Liberation of The Medium: Decentralization of Dynamic Generative Art Creations by NFT Marketplaces

Alp Tuğan, MSc
Graduate School of Social Sciences, Özyeğin University, İstanbul, Turkey
www.alptugan.com
e-mail: alp.tugan@ozyegin.edu.tr

Alp Tuğan, MSc
Graduate School of Social Sciences, Özyeğin University, İstanbul, Turkey

Abstract

As an artistic practice, generative art has constantly been evolving in terms of its medium and praxis along with technological innovations. Blockchain technology, which causes significant changes in socio-economic terms, also leads to the emergence of new practices and the crypto art movement. NFT (Non-Fungible Token) Marketplaces use that technology to push the boundaries of generative art beyond what was not possible before, such as rendering realistic 3D (Three Dimensional) graphics in real-time without using specific hardware systems. While Crypto Art galleries decentralize the traditional art market, emergent technologies liberate generative artworks requiring specific hardware systems by transforming a standard web browser application into a computational medium. In this paper, the author first proposes a taxonomy for "Generative Art" creations as "Dynamic" and "Static" in terms of generated media type to distinguish fixed time-based creations (Image files and videos) from animated works that need technological mediums. Afterward, the author asserts that online NFT Marketplace environments dematerialize the "Dynamic" generative works of art by transforming regular web browsers into computational mediums. Thus, the code-based creations become conceptually independent from additional hardware systems. That innovation offers an alternative solution on selling, transporting, preserving, and remaining the uniqueness of "Dynamic" works of art that was not possible before.

1. Introduction

“The idea becomes a machine that makes the art.” – Sol Lewitt

Since the 1960s, artists have been experimenting with to reveal new possibilities in visual and sound arts [1]. Most engineers and scientists held early studies on computer-generated graphical works because of the limited sources at the time [2,3]. Afterward, the establishment of computer science departments, computer graphics, and computer art gradually emerged at universities [4]. Thanks to this continuum, programmer-artists[1] utilize computational systems as a medium to produce their works of art.

Lately, we have gotten familiar with the terms; Blockchain, NFT[2] and, crypto art frequently due to several reasons, such as the growth in the stock market values of Bitcoin. We will not go deeper into why these new technologies are trending nowadays. However, it would be relevant to provide technical information for the reader unfamiliar with the concept of Blockchain, NFT and crypto art. The Blockchain started as an alternative method for transferring money from point A to point B by eliminating the central authority such as banks and governments. However, its underlying technical structure allows people to reimplement existing technologies and transform them into a more sustainable model. Indeed, everything starts with a whitepaper that proposes a new “peer-to-peer” cash transfer system by Satoshi Nakamoto [6]. Bitcoin is the main asset in this system that represents a financial value. People can send and receive payments between each other according to the amount of Bitcoin they hold in their digital wallets. Blockchain is the central database for the system that enables these transactions between peers. One of the main features of the Blockchain is its decentralized technology. No one or any other authority cannot dominate the system or take control of this public database. Blockchain does not have any specific database farm located in a specific part of the world, and there is not any commercial company behind it [7]. In a broader sense, the Blockchain allows people to control their financial assets on their own by eliminating banks and governments.

The effects of Blockchain show up themselves in diverse fields such as visual arts, sound, and other creative industries as well [8]. NFT marketplaces, which are a new kind of online art galleries, led to the emergence of a new term called “crypto art” or “blockchain art” [9]. When an artist submits (a.k.a. “minting”) an artwork on one of the existing marketplaces as a digital document, the artwork is converted to a unique digital asset called NFT. These marketplaces are part of particular blockchain technology. Every single NFT gallery has its ecosystem or inherited technology to manage uploaded artworks. For instance, SuperRare[3] Marketplace runs on the Ethereum Blockchain, where artists mint their digital artworks according to the type of Blockchain algorithm, and they receive payments as Ethereum if someone buys it. We are witnessing a new digital renaissance in cyberspace. As Zeng. et al. state in their paper, Blockchain technology dominates the existing internet interaction behaviors [10]. It gradually penetrates every part of web-based applications.

Many of the discussions about crypto art in the literature on Blockchain technology circulate around the benefits for the artist, including individual's rights, decentralization of art market, authorship issues [7,11] and conceptual frame in terms of art [11,12,13,14]. Along with the second section, the author will discuss the state of computational systems and generative art for the artist and how the artist can benefit from computers by referring to pioneering precedents of computer art. The third section of the article, will first briefly define Generative Art practice, then will categorize works of Generative Art under two main topics as "Dynamic" and "Static" to frame the perspective on how NFT marketplaces transform the medium in terms of hardware dependencies for live creations. The fourth section focuses on Blockchain technology, regarding terms such as crypto art discussed recently, and how the system maintains an alternative medium for Dynamic generative works of art by utilizing online web technologies. In the "Conclusion", the author will discuss how Blockchain and NFT marketplaces liberate generative works of art requiring specific computational systems to run.

2. The Role of Computational Systems for Generative Art

Making art with computational systems is an ongoing discussion. It would be helpful to begin with the definition of "computation" to clarify the state of computers as a medium. According to the Cambridge Dictionary, "computation" is [15];

"The act or process of calculating an answer or amount by using a machine."

According to the definition, one can say that computational systems operate as assistants for revealing the results of requested instructions. Pragya questions in her article "Why artists use computers to produce work of art?" [16]. As human beings, we have limited physical capacity to realize several processes in a small amount of time. At this point, artists benefit from the processing power of computers. As Kugel states, computers can help artists to create variations of their ideas that have procedural workflows [17]. For instance, drawing hundreds of parallel lines onto a paper by hand would be highly time-consuming and tedious because of the repetitive process of the same gestural action. Any particular bodily or mental action that is predictable has the tendency to become dull and causes a lack of desire for the individual [18]. In that sense, working with computers can reduce the negative effect of repeated actions for an artist. Using procedural workflows can easily handle that tedious task for the artist instantly. So, the artist can benefit from using computational systems.

The creation of an artwork using computational practices is not only limited to duplicating the same graphical image. The recursive process of computational environments opens up endless possibilities for the artist. Using the processor cycle in a computer program allows artists to modify existing parameters of the visual composition by employing computer time as a dynamic variable. For instance, the artist can instantly distribute thousands of squares on the screen space by utilizing random number generators. Using randomness

may help to create variations of an idea instantly for the artist. Vera Molnar is considered to be one of the pioneers of using computational systems to create algorithm-based artworks. Molnar started her career as a traditional artist in Budapest. Later, she met with computers. In an interview, Molnar states that working with computers allows her to create countless number of combinations that are not possible to do with her hands in the visual space [2]. Besides, computers can make calculations faster than humans, and they have benefits in extending the artist's physical capacity.

Sometimes the use of computational power and mathematical algorithms may cause unexpected outcomes for the artist. In the literature, we come across terms such as "surprising", "unpredictable", or "unexpected" regularly on Generative Art [19,20,21,22,23,24,25, 26]. More or less, all of them depend on a similar idea. One can say that the surprising outcome of generative art is defined by unexpectedness. Similarly, many of the programmers refer to that "surprising" output as "happy mistakes" which occur when the programmer makes typing mistakes on the computer program [27,28]. These mistakes cause the computer to execute unintended calculations. For instance, before executing the computer program, the artist would make a typing mistake using the addition operator (+) instead of the multiplier operator (*). The result of that instruction operation can lead to the generation of unintended graphical creations. Soddu says that the "unpredictability" of the end-products are recognizable versions that are generated by the same *Idea* [29]. More or less, many of the notions on the "surprising" feature of Generative Art practice are close to each other. However, the output referred to as "surprising" is not the product of the utterly unexpected behavior of the computational system. Since the artist creates the logic of the software applying several phenomena such as algorithms that are operated by random values, it would not be so appropriate to declare a complete "unexpectedness". Eventually, the autonomous system will create possible variations of the same idea, whose boundaries are set by the artist.

Several descriptions exist in the literature on the definition of Generative Art by critics, artists, and academics. The common point of that arguments is the autonomous system created by the artist. That phenomenon generally creates variations of the existing concept by applying repetitive actions partly, entirely, or by never modifying the system's ingredients. Also, the artist does not have to use technological hardware systems in order to create a generative work of art [19]. Repeating a graphical image with modifications in the process using existing computer-based phenomena such as a random number generator allows the artist to create various outputs of the same idea. Molnar's plotter drawings (*Figure 1*) called "Hyper-transformation" are prominent examples of that practice [30]. In three different canvases, the viewer can observe the use of square forms that build the main idea of the artwork. The spectator perceives several modifications to the square images. Squares are in slightly equal sizes and distributed on a grid-like pattern with small off-grid positions on the left. In the middle, the sizes of the squares are the same, but this time one

can say that the positions of the forms are entirely out of grid order. In the last work on the right, it is possible to see that the square forms are neither drawn at the same scale nor in a regular grid structure. These three plotter drawings of Molnar utilize the same idea with several structural modifications on the form. Every single form belongs to the square image, but computational systems make it possible to create countless combinations for the artist in a small amount of time.

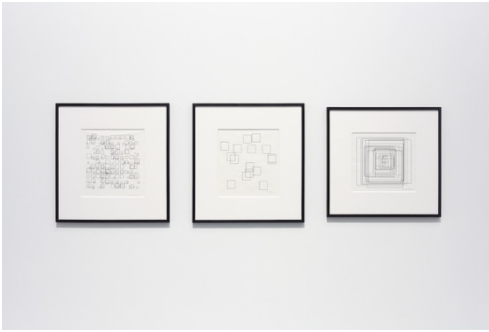

Figure 1. Vera Molnar, From the left: Small Squares, 1973, Hypertransformation, 1974, Large Squares, medium: ink, paper, plotter drawing.

Using computational machines as a medium for producing and presenting a work of art reveals several possibilities for the artist. Thanks to the increased processing power and hardware upgrades, computers have higher computational power capacities than before. That provides the artist with a wider variety of possibilities while presenting and producing the artwork. Evolving technological tools provide benefits in terms of production time and open up the doors to the simultaneous presentation of real-time generative works that were not possible in the past. Many of the programmer-artists like Molnar employed algorithms to create still image versions of their artistic works. Display technologies and computational tools were insufficient to render real-time graphics in high resolutions on large screening frames. Even regular computers are capable of executing live computer programs to create generative art today. Therefore, categorizing the generative art productions (of today) would be helpful to distinguish the still image versions from the live ones.

3. Dynamic and Static Form of Generative Art

In the literature, it is possible to find several answers and discussions on the “What is Generative Art?” question. For example, Dorin and McCormack describe the term using analogies inherited from biology [20]. Likewise, as Bailey, some authors also focus on the technical aspect of that practice and claim that Generative Art can only be possible using computational systems, which is not quite right [31,32]. According to Galanter, to call an artwork “generative”, it does not have to be produced using merely technological tools. A mechanical autonomous agent also can be utilized by the artist to create the generative composition [19]. Many of the arguments have some common points regarding the process of Generative Art in the end. The creation process of the artwork involves randomness, chance factors, autonomous agents, un-predictability, unexpected results, or probability [22]. Borrowing from Galanter’s statement, one can say that generative art derives from an autonomous system that handles

all or part of the creation process by the artist's decisions.

Recently, generative art has gained more popularity in correlation with the increasing number of new digital media instruments [33]. Social media platforms such as Instagram hosts many artists who are not only posting photographs also presenting their artworks [34]. Some artists also sell their algorithm-based works using that social media platform in either printed or animated versions. Viewers can display the generative creations in two media types: still image or video format on most social sharing platforms like Instagram. In that sense, existing online platforms are sufficient for displaying or documenting the generative artworks technically. However, most of them cannot host and execute custom applications to display live artwork requiring specific technical requirements. The author will evaluate generative art creations under two different categories, Dynamic and Static, to distinguish still-image and rendered video creations from those needing computational systems. "Dynamic" ones represent animated or interactive artworks that require technological systems to execute computational functionalities (a dedicated computer running a custom application that creates generative visuals in real-time or web-based environments that are capable of code compilation). P5js[4] and OpenProcessing[5] are good examples of web-based environments that allow displaying dynamic generative art productions. Both of the web pages allow artists, designers, and curious individuals to write, compile and host their codes with the community. Any user can edit the existing code project and get inspiration from others. These computational environments also encourage users and programmer-artists to explore the possibilities of code-generated computer graphics. At the same time, web-based computational environments allow artists to customize technical features of the generative artwork, such as displaying the content on specific devices or adjusting minimum/maximum resolution requirements for different kinds of hardware systems.

The emergence of browser-based computational systems has transformed the mediums toa new level. In the early days of computer art, artists were producing generative artworks using plotters [33,35]. Because computational systems were not capable of rendering real-time graphics with high FPS (frame per second) rates at the time, along with increasing computational power of the hardware systems, digital display frames transform into default output devices [33]. In a sense, computational systems affect the output medium of dynamic generative art creations. Now, it is possible to render dynamic generative artworks in real-time using even regular computers. While this situation increases the number of environments akin to OpenProcessing platforms, it also fosters these environments to create new ecosystems on alternative markets, such as Blockchain and its sub-technologies.

4. NFT Marketplaces as Alternative Medium for Dynamic Generative Art

Today, artists can mint their digital artworks in these NFT marketplaces in various media formats such as still images, animated GIFs, or videos.

Several kinds of digital artworks are being minted day by day. Generative art creations have also become popular recently on NFT marketplaces. It is possible to come across an NFT created with generative art practices on one of the existing marketplaces. Minting static type of generative art productions currently available for all marketplaces. Even if an autonomous agent coded as a custom computer application generates the artwork, the final product or the desired animated version can be extracted as supported media types in video or still image format.

Indeed, there are available platforms to present dynamic type generative artworks like OpenProcessing. Nevertheless, these web-based environments lack features and benefits that NFT marketplaces have, like recording the artwork's provenance. Also, open-source community-based platforms that allow users to edit the original code snippets cause the lack of keeping the uniqueness of the artwork. When we consider generative artworks, any individual can produce variations of another artist's work without modifying the existing codes. In this sense, NFT market environments provide an alternative solution for artists to keep the originality of their artworks. As new technologies become available that employ Blockchain, new paradigms emerge for the artist in terms of the creation process of the artwork. Most of the NFT marketplaces allow the artist to mint their artworks in several media formats like still-image (JPG, PNG, …), sound (MP3, WAV, FLAC, …), or video (GIF, MOV, MP4, …). The supported media types are sufficient to exhibit static generative works for the programmer-artist. However, only a few platforms make it possible to display and mint dynamic generative art creations.

In 2021 April, a community based open-source NFT marketplace called HCN[6] running on Tezos[7] Blockchain announced that they support minting interactive applications developed using JavaScript programming language. That innovative contribution turns into a great opportunity for the programmer-artists who are producing dynamic generative artworks that need a computational system to run. In a sense, the artwork becomes free from its medium without losing its conceptual identity. Sol LeWitt's drawing instructions to create his "Wall Drawings" series would be a useful example illustrating that argument. LeWitt had created a set of instructions to compose his "Wall Drawings" pieces that made it possible for anyone who had the instructions to create his works of art around anywhere in the world [36]. He had just passed the instructions *(Figure 2)* and let anyone implement a variation of his idea for him.

Similarly, NFT marketplaces transform any computer with an internet browser into a computational medium for the artist. Sol LeWitt conceived the main idea behind the "Wall Drawings". However, these instructions are not strictly bounded by specific instructions. For instance, LeWitt declared that "...place fifty points at random. The points should be evenly distributed over the area of the wall." *(Figure 2)*, but he did not limit the wall size or not clearly state the distance of each point between each other. There is not a measurable expression in his directive on the exact positions of the points.

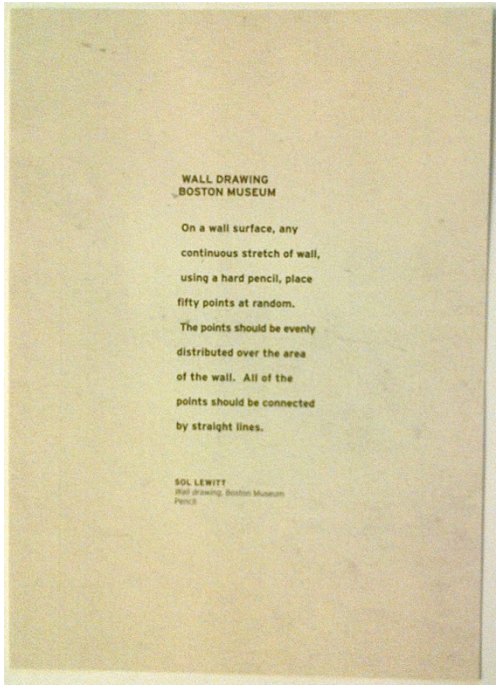

Figure 2. Instructions for Sol LeWitt's 1971 Wall Drawing # 118 for the School of the MFA Boston 2012

He just stated placing the points on the surface as "evenly", which the operators could interpret differently. The implementation of these instructions made by the individuals would be slightly different from each other whenever they reimplement LeWitt's work of art *(Figure 3)*. Nevertheless, the final output would be the conceptual artwork of Sol LeWitt. Although the guidelines seem to standardize the formal features of the final work of art, they also make it possible to produce similar variations due to the open-ended terms.

If we recall Molnar's "Small Squares" *(Figure 1.)*, we can realize the similarity in personal declarations. There could be countless versions of the "Small Squares" drawings made by the computer. The composition of the square graphics would be different whenever the instructions were read and interpreted by the computational device. Because none of us also, Molnar could not know the machine's choices from a set of randomly distributed numbers. Whenever the computational machine executes these instructions, it can create another variation akin to previous ones. But the final composition would be a new version of Molnar's idea, which is the computer program itself just as it is on Lewitt's "Wall Drawings". One of the most apparent differences from LeWitt's "Wall Drawings" can be; Molnar had written her instructions for a computer in machine language. Even though one artist employs the non-human agency to create her work and the other uses a human agency, in the end, the conceptual idea gets significant importance by dematerializing the medium [14]. One can say that both of the artists set free their works of art from their required mediums. Anyone or anything capable of interpreting the instructions can create a new version of their conceptual artworks. Even the artists passed away; a living or non-living entity could re-create the conceptual idea according to the artist's procedural instructions at any time.

For sure, dynamic generative works that need non-human interpreters are not different from Molnar's or LeWitt's works conceptually. Anyone who has the source codes can create the artwork at any time. The complicated part regarding computer-based artworks arises when they are being exhibited and later on. The conservation and keeping the uniqueness of new media artworks is an ongoing discussion today [37].

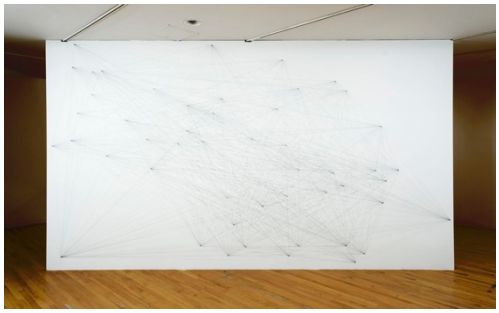

Figure 3. Sol LeWitt's "Wall Drawing # 118" redone at the MFA Boston 2012

The preservation issues are more manageable for the static form of generative artworks than the dynamic ones. Existing platforms have already supported the minting of artwork in various file formats. For instance, the artist can sell or exhibit her work in paper form by printing the output (what I call astatic form of generative artwork) generated by the custom application that she develops. A collector can also purchase that artwork using the NFT marketplace environment by paying its fee. For static forms of generative artworks, there is no requirement for specific hardware systems. The user merely needs a digital display system and a regular computer capable of daily computational tasks. The owner of the static artwork will not have to deal with hardware-related technical issues. A regular computer will probably be capable of displaying static images or video files in the future. Also, transportation of a static form of generative artwork as a digital file would not be problematic. The artist can deliver the artwork using web technologies depending on the digital file size. In the case of large file formats like 8K[8] video or image files, using external hard drives could make possible transportation easily.

When considering a dynamic artwork that requires a computational system to perform its generative features, several concerns could arise. Transportation of the hardware system, technical knowledge to set up the artwork, or periodic maintenance tasks could be more challenging than static artwork. Thanks to the systems such as Blockchain and web-based environments, these issues can be partially fixed related to dynamic generative artworks re-quiring computational mediums. Online mediums like HCN allow the artist to utilize existing web technologies for exhibiting dynamic generative artworks. In this sense, the artwork be-comes independent of its medium and preserves its conceptual meaning in any display system. The new generation NFT marketplaces like HCN solve the specific computational hardware requirement by transforming regular web-based browsers into computational mediums.

5. Conclusion

The recent information and communication technologies shape the existing behaviors of the artists and encourage them to experiment with new mediums to enhance the frame of contemporary art [12]. As a medium, computational systems are evolving rapidly today and foster the transformation of existing mediums of new media art. The change in the medium also causes to reveal new economies and political aspects. Every new technological development allows the artist to develop new forms of expression that were not possible before technically. The emergence of alternative practices in traditional environments such

as online art galleries and NFT marketplaces also affects the notional value of the artwork. NFT marketplaces provide alternative ways to buy, sell and present artworks [12]. While the existing art market serves as an authority by detecting the price and the medium of the artwork, the NFT marketplaces allow artists to list their artworks as they prefer [14]. Crypto artists are free to set the number of editions of their artworks, set the commission percentage for after-sales, and the medium itself. In that sense, NFT marketplaces seem to be a good offer for artists who cannot exhibit their artworks or are not being represented by any local gallery.

Blockchain technology releases the hardware dependency of dynamic generative work of art by setting free the artwork from its medium and allowing it to be presented using online technologies with existing hardware systems. Thus, the artist can present generative work in a dynamic form instead of a video or still image. The NFT form of digital artwork has numerous positive contributions to generative art.

The rapid development of technology brings with it many discussions on the preservation of New Media artworks. A computer system produced fifty years ago can dis-function today because of various technical or physical conditions. Besides, it would be nearly impossible to reproduce many of these old-fashioned technological devices and software tools. For sure, experts can re-implement the computer programs employing modern technologies to renovate the artwork. This situation causes several issues for the artwork regarding its uniqueness, authenticity, and conceptual meaning. Blockchain technologies offer an alternative solution to these problems by using regular computers and smart technologies. Every single device that has an internet browser application transforms into a digital frame. Instead of installing the artwork in the gallery, Sol LeWitt sends a set of instructions written on a document to the gallery that must be followed to create the artwork, allowing the artwork itself to become immaterial while keeping its conceptual meaning. Dematerialization of the artwork provides solutions for many issues such as transportation, conservation, and sale conditions. Similarly, NFT Marketplaces emancipate the dynamic generative artwork by eliminating its computational medium. Since there is no need for specific technological hardware systems, the potential complications in the future regarding the preservation, conservation, and transportation of the artwork would be eliminated.

Notes

1. I will use the term for the artists who are capable of computer programming. McLean uses the term in his thesis [5]

2. NFT is an acronym for Non-Fungible Token

3. https://superrare.com

4. JavaScript port of Processing creative coding environment: https://editor.p5js.org

5. Code sharing and compiling platform based on Processing: https://openprocessing.org

6. Hic Et Nunc is an open-source NFT marketplace built upon Tezos blockchain with the energy-efficient notion: https://www.hicetnunc.xyz

7. "Tezos is an open-source platform for assets and applications backed by a global community of validators, researchers, and builders.": https://tezos.com

8. Represents an image resolution that has 8000 pixels width.

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