# Historical Significance and Prospect of Digital Calligraphy Media in the Context of Artificial Intelligence

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## ABSTRACT

For the development of modern and contemporary calligraphy, the research on digital calligraphy media has broken the barrier of writing brushes, ink sticks, paper and inkstones as in traditional calligraphy, realized modern transformation with a more inclusive vision and diversified exploration and drawn forth a new calligraphy ecology. In this paper, we aim to focus on the historical significance of the innovation of digital calligraphy media on the development of calligraphy art, from the perspective of the effect of traditional and digital media on the styles of calligraphy art and reflect on existing problems, in the hope of contributing to the contemporary and future development and cultural inheritance of calligraphy art.

## CCS CONCEPTS

• **Computing methodologies**; • **Artificial intelligence**;

## KEYWORDS

Artificial Intelligence, Digital Calligraphy, Calligraphy Media

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Digital technology has injected new vitality into the development of traditional culture and art. As stated by Jonathan Crary, "Real-life activities that do not have an online correlate begin to atrophy, or cease to be relevant. There is an insurmountable asymmetry that degrades any local event or exchange. Because of the infinity of content accessible 24/7, there will always be something online more informative, surprising, funny, diverting, impressive than anything in one's immediate actual circumstances. It is now a given that a limitless availability of information or images can trump or override any human-scale communication or exploration of ideas." [1] Indeed, to make traditional calligraphy art in real-life activities not to atrophy, or cease to be relevant, we need to build a brand-new survival paradigm in the virtual cyberspace.


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In this new survival paradigm, modern calligraphy media has mastered the right to speak, making the content disseminated by calligraphy art more personalized and massive in number and have the hypertextual features in information forms and constituting a powerful force of public opinion, which not only sways the aesthetic trend of the public, but also exerts an impact on the development direction of calligraphy. As Chen Zhenlian stated in History of Modern Chinese Calligraphy: "The first starting point of the development of modern calligraphy is not built on literati's writing desk, but on modern exchange channels of news and information which can cover a thousand miles in the twinkling of an eye." [2] With the digitalization of art media, in recent years, the new art media has created new development opportunities for calligraphy and ushered in profound changes in the values, creation and aesthetics of calligraphy. They play a vital role in advocating new thoughts of calligraphy, reflecting the new phenomena in calligraphy, changing the concepts or position of calligraphy audience and the aesthetic tendency of the society, guiding calligraphy activities in various areas, preserving precious historical data on calligraphy, and building a discipline system for calligraphy. In the current age of artificial intelligence, the creation carrier of calligraphy also shows a trend towards digitization. Digital calligraphy media is a kind of modern transformation of the traditional "Four Treasures in the Study", that is, writing brushes, ink sticks, paper and inkstones. And how to view the impact of digital calligraphy media on calligraphy art from a historical perspective has become an issue demanding prompt discussion.

## 1 INNOVATION OF CALLIGRAPHY MEDIA AND THE STYLES OF CALLIGRAPHY ART

The media carrier of calligraphy art produces a great impact on calligraphic styles. In a given period in history, there was a specific calligraphic genre, and this specific calligraphic genre was often accompanied by a specific media carrier. We even distinguish calligraphic styles by the materials of carriers, such as the inscriptions on oracle bones, inscriptions on ancient bronze objects, bamboo slips and epistles, etc. The progress of science and technology has triggered changes in calligraphy media, for example, the emergence of ironware in the Warring States Period made cast inscriptions on bronze ware, etc. replaced by engraved inscriptions on stones. In the late Han Dynasty and Wei and Jin Dynasties, the popularization and application of paper had gradually made it replace bamboo slips and epistles. . .Thanks to the advancement of science and technology, the fabrication of paper has been improved and acquired a texture that was "as delicate as skin". This has made the contact effect between brush and ink highly appreciated, and sparked discussions on calligraphy art. For example, No Cursive Script, written by Zhao Yi as a criticism of the calligraphy trend at that time,

made the running cursive script develop and served as an important enabler for the style to change from "simple and unadorned in ancient times to gorgeous in modern times". The pursuit of the representation effect of brush and ink gave birth to research on the innovation of carriers and tools, such as paper, brush and ink after the Han Dynasty. As one of the carriers of calligraphy, paper comes in a variety of types, with the development of times. The most characteristic examples are: the papermaking process in the Song Dynasty backed the creation of long-roll paper, so the form of scroll prevailed at that time, forming a unique display space for Chinese calligraphy. In the late Ming Dynasty, owing to the boom of textile industry, a large amount of silk and ghatpot was used to make huge works. New composition and layout, the expression and exploration of brushwork and ink approaches represent the visual space and calligraphic genre of the new era. The combination of raw paper and goat hair brush in the Qing Dynasty allowed the ink approaches to work better than before, and was more suitable for expressing the unique flavor of bronze and stone tablets in Qing epigraphy. From the perspective of history, media, as the carrier, has exerted a profound influence on the development of ancient calligraphy in every stage. It has determined the materialized form, style, characteristic, aesthetic concept and communication of calligraphy, etc.

Along with the development of science and technology, the communication channels of art have also been largely enriched. The popularity of Internet, in particular, has made it possible to transmit artistic works remotely through multimedia. Artistic works blossom in radiant splendor in all kinds of electronic devices, such as IPAD, PDA, mobile phones, MP4 and computers. In a manner of speaking, the network media endows traditional media with new life, and the greatest impact of the new era on traditional calligraphy appeared first in the communication media. As the communication media of calligraphy transforms from traditional tablet inscription and rubbing and the publication of books to modern new media approaches, we gradually pay attention to how the creation tools, creation carriers, visual artistic effects and creation modes, etc. of traditional calligraphy reproduce in a digital manner in the era of artificial intelligence. At the same time, the creation thoughts, spreading consciousness, social identity, aesthetic concepts and evaluation system of calligraphy have undergone profound changes.

## 2 STUDIES ON DIGITAL CALLIGRAPHY MEDIA AND THEIR INFLUENCE ON THE DEVELOPMENT OF CHINESE CALLIGRAPHY ART

Since the 1990s (1986), after more than 30 years of research on digital calligraphy system, digital calligraphy has yield some fruits in the digital modeling of calligraphic tools, the analysis and processing of calligraphy images, and the characterization and synthesis of calligraphic glyphs, etc. According to A Survey of Digital Calligraphy[3]by the scholar Zhang Junsong, the author compiled the following table, with a view to clearly demonstrate the current research status and achievements in digital calligraphy media, analyze the breakthroughs and defects therein and further illustrate their impact on calligraphy art.

From the above table, we can draw the following conclusions:

Most studies on digital calligraphy focus on the characterization and synthesis of calligraphic glyphs, which suggest that a big database for digital calligraphy is still under exploration and construction. At present, there is no public and authoritative benchmark database at home. It is one of the development trends of digital calligraphy to generate a database with a considerable size that was based on reasonable algorithms.

For studies on the analysis and processing of calligraphy images, they have a host of practical applications, such as the collection of characters, retrieval, the design of artistic fonts, etc. What's more, at present, calligraphy robots and animations that simulate the creation process have gradually been applied to calligraphy teaching, the protection of traditional calligraphy culture and other aspects [36] updating the teaching methods of traditional calligraphy, improving the efficiency and accelerating the process of calligraphy learning. As far as it goes, the denoising algorithm with manual interaction in digital calligraphy is too complicated, and has certain room for improvement [37].

As an art of lines, the value of calligraphy in fine arts, as Liang Qichao summed up, includes "the beauty of lines, the beauty of light, the beauty of force, and the beauty of personality" There are many aesthetic descriptions about strokes and composition in traditional calligraphy, although a vast majority of them are subjective and subtle. For this reason, the deep fusion between the aesthetic theory of traditional calligraphy and digital technology is one of the research directions of digital calligraphy now.

Digital calligraphy is neither a substitute nor a symbiote for traditional calligraphy. The development of digital media cannot completely supersede traditional media, such as writing brushes, ink sticks, paper and inkstones. Instead, it just serves as one of the creation carriers for calligraphers, fuses and integrows with traditional media. The creation tools of traditional calligraphy are digitized, and the visual effect of traditional artistic creation are also digitized. For the time being, these studies are still unable to fully express the complex representation effect of brush and ink, for example, the representation of the strokes of running cursive script is a difficult point. As a result, no similar electronic products appear on the market, to generate creation media for calligraphers to break away from traditional calligraphic tools.

## 3 THE PROSPECT OF DIGITAL CALLIGRAPHY MEDIA

The development of new media will inevitably brought about new calligraphy cognition and concepts, thereby affecting the creation styles of calligraphy and the research and identification paradigm of calligraphy. New changes and trends are also taking place in such aspects as the education and dissemination of calligraphy. The traditional calligraphy pattern has been overturned, and the ever-updating digital calligraphy media becomes a helmsman in the current modern development trend of calligraphy. From real to virtual, new media calligraphy is diametrically different from traditional manual calligraphy, in that it provides a new platform for the development of contemporary calligraphy art, and also inflicts a great shock on traditional calligraphy art. The new calligraphy media create a kind of new mirror images, expanding the expression form of calligraphy art, facilitating the dissemination of calligraphy

**Table 1: Statistics on Studies on Digital Calligraphy Media**

| Research Direction | Quantity | Specific Type | Technical Contents and Achievements |
|---|---|---|---|
| The Digital Modeling of Calligraphic Tools | 7 | Empirical model | Strassmann set up a two-dimensional brush model and drew the basic textural effect of calligraphy [4]; Guo and Kunii simulated the diffusion effect of ink [5]; Yu came up with a brush model to examine the strokes of brush[6]; Wong and Ip proposed an elliptical model to examine brushwork[7]; MI simplified operation and parameter setting by using a parameterized model[8]; Xu put forward a virtual brush model based on solid modeling and optimized the algorithm [9]; Girshick forwarded a parameterized brush model [10]. |
| | 4 | Physical model | Lee modeled the deformation of the tip of a writing brush by using the theory of elastic mechanics [11]; Chu et al. simulated the infiltration effect of ink paper by means of fluid mechanics [12]; Saito simulated the brush tip using physics [13];Baxtor simulated the skeleton of brush tip through the theory of elasticity [14]. |
| The Analysis and Processing of Calligraphy Images | 1 | To denoise tablet inscription | Wang et al. denoised calligraphy images with a binarization algorithm [15]; |
| | 4 | To describe glyph outlines of tablet inscription /rubbing images | Ma initiated a processing system that fitted the glyph outlines of oracle bone inscriptions by using the Bezier curve [16]; Wong recommended a method to estimate the parameters of a virtual brush model from calligraphy images automatically [17]; Cheng et al. proposed a method to estimate the skeleton of Chinese characters from calligraphy images [18]; Zhu et al. forwarded a Chinese character retrieval method based on shape similarity [19]; |
| | 1 | To extract strokes from calligraphy images | Yao et al. tried to create calligraphy works by imitating brushwork trajectory with a calligraphy manipulator [20]. |
| The Characterization and Synthesis of Calligraphic Glyphs | 10 | To synthesize glyphs | Xu et al. established a topological stability calculation model to characterize strokes [21]; Yu came up with a method to synthesize works with cursive styles [22]; Shi et al. analyzed and modeled strokes and radicals of Chinese characters, and guided the synthesis of glyphs by using Marr's theory of vision and priori knowledge of calligraphy[23]; Xu[24] and Dong[25] et al. advanced a calligraphy creation model based on statistical model, and introduced the simulation of figurative thinking into the computer-based generation of calligraphy; Orbay et al. put forward a method to synthesize personalized fonts [26]; Chang et al. introduced artificial intelligence technologies, for example, deep learning, into glyph synthesis[27]; Lyu generated calligraphy images from standard font images on the basis of deep neural network model [28]; Sun et al. brought forward a style-perceiving variational auto-encoder framework to capture different features of Chinese characters [29]; Xu et al. combined multi-scale convolutional neural network (MCNN) and long short-term memory (LSTM) network LSTM, to recognize the temporal and spatial characteristics of strokes [30]. |
| | 5 | To beautify the glyphs | Jin et al. generated beautified handwritten Chinese characters on the basis of case learning [31]; Zitnick defined a kind of stroke descriptor called "Token" and beautified handwriting with this descriptor [32]; Hou et al. suggested a glyph beautification method that considered writing speed and stroke width [33]; Shi et al normalized the input handwritten images and beautified glyphs on the basis of Bayes model [34]; following the idea of "broken strokes, but coherent meaning" in the calligraphy theory, Dai set up a connection model for common strokes and optimized the glyphs [35]. |

art, enriching the creation techniques of calligraphy art, and also changing the production process of traditional calligraphy at the technical level. It goes without saying that this doesn't mean the extinction of traditional calligraphy, but that both of them constitute a pluralistic pattern for current calligraphy carriers.

The application of digital calligraphy media has turned a new page in sci-tech calligraphy, covering almost all aspects of calligraphy, such as its education, creation, research, review, collection and sales. It has the advantages of rapidity, timeliness, freedom, globality, multimedia, and opens up a new survival area and display space for calligraphy. The perfection and development of digital calligraphy is badly in need of interdisciplinary talents, in order to realize the dialogue and integration between tradition and modernity, art and science, technology and humanities. As far as calligraphy is concerned, the new media of art is actually a double-edged sword, which brings a large number of impacts, while creating new opportunities and room for the development of calligraphy art. It is undoubtedly of positive and important practical significance to point out problems with calligraphy media during the development of calligraphy undertaking as objectively as possible and make a reasonable prediction concerning its prospect.

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