as an NFT. This piece exemplifies how digital art can respond to social events and address these events with artistic expression (Elden, 2021). These artists' works demonstrate the transformative effect that NFT technology has on the presentation, sale, and authentication of artworks. However, our research paper is one of the first examples to comprehensively cover the digitalization process of ceramic art, addressing stage with academically. The process from the creation of the work, its digitalization, registration as an NFT, to its offering for sale has been detailed in this study. Consequently, this work highlights the significance and potential of ceramic art in the digital age and aims to fill the gaps in this field. It sheds light on the future of ceramic art by presenting not only the opportunities brought by digitalization but also the challenges encountered and the solutions to them.

Methods

Modeling

In the initial stage, the topographic features of the ceramic work were modeled in three dimensions using the 'landscape tool', in line with the capabilities provided by Blender software (Caudron, 2016) (Figure 1A-C). At this stage, the number of polygons on the model was reduced using the 'polygon reducer' function, which not only decreased the file size but also increased the efficiency of the 3D printing process. Saving the model in STL (StereoLithography) format ensured compatibility with a wide range of 3D printers and significantly reduced the workload required for the printing process. Blender is a powerful software commonly preferred in the field of 3D modeling. The 'Landscape tool' is used to create realistic terrains and surfaces, while the 'polygon reducer' tool enables the reduction of the model's detail level, using fewer polygons and thus saving time and materials during the printing process. Saving the model in STL format enhances compatibility with 3D printing software, ensuring the model's usability across a broad spectrum of printers.

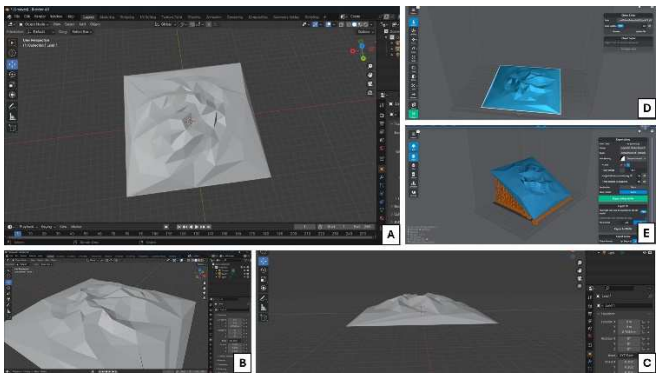

Figure 1.
(A, B, C) Modeling stage with blender 3D software, D) Lychee slicer software interface, E) Adding support for model

3D SLA (Stereolitografi)

Following the modeling process, Stereolithography (SLA) technology has been adopted for three-dimensional (3D) printing. This technology is preferred especially for its ability to produce high-detail and smooth surfaces. The selection of SLA has ensured consideration of the model's printability as well as its aesthetic and functional qualities. Using slicer software, the model has been segmented layer by layer, preparing a set of instructions to be sent to the printer. The 30-degree positioning performed through the Lucgee program plays a critical role in minimizing the need for support material during printing and preventing potential errors. Each of these stages is a factor that directly affects the quality of the final product and has therefore been handled with great meticulousness (Figure 1D-E).

Slicing and Printing

The slicing and printing process, which is the third stage, involves dividing the model into layers to be printed by a 3D printer (Anycubic Photon Mono X). The slicer software performs this segmentation, determining how each layer of the model will be processed by the printer (Fedorov et al., 2012). This process has resulted in the production of a total of 29 pieces, which provides significant information about the scale and complexity of the project. The slicing operation is a vital step that directly affects the success of the print and thus requires great care and precision. With the printing of the model, the physical realization of the designed work begins, and this represents one of the most critical stages of the process (Figure 2).

Figure 2.
Rendering and slicing stage of our study with Lychee slicer software

Molding

Molding, the fourth stage of ceramic art, plays a critical role in the production of physical copies of the work. During this stage, ESÇ1 casting slip is used to achieve high-quality castings. A total of 29 pieces have undergone this process. However, one of these pieces has been produced using only porcelain, specifically to achieve a white color. Porcelain, when fired at high temperatures, retains its unique

brightness and whiteness, thus this piece is intended to stand out aesthetically. Traditional molding methods ensure that this material shapes the details of the work completely. Parts from 3D printing are molded using these methods, aiming to preserve and replicate the original form of the ceramic work. The molding process represents a tradition that has continued for centuries in ceramic art and, when combined with modern technologies, allows for the enhancement of both the aesthetic and functional qualities of the work.

Biscuit Firing

Biscuit firing represents the initial firing stage in the ceramic production process and is typically carried out at high temperatures, usually around 900°C. This crucial phase enhances the structural integrity of the ceramic pieces obtained after casting, preparing them for subsequent processes, particularly glazing and the second firing. Biscuit firing reduces the porosity of the ceramic parts, ensuring better adherence of the glaze, thereby establishing a fundamental process that determines the aesthetic and functional quality of the final product.

Glazing and Firing

The glazing process in ceramic art is a critical operation that enhances the aesthetic and protective qualities of the piece. At this stage, a transparent glaze at a 6% ratio and a colorant at a 12% ratio, added to 100 ml of water, are used to adjust the viscosity of the glaze and the depth of color. Applied to the ceramic pieces after biscuit firing, this mixture melts uniformly over the ceramic surface during the second firing at 1040°C, solidifying in the process. This step is a determining factor in both the visual appeal and physical durability of the glazed surface, significantly impacting the quality of the final product. Glazing extends the lifespan of ceramic pieces by making the surface waterproof, thus enhancing their functional value. The painting applied after the glazing process not only adds aesthetic richness to the ceramic work but also expresses the story and character of the piece. The colors and techniques used at this stage significantly affect the artistic expression of the work. The final firing process ensures that the paint and glaze form a chemical bond on the ceramic, making it permanent. This procedure guarantees the durability of the work's surface and its long-term preservation. The final firing is necessary for the ceramic pieces to be ready for use, representing a point where traditional techniques and modern applications of ceramic art converge (**Figure 6B**).

Creating Non-fungible Token (NFT)

The creation and sale process of NFTs is a crucial phase that facilitates the definition and registration of a ceramic piece as a digital asset. This process enables the artwork to acquire a unique identity in the digital realm, allowing for its transaction based on this identity. The OpenSea.io platform stands out as one of the most popular marketplaces for the creation and trading of NFTs, with the MetaMask wallet providing a secure interface for these transactions (Figures 3 and 4).

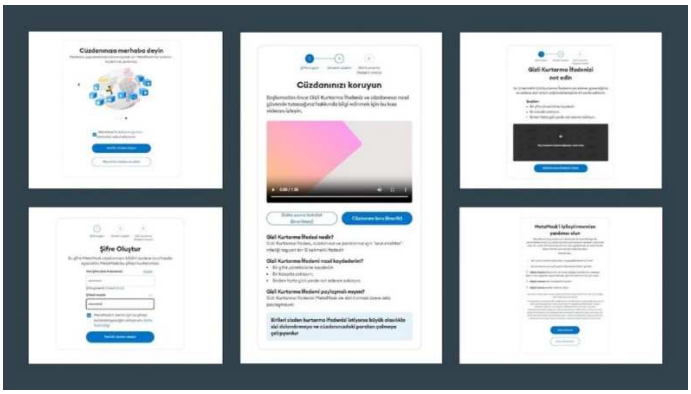

Figure 3.
Creation of a metamask wallet to produce NFTs

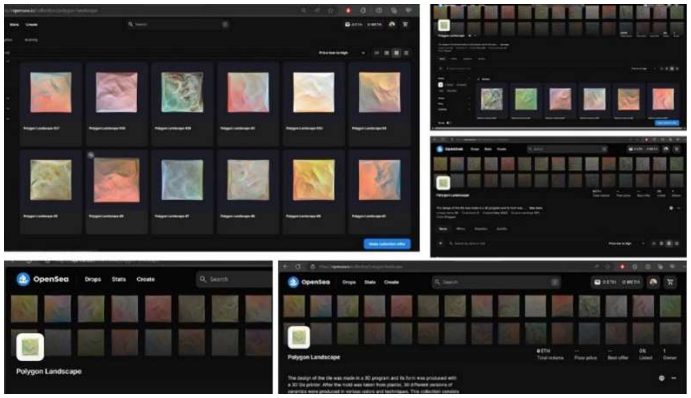

Figure 4.
After collection, Opensea.io collection NFTs images in our study

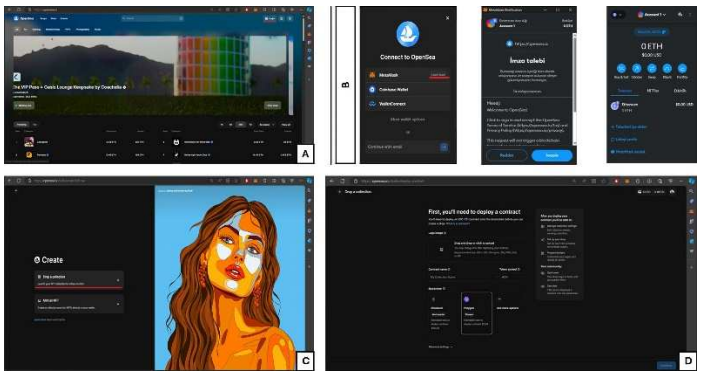

Figure 5.
Registration process to the Opensea.io platform. A) Opensea.io homepage, B) Connect with metamask extensions to Opensea.io. C) Creating NFTs in Opensea.io. D) Choosing polygon blockchain network

The Polygon blockchain network is distinguished by its low transaction costs and rapid confirmation times, which permits the efficient creation and management of an NFT collection. Listing the digital version of the artwork as an NFT

on OpenSea is accomplished using the 'Create-drop collection' option. During this process, photographs of the artwork are uploaded, and the piece is registered as a unique collection on the Polygon network (Figure 5). This procedure encompasses the journey from defining the ceramic piece as a digital artwork to its secure sale using blockchain technology, ensuring the digital preservation and value enhancement of the artwork. Listing the piece as an NFT also secures its authenticity and ownership rights.

Results

The research has meticulously explored the entire process of transforming ceramic art into digital form and its subsequent sale as Non-Fungible Tokens (NFTs). It has spanned the full gamut of techniques from age-old ceramic shaping methods to cutting-edge 3D printing and SLA technologies, with each step being instrumental in the digital conversion and NFT authentication of the ceramic creations. The utilization of porcelain to produce a piece with the intent of achieving a pure white hue has served to emphasize the variety of materials and the adaptability in their application, thereby enhancing the intricacies of our study. The investigation has shed light on the prospective transformation of ceramic art in the era of digitization, underscoring the sector's capabilities. The digitization process has streamlined the safeguarding, distribution, and monetization of artistic works, concurrently affording artists the opportunity to reach an expanded audience base. The emergence of NFTs has brought forth a novel aspect in safeguarding the uniqueness and proprietary rights of the artworks. Within the framework of this study, a total of 30 products have been devised, which are illustrated in Figure 6B.

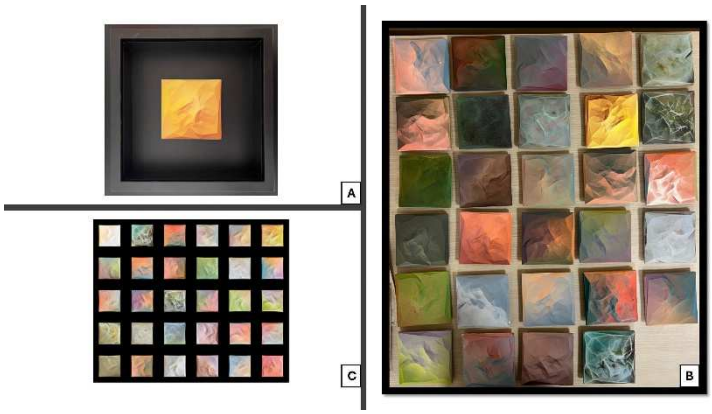

Figure 6.

A) Physical product: The physical product section shows the real, tangible state of the ceramic work. This demonstrates the existence of the work not as a digital asset but in the real world, B) Glazing and firing: The surface of the work was made waterproof and given an aesthetic shine, C) Digital visual: The digital visual is a digitized representation of the ceramic work. It shows how the work looks in a virtual environment and how it can be presented as a part of a digital collection

Discussion

This study has thoroughly investigated the process of digitizing ceramic art and its offering as NFTs, encompassing every aspect from traditional ceramic molding techniques to contemporary 3D printing and SLA technologies, as well as from biscuit firing to glazing processes. Stages has been critical in transferring ceramic works into the digital realm and securing their NFT certification. The production of a piece utilizing porcelain specifically for achieving a white color has underscored the diversity of materials and the flexibility of application, enriching the details of our study. Our research has demonstrated the potential evolution of ceramic art in the digital age and highlighted the field's potential. Digitization has facilitated the preservation, sharing, and commercialization of art pieces, allowing artists to present their works to a wider audience. The rise of NFTs has introduced a new dimension to the preservation of the originality and ownership rights of artworks. However, this process has also brought technical challenges and ethical questions. The need for technical knowledge in digitization and NFT creation processes has created new learning areas for artists. Moreover, the absence of fully established standards for evaluating and protecting artworks in the digital space indicates the necessity for further research in this area. In conclusion, our study has shown that the process of digitizing ceramic art and its sale as NFTs could have significant implications for the future of art. By presenting both the opportunities brought by digitization and the challenges encountered, as well as the solutions to these challenges, our work sheds light on the future of ceramic art. Our study emphasizes the significance and potential of ceramic art in the digital era and aims to fill the gaps in this field. Furthermore, the convergence of ceramic and digital art is expanding the boundaries of art and creating new forms of expression. This study proves that the digitization of ceramic art represents not only a technical achievement but also a cultural transformation.

Conclusion and Recommendations

This study has conducted a comprehensive examination of the digitization of ceramic art and its introduction into the marketplace a NFTs. From traditional molding techniques to advanced 3D printing and SLA technologies, each phase has played a pivotal role in the digital translation and NFT certification of ceramic works. The research has revealed that digitization facilitates the preservation, sharing, and commercialization of artworks, enabling artists to reach a broader audience. Recommendations include the development of technical training programs for artists in digitization and NFT creation processes, the establishment and adoption of standards for the evaluation and protection of artworks in digital form by artists, collectors, and

marketplaces, and legal reforms to address copyright and ownership issues arising with the advent of NFTs. Further research into the cultural impacts of the digitization of ceramic art is suggested, alongside the advancement of technologies used in the digitization process and the encouragement of innovative applications. These recommendations aim to contribute to the future development of the digitization of ceramic art and its sale as NFTs, ensuring sustainable growth in the field.

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