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Research Article

Fusion of Digital Printmaking and Traditional Printmaking Using Edge Computing Optimization Model

Hao Zhang,[1] Tingyu Jiao ,[2] and Shuo Yang [3]

[1]*Department of Printmaking, Luxun Academy of Fine Arts, Shenyang 110004, Liaoning, China*
[2]*Department of Basic Education, Luxun Academy of Fine Arts, Shenyang 110004, Liaoning, China*
[3]*School of Sculpture Art, Luxun Academy of Fine Arts, Shenyang 110004, Liaoning, China*

Correspondence should be addressed to Shuo Yang; yangshuo@lumei.edu.cn

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With the development of the digital age, the hardware equipment and system software of digital painting are becoming more and more popular, and the penetration of digital technology in the field of printmaking is getting deeper and deeper. However, traditional skills are gradually being eroded under the pressure of a homogeneous and efficient modern digital society. This paper aims to use the edge computing optimization model to provide a new path for the integration of digital prints and traditional prints. While retaining the exquisite skills of traditional printmaking, it also uses modern digital technology to make digital printmaking more alive. Based on this, this paper focuses on analyzing the optimization model of edge computing, and it optimizes the upload and downlink transmission for the creation of digital prints. Through experiments, it is found that the system energy consumption of the initialization scheme does not change with the change of T, while the system performance of the MEC optimization scheme has been improved, and the improvement range is between 80% and 100%. As T grows, the optimization of the task assignment variable L_u will improve the overall system performance.

1. Introduction

The rapid development of digital technology has changed people's living habits and aesthetic concepts, and it has also brought earth-shaking changes to the creation of visual art, and digital art has also emerged as the times require. Computer technology can convert all visual things into binary numbers. It unifies sound and text into binary code. The art forms based on computer technology are also unified because of the high intelligence of computers, which complement each other. As a new type of printmaking, the emergence of digital printmaking has brought new vitality to the traditional printmaking art—greatly expanding the artistic language of printmaking. It brings more creative inspiration to artists and enriches the content and form of printmaking. Corresponding to traditional printmaking, digital printmaking is a form of printmaking that uses digital equipment and technologies (such as computers, digital cameras, scanners, computer graphics processing software, etc.,) to create, plate, and print on substrates. Therefore, it is necessary to explore the artistic language of integrated printmaking, the relationship between integrated printmaking and painting art, the use of digital printmaking media, and the visual effects it is suitable for creating. Based on the discussion of digital technology, this paper discusses the combination of printmaking technology, as well as the connection between the two and the probability of the expansion of printmaking under the combination of digital technology. At the same time, it expands thinking, which provides a feasible way for the development of printmaking in the digital age. Digital technology brings great convenience to the creation of printmaking, which is the future development trend of modern printmaking technology.

The research on the fusion of printmaking has two main innovations: (1) for the fusion of traditional printmaking and digital printmaking, this paper defines a new fusion printmaking. In this paper, the printmaking that combines the fast, functional, editable, and other characteristics of digital printmaking with the texture, personality, and creativity of traditional printmaking is called fusion printmaking. (2) For the digital fusion creation of prints, this paper optimizes communication based on mobile edge computing, which improves the efficiency of uplink and downlink. This provides a good network guarantee for the creation of digital prints, which guarantees that the creation will not be disturbed by Caton.

2. Related Work

As a product born out of the fifth-generation communication technology, edge computing technology aims to perform data processing on terminals at the edge of the network. With the advent of the Internet of everything era, massive terminal devices connected to the network and explosive data growth continue to consolidate the position of edge computing technology in the field of IoT applications. Zhou developed Robust Moving Crowd Sensing (RMCS), a framework that integrates deep-learning-based data validation and edge-computing-based local processing [1]. Zhi believed that Bitcoin has revolutionized the world economy in several ways by introducing decentralized peer-to-peer transactions. In this way, he launched the application of edge computing in the world economy [2]. Taleb presented a survey of MECs and highlights the basic key enabling technologies. He analyzed the MEC reference architecture and main deployment scenarios, which provide multi-tenancy support for application developers, content providers, and third parties [3]. To further reduce the latency and transmission cost of computational offloading, Ke et al. proposed a cloud-based mobile edge computing (MEC) offloading framework in in-vehicle networks [4]. He brought deep learning for IoT into the edge computing environment. He devised a novel offloading strategy to optimize the performance of IoT deep learning applications via edge computing [5].

Many people have also done research on digital printmaking. Printmaking based on computer technology has various forms, and the art form is more realistic than the previous printmaking process. At the same time, due to the open source of information on the Internet, it provides more materials and creative inspiration for printmakers and artists. But at the same time, it also brought an impact on traditional printmaking, and many people think that this goes against the original intention of printmaking. Computer engraving has greatly reduced the difficulty of printmaking. Larsen believed that the cost of digital printing is falling. Digital printmaking is becoming increasingly attractive for labels and flexible packaging converters for custom, short-run production [6]. Haggett believed that as digital printing continues to develop in an ever-expanding range of applications, people must be clear about what digital printmaking is, because digital printmaking is not just copying and printing [7]. Brunton has done research on the application of digital printing in packaging. He believed that digital printing is easier to do than traditional printing, has a limited environmental impact, and costs "just right" [8]. However, through related research, it can be found that the research on traditional printmaking and digital printmaking is rarely related to the application of design to edge computing. Therefore, it is necessary to combine edge computing to protect traditional prints and optimize digital prints.

3. Edge Computing Optimization Model

3.1. Features of Edge Computing. Edge computing is a new computing concept derived from the continuous development of the fifth-generation communication technology (5G) [9]. Its main purpose is to solve the problem of poor performance of cloud computing in the face of multi-terminal and complex device connection methods and explosive growth of massive multi-dimensional data in the 5G era. As shown in Figure 1, edge computing technology can collect, store, and process data at the edge of the network, avoiding the bidirectional mass transmission of cloud computing and edge computing data [10].

Regarding the specific definition of edge computing, the academic circles have different ideas and different standards. In 2011, Cisco proposed the concept of fog computing. And it defined it in detail in 2012 and pioneered the organic combination of cloud and network edge (fog) at the architectural level. In 2014, the European Telecommunications Standardization Association proposed mobile edge computing technology. In 2016, it extended the concept of MEC to multi-access edge computing, which extended MEC from a single cellular network to multiple wireless access networks (such as WIFI). In 2016, led by Huawei, guided by the China Telecom Standardization Association, the Edge Computing Industry Alliance was established. It is committed to formulating the Chinese standards for edge computing and guiding the development of the edge computing industry [11, 12]. Although the above concepts are proposed by different organizations in different contexts, they all share a common original intention, which is to deploy edge devices that integrate network, computing, storage, and applications in a distributed manner on the edge side of the network. It provides users with fast and efficient cloud services and edge intelligent services nearby.

In recent years, in the context of the widespread implementation of "Internet +" in various industries in response to national policies, the Internet of Things has endowed a large number of existing equipment in social production and life with monitoring, perception, data communication, and interactive computing capabilities. It forms a node network of "Internet of Everything" in units of hundreds of millions. The complex network and massive data not only bring challenges to the cost of data communication and data storage, but also bring the potential for new value mining by using such data. For example, in the production process, it can effectively identify faults and abnormal states, forecast data when formulating and predicting future strategies, and improve control methods through effective and timely analysis of data. In the process of solving such problems, the data samples are sensed and acquired by the network edge devices, and after analysis and calculation, the operation strategies for such devices are executed by nearby devices [13]. At this time, the edge device group acts as both the collector and the executor of the information. If it has certain computing power and obtains some or all of the computing tasks migrated to it by the cloud computing center, it will greatly improve the overall work efficiency of the Internet of Things. This is also the core advantage of edge computing, which can be summarized into the following three aspects, as shown in Figure 2:

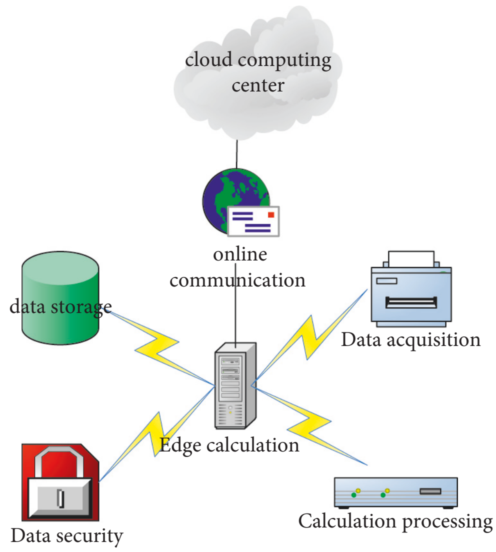

Figure 1: Structural and functional diagram of edge computing.

(1) It has low-latency characteristics during data transmission, which can reduce communication costs. The transmission of the huge amount of data brought by the connection of large-scale devices to the Internet of Things to the cloud computing center will inevitably lead to bandwidth problems: some special communication scenarios such as satellite communication cannot build enough bandwidth. However, localized large-scale information collection requirements such as video surveillance cannot afford the cost of multimedia data transmission. Faced with these types of problems, edge computing technology can use local computing and processing of information. By transmitting the processed key information to the cloud or directly calculating the execution strategy, it fundamentally solves the problem of communication delay. It guarantees the real-time nature of data processing, and at the same time, it reduces the bandwidth requirements for data transmission and reduces communication costs.

(2) It has the characteristics of low power consumption during data processing, which can reduce the cost of equipment. On the basis of low communication costs, thanks to the iterative progress of chip technology, the cost of chips for edge computing is also decreasing. In 2019, manufacturers such as Huawei and Cambrian have launched chips such as Ascend310 and MLU220 for edge computing. Among them, the MLU220 chip listed in the second half of the year can perform 32 trillion operations per second (Tera Operations Per Second, TOPS). As can be seen from Table 1, because edge computing chips have the characteristics of differentiated design and flexible application layout, in comparison with cloud computing, they have the advantages of lower communication delay and higher computing power per unit power consumption. Its computing power can already cover the scene functional requirements of the IoT edge device group. This makes edge computing the best technology for information services such as communication, computing, and storage for IoT devices [14].

As shown in Figure 3, edge computing is an optimization method between edge nodes and edge devices outside of cloud computing.

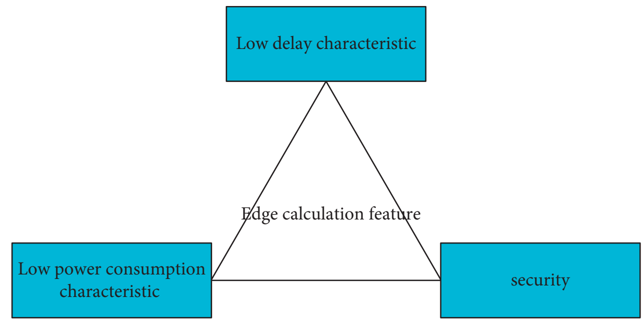

Figure 2: Advantages of edge computing.

(3) It has better security when data is stored interactively. Localized data storage and processing of IoT-generated information eliminates the need to upload this information directly to the cloud. It effectively avoids the danger of leaking sensitive user information due to cloud databases or communication paths. At the same time, edge computing technology gives edge device groups the ability to localize high-frequency access data. For example, the feature images and feature information of image recognition and pattern recognition are stored locally, which avoids the security risk brought by uploading key information to the cloud.

3.2. Edge Computing Functional Architecture. The use of edge computing technology in regional integrated energy systems is divided into two main application scenarios. The first direction is for the power equipment in the system, monitoring the real-time processing of new energy in the regional integrated energy system through remote sensing capabilities. For example, by sensing physical information such as temperature, wind speed, and light intensity, sensors and other equipment are used to judge the output changes of solar thermal, wind power, photovoltaic, and other power generation methods in the system and the state of charge of various energy storage devices. It also tracks user load at all times. The second application scenario is for the existing data of the database in the system. The edge computing device senses and collects different types of information generated by various power devices in the regional integrated energy system in real time, and records and stores it. At the same time, it uses the historical data of this type of information to complete pattern recognition functions such as system state perception or load forecasting functions when given strategies and methods [15, 16].

As shown in Figure 4, in a localized regional integrated energy system, the historical information and user information of each power device in the system are communicated and

Table 1: Comparison of cloud computing and edge computing.

Calculation method	Cloud computing	Edge computing	
Equipment used	Data center	Ascend 310	MLU220
Computing power	>200TOPS	8TOPS	32TOPS
Power consumption	>200 W	8 W	10 W
Delay	<1 s	<200 ms	<200 ms
Cost	>$300000	$2000	$2000

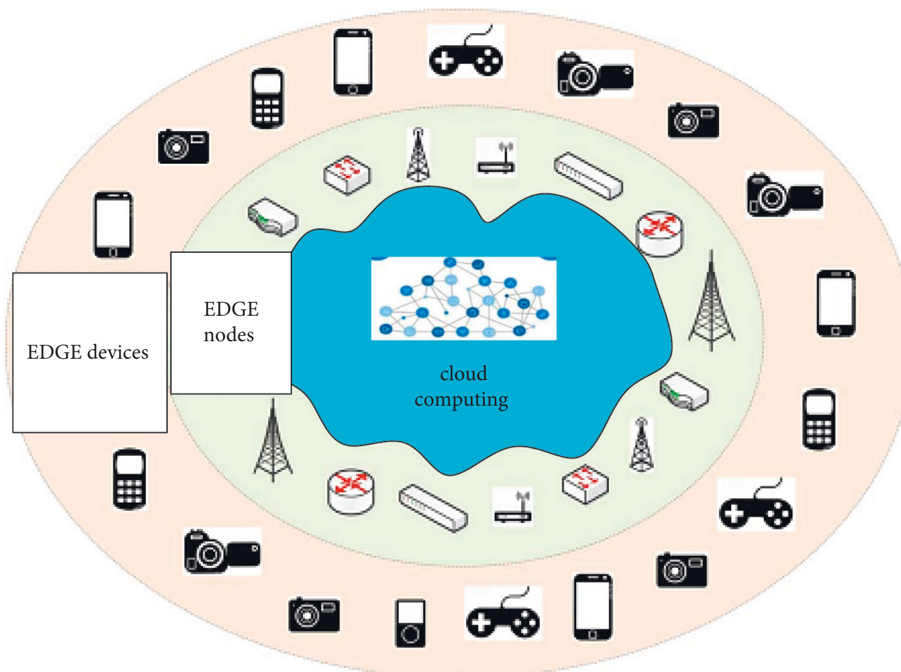

Figure 3: Cloud computing and edge computing.

recorded through edge computing devices. And it is stored in the local database, and users can directly call the required data through local mobile or terminal login without occupying the computing power of the edge computing device. At the same time, the inclusion of edge computing equipment also makes it possible for users to directly operate and control power equipment from local equipment terminals. The real-time query control of local users enables users to know the running status of the system at any time. It corrects abnormal operation problems in time and improves the fault location speed of the system. On the premise of ensuring the security of system information, it enhances the reliability of the system [17].

3.3. MEC Optimization Scheme. In this chapter, a wireless energy-carrying-based MEC system is proposed, as shown in Figure 5. Among them, the terminal is a single-antenna user equipment (UE) and is equipped with a PS receiver, and the edge end is a single-antenna access point (AP) connected to a MEC server. It also has a multi-antenna full-duplex relay between the UE and the AP.

Before deriving the specific problem establishment process, this paper first gives a comprehensive introduction to the channel model involved in the communication process. The abbreviations and symbols used in the following derivation are shown in Tables 2 and 3. It can be seen from Figure 5 that the entire system contains a total of six channels, all of which are Rayleigh fading channels, $h_{ur} \in C^{M\times 1}$ represents the uplink channel vector from the UE to the relay; $h_{ur}^{T} \in C^{M\times 1}$ represents the uplink channel vector from the relay to the AP. $h_{ar} \in C^{M\times 1}$ represents the downlink channel vector from the AP to the relay. $h_{ru}^{T} \in C^{M\times 1}$ represents the downlink channel vector from the relay to the UE; $G_{rr} \in C^{M\times M}$ represents the downlink self-interference channel matrix at the relay. Here, this paper assumes that the perfect channel state information can be perceived by the whole system. That is to say, in the whole communication process, there is only noise interference, and there is no channel estimation error [18]. And because the time block length is usually very small, this paper assumes that these channels are all quasi-static flat fading channels within a time block. That is to say, within a time block, the channel state coefficients of these channels are kept constant. Next, the two parts of uplink transmission (uploading of computing tasks) and downlink transmission (downloading of calculation results) are modeled and optimized, respectively.

3.3.1. UE Uplink Transmission Calculation Task to AP. In order to allow the AP enough time to receive the computing tasks from the UE and download the computing

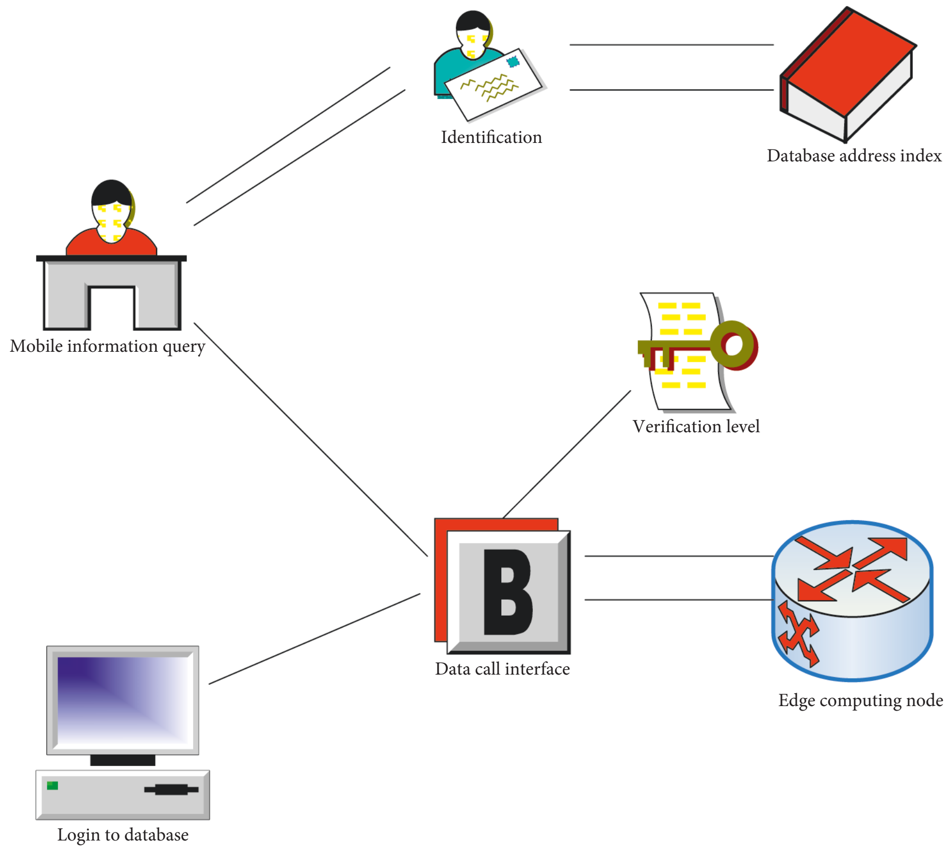

Figure 4: Edge computing architecture in regional integrated energy system.

results to the UE, this paper assumes that at the beginning of each time block, the UE will first upload the computing tasks to the AP. In addition, due to distance reasons, this paper assumes that the UE cannot communicate with the AP directly. That is to say, both the uploading of the computing task and the downloading of the computing result must be forwarded by the relay device.

Correspondingly, if the transmit power of the UE is P_u, the transmit signal of the UE is as follows:

$$x_{ue}^{up} = \sqrt{P_u} s. \tag{1}$$

After transmission, the uplink signal received by the relay from the UE is as follows:

$$y_r^{up} = \sqrt{P_u} h_{ur} s + h_{rr} x_r^{up} + n_r. \tag{2}$$

The three addition terms of formula (2) represent the signal from the UE, the self-interfering signal at the relay, and the noise at the relay, respectively. Because the article assumes that perfect channel state information can be sensed by the entire system, the relay can eliminate the self-interfering signal (second term) generated by the full-duplex protocol. After eliminating the self-interfering signal, the received signal at the relay can be written as follows:

$$y_r^{up} = \sqrt{P_u} h_{ur} s + n_r. \tag{3}$$

Table 2: List of abbreviations.

Abbreviation	Explain
UE	User equipment
AP	Access point
MEC	Mobile edge computing
L	Amount of computing tasks
RF	Radio frequency
SI	Self-interference

Table 3: List of symbols.

Symbol	Explain
α	Scale factor
x	Transmit a signal
σ	Covariance
B	Transmission bandwidth

Through relay amplification and forwarding, the uplink transmission signal at the relay can be expressed as follows:

$$x_r^{up} = K_r I_M \left(\sqrt{P_u} h_{ur} s + n_r\right), \tag{4}$$

K_r is the amplification factor at the relay. By using the above formula, the uplink transmit power of the relay can be deduced:

$$P_r^{up} = K_r^2 P_u Tr\left(h_{ur} h_{ur}^H\right) + K_r^2 \sigma_r^2 Tr\left(I_M\right). \tag{5}$$

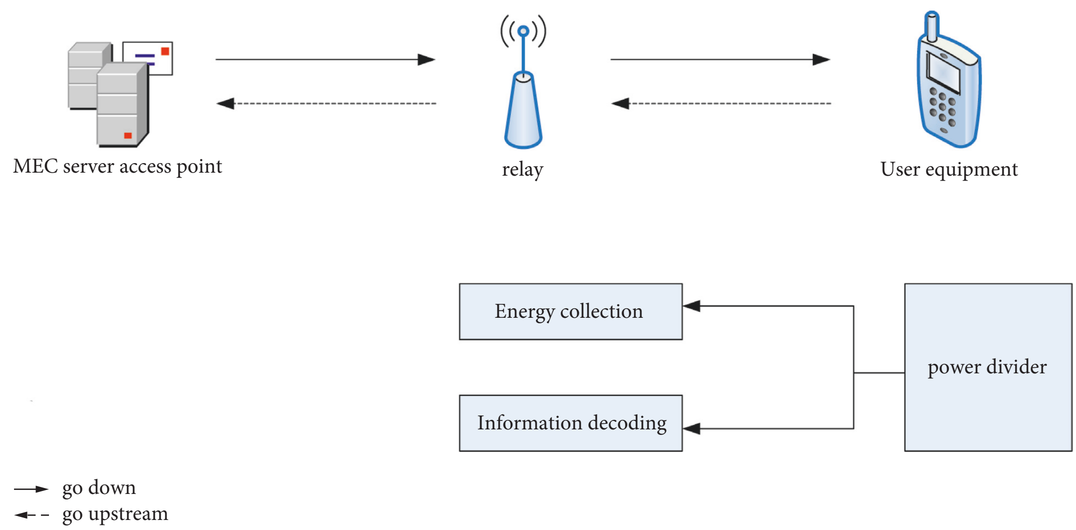

Figure 5: MEC system based on wireless energy carrying.

The additive white Gaussian noise at the AP is represented by n_a, and the covariance is σ_a^2, so the received signal at the AP can be expressed as follows:

$$y_a = h_{ur} K_r I_M \left(\sqrt{P_u}\, h_{ur} s + n_r\right) + n_a. \tag{6}$$

From the signal received at the AP, the signal-to-interference and noise ratio (SINR) during the entire uplink signal transmission can be derived:

$$SINR_{up} = \frac{Tr\left(K_r^2 P_u h_{ra} h_{ur} h_{ur}^H h_{ra}^H\right)}{Tr\left(K_r^2 \sigma_r^2 h_{ra} h_{ra}^H\right) + \sigma_a^2}. \tag{7}$$

According to the signal-to-interference-noise ratio, the theoretical maximum transmission rate during uplink task transmission can be deduced:

$$R_{up}^{\max} = B\left(1 + SINR_{up}\right). \tag{8}$$

Among them, B represents the signal transmission bandwidth of the system. Here, the actual uplink transmission rate is defined as R_{up} (unit is bps/Hz), because the actual uplink transmission rate will definitely not exceed the theoretical maximum achievable rate, and the following constraints are obtained:

$$\begin{aligned} R_{up} &\leq R_{up}^{\max}, \\ t_{up} &= \frac{L_u}{R_{up}}. \end{aligned} \tag{9}$$

Similarly, according to the formula and the UE transmit power, the uplink transmission energy consumption of the UE and the relay during the transmission of the uplink calculation task can be obtained:

$$\begin{aligned} E_{ue,up} &= P_u t_{up}, \\ E_{r,up} &= P_r^{up} t_{up}. \end{aligned} \tag{10}$$

3.3.2. The AP Downloads the Calculation Result to the UE.

$$x_{ue}^{\text{down}} = \sqrt{P_a} d. \tag{11}$$

After wireless channel transmission, the downlink signal received at the relay is

$$x_r^{\text{down}} = K_r I_M \left(\sqrt{P_a}\, h_{ar} d + n_r\right). \tag{12}$$

Using the above formula, the downlink transmit power of the relay can be deduced:

$$\begin{aligned} P_r^{\text{down}} &= K_r^2 P_a Tr\left(h_{ar} h_{ar}^H\right) + K_r^2 \sigma_r^2 Tr\left(I_M\right), \\ y_u &= h_{ru} K_r I_M \left(\sqrt{P_a}\, h_{ar} s + n_u\right) + n_u. \end{aligned} \tag{13}$$

In this paper, a PS receiver is used at the UE. In the downlink received signal of the UE, the signal power used for information decoding accounts for $\beta \in (0, 1)$ of the total power, and the information decoding signal can be expressed as follows:

$$\hat{y}_u = \sqrt{\beta}\left[h_{ru} K_r I_M \left(\sqrt{P_a}\, h_{ar} s + n_r\right) + n_u\right] + n_{ps}, \tag{14}$$

n_{ps} is a zero-mean additive white Gaussian noise generated by the PS receiver and satisfies the covariance $|dn_{ps}|^2 = \sigma_{ps}^2$. According to formula (14), the signal-to-interference-to-noise ratio of the downlink transmission process can be deduced:

$$SINR_{\text{down}} = \frac{Tr\left(\beta K_r^2 P_a h_{ry} h_{ar} h_{ar}^H h_{ru}^H\right)}{Tr\left(\beta K_r^2 \sigma_r^2 h_{ru} h_{ru}^H\right) + \sigma_{ps}^2}. \tag{15}$$

According to the signal-to-interference-noise ratio, the theoretical maximum transmission rate during downlink task transmission can be derived:

$$R_{\text{down}}^{\max} = B\left(1 + SINR_{\text{down}}\right). \tag{16}$$

Here, the actual downlink transmission rate is defined as R_{down} (unit is bps/Hz), and the constraints are obtained:

$$R_{down} \leq R_{down}^{max}. \tag{17}$$

The size of the calculation result generated by the MEC server is proportional to the size of the uploaded calculation task: $L_d = \alpha L_u$ and the downlink transmission rate is R_{down}, the downlink transmission delay can be obtained as follows:

$$t_{\text{down}} = \frac{L_u}{R_{\text{down}}}. \tag{18}$$

Similarly, according to the formula and the UE transmit power, the uplink transmission energy consumption of the UE and the relay during the transmission of the uplink calculation task can be obtained:

$$\begin{aligned} E_{ap,\text{down}} &= P_a t_{\text{down}}, \\ E_{r,\text{down}} &= P_r^{\text{down}} t_{\text{down}}. \end{aligned} \tag{19}$$

4. Fusion of Digital Printmaking and Traditional Printmaking

4.1. Digital Printmaking. At present, there are two current understandings of digital prints: one is the reproduction of the original. The other is original prints. The digital prints discussed in this paper are specifically aimed at the second. Traditional printmaking refers to the artist's personal use of some specific plate materials, the use of carving, etching, missing plates, and other methods to participate in artistic creation, and printing a number of original works, which is a kind of indirect art with master as the medium. Therefore, "indirectness" and "multiplicity" are the two most remarkable characteristics of traditional printmaking. "Indirectness" means the existence of "plate," the texture of plate, and the sense of chance and printing in the rubbing process, which are the obvious characteristics of traditional printmaking. "Plurality" means that traditional prints can not only be copied in multiple copies, but also achieve "one print with multiple colors and one print with multiple prints." Repeatedly rubbing the same print in the same picture can achieve unique artistic effects [19, 20].

In essence, digital technology is also a way to create prints, but tools such as carving knives and silk screens are replaced by digital products such as computers and printers. However, compared with traditional prints, digital prints have several different characteristics, as shown in Figure 6.

There are similarities and differences between digital printmaking and traditional printmaking. It can be seen from various skills of Photoshop that the existing digital technology can easily imitate the artistic language of traditional printmaking, such as the "knife taste" and "wood taste" of woodcut printmaking, the "corrosion technique" and "flying dust effect" of copperplate printmaking, and the printing taste of grid printing. Besides simply imitating the existing artistic language of printmaking, digital technology can also realize many artistic languages that traditional printmaking cannot realize.

Generally, there are two main types of digital prints created. For example: in black-and-white woodcuts, it is specialized with digital tools. It shows a contrast between tradition and modernity. The other is a digital print made entirely by computer. It is further screened by the computer for the candidate pictures. It edits and modifies it by means of digital software. It incorporates the language of traditional printmaking, which is finally output using the substrate. Generally speaking, general printers can meet the output requirements of printing, and general printers can be used for small drafts and first drafts. However, the color requirements are relatively high or the final product needs a professional printer, so as to ensure the printing effect.

4.2. Fusion Prints. This article combines the fast, functional, editable, and other characteristics of digital printmaking with the texture, personality, and creativity of traditional printmaking. Its prints are called fusion prints.

The uniqueness of printmaking works lies in the "imprint beauty" of the work itself, and "form and material" are important factors in the formation of printmaking art. The language and form of printmaking is reflected in the artistic rules and technical skills of printmaking, which are fully reflected in the three stages of painting, engraving, and printing. In the art of printmaking, the difference in the formal language of various editions depends entirely on the material used, which directly affects the formal language.

The formal language of prints has its own characteristics. As shown in Figure 7, the formal language of woodblock prints is rather short and universal, and the knife skill and appeal are the key to this formal language. The formal language of lithographs pays attention to delicacy and softness. Lithographs mainly use pencil and ink. Its mix with smooth and natural stone are key factors in the development of its formal language qualities. Copper engravings are subject to particular conditions, and chemical acid corrosion is one of them. Copper engraving's rich texture is its defining feature, as well as its own formal language. Printmaking is a basic form that fully uses media such as flat, concave, convex, and hole. It uses physical and chemical processing methods to make it unique in its artistic and artistic characteristics. In stark contrast to other easel art, some language elements such as dots, lines, planes, black and white, texture, and imprints reflect the uniqueness of the language of printmaking. Nowadays, more and more printmakers are using these language elements to construct the art of printmaking with formal beauty.

In short, at the technical level of the comprehensive version, the innovation of the effect of the picture lies in the full use of the uniqueness of the different versions. In the West, there are many artists who have made important efforts to explore the best means of expression among several painting types. For the expression language of prints that they can already master, printmakers can change their thinking and actively innovate on the original form of

Figure 6: Various styles of digital prints.

Figure 7: Print form.

expression. For the artistic techniques of various editions, they can fully learn from and use their characteristics, and combine and promote each other.

4.3. Creation of Fusion Prints under Digital Technology. Generally speaking, the creation of integrated printmaking is divided into three processes: collection, production, and output, among which collection and production are collectively called the process of plate making. In every process, there are a lot of digital devices (such as scanners, computers, digital cameras, graphics tablet, inkjet printers, etc.,) involved, as shown in Figure 8.

The acquisition process is to input the required image materials into the computer for subsequent processing and editing. In this link, digital cameras or scanners are often used to input raw materials into computers. The higher the resolution, the better the input effect. Generally, the resolution of the scanner used for printing needs to reach more than 300 dpi, and 600 dpi is preferred; digital camera pixels should reach more than 8 million pixels, preferably 24–40 million pixels.

The production process is to use computer software to edit all kinds of input image materials. Here, taking Photoshop as an example, we introduce some common techniques in integrating printmaking.

Adjustment of color channel: in Photoshop, the main function of channels is to store color information. For example, an RGB color map is composed of four channels of red, green, blue, and RGB, while a CMYK color map is composed of five channels of cyan, magenta, yellow, black, and CMYK. If other channels are turned off in RGB mode and only the blue channel is kept, then only the blue tone image will appear in the picture, and then the gray scale, purity and brightness of the blue tone will be edited according to different levels of black, white, and gray, which is similar to making a print with only blue ink.

Edit and overlay of layers: in this link, the advantages of digital creation are fully reflected. Because Photoshop usually edits images in different layers, it allows users to change the opacity of a certain layer at will, and it has rich superposition modes. This “non-destructive editing method” can easily realize various artistic styles or imitate the texture of traditional prints. For example, setting the

FIGURE 8: Authoring equipment.

superposition mode of layers to "positive and negative" successfully imitates the effect of layer-by-layer corrosion of traditional copperplate, and it also avoids the time-consuming and laborious creation of traditional copperplate. For example, if people want to make the "flying dust" effect in traditional copperplate printing, people can first create a layer and fill it with black, then execute the add noise command in the filter, which adjusts it to a suitable quantity value, reduces its opacity to a suitable degree. And then, it creates a new layer and fill it with gradient color to achieve the desired effect. For example, placing all kinds of irrelevant pictures in different layers, combining them together, and adjusting the blending mode according to the creator's imagination can achieve a surrealist style that seems real and unreal.

The use of filters: Photoshop has rich and powerful filter effects, many of which are similar to traditional printmaking techniques, such as woodcut filter, which can imitate the effect of black and white woodcut prints, and copperplate engraving filter, which can imitate the effect of copperplate prints. In addition, the combination of filter and layer overlay effect can also create various print effects that are genuine and fake.

The output process is to print the processed image (master) on the substrate through digital media. In this process, the choice of output device directly affects the final output picture effect. At present, inkjet printer is generally used as the output device to realize the output of integrated printmaking, and the selected ink is generally water-based ink, because water-based ink has the characteristics of bright and stable ink color, strong adhesion, and low pollution. After many times of practice, it can be found that the type of substrate has a slight difference in the performance of the picture. The smoother the substrate, the brighter the color. However, the integrated print output belongs to the creation of artistic works, which is different from the general printed matter. The artist conveys the artist's thoughts through artistic form and language, and uses corresponding means and artistic works presentation to complete a work of art. As long as this means can convey the artist's thoughts and present them in artistic form and language, it should be an artistic work. Therefore, due to the consideration of the artistic value and concept of integrated printmaking, we must improve the quality of integrated printmaking by the standard of painting art in the output technology of integrated printmaking. Since materials are involved in art collection, we should try our best to avoid lowering the value of fusion prints. Therefore, it is generally not recommended to use coated paper or photographic paper as the substrate of fusion prints, and water-colored paper and professional printing paper can be used as the substrate of fusion prints, so as to achieve the collection standard of painting art.

4.4. Transmission Optimization. Due to the creation of digital prints, various operations and transmissions are carried out on digital platforms. Moreover, the creation of fusion prints requires high response sensitivity, so that the idea of not being delayed by transmission and operation in the creation is not delayed. Therefore, in the experiment, this paper adopts the edge computing optimization model proposed in Chapter 3 to optimize the communication of the integrated printmaking digital creation platform.

As shown in Table 4, the transmit power of the UE is $P_u = 1W$, the amplification factor at the relay is $K_r = 4$, the transmit power of the AP is $P_a = 5W$, and the power of the additive white Gaussian noise is $\sigma_r^2 = \sigma_u^2 = \sigma_a^2 = \sigma_{ps}^2 = 10^{-7}W$. We set the channel bandwidth $B = 2MHz$, the PS receiver distribution coefficient $\beta = 0.1$, the effective capacitance coefficient of the UE is set to $k = 10^{-28}$, the CPU cycle required to calculate a 1 bit task is $C = 10^3$ (cycles/bit), and the ratio coefficient of the calculation result to the calculation task is $\alpha = 0.2$. In order to improve the accuracy of the simulation experiments, this paper conducts 1000 Monte Carlo simulations on the optimization problem on the simulation platform, and averages all the optimization results.

As shown in Figure 9, in this simulation, the time block length is set to $T = 0.3$ s and the number of relay antennas is set to $M = 4$. It can be seen that the MEC optimization scheme has achieved a greater system performance improvement than the initialization scheme. It is worth noting that with the increase of the computing task size L, the performance gap between the MEC optimization scheme and the initialization scheme is gradually narrowing, so a conclusion is obtained. That is, for this energy-optimized system, as the computing task size L increases, the UE will tend to upload more tasks to the AP to reduce its own energy consumption and ensure that the task can be completed.

In Figure 10, the size of the computing task is fixed, and the number of relay antennas is set to $M = 4$. As can be seen from the figure, the system energy consumption of the initialization scheme does not change with the change of T, while the system performance of the MEC optimization

Table 4: Basic simulation parameter settings.

UE transmit power	$P_u = 1W$
AP transmit power	$P_a = 5W$
Relay amplification factor	$K_r = 4$
Noise power	$\sigma_r^2 = \sigma_u^2 = \sigma_a^2 = \sigma_{ps}^2 = 10^{-7}W$
Channel bandwidth	$B = 2MHz$

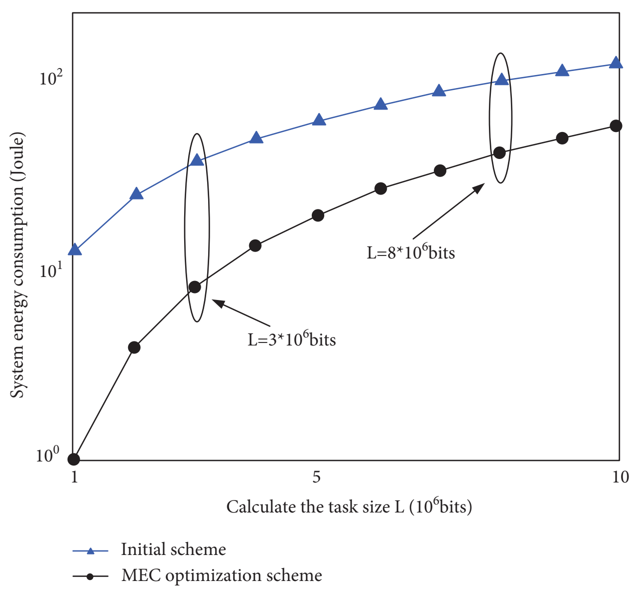

Figure 9: The average energy consumption of the system relative to the size of the computing task L.

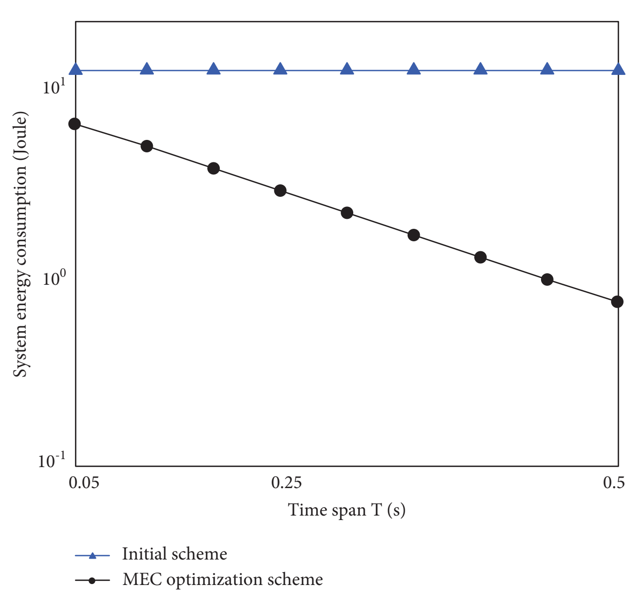

Figure 10: The average energy consumption of the system relative to the length of the time block T changes.

scheme is improved. Through the simulation results, a conclusion is also drawn, that is, the change of the time block length T only affects the energy consumption of the local calculation, and in the initialization scheme, there is no local calculation. So, the system performance is not affected. It can also be said that with the growth of T, the optimization of the task allocation variable L_u will improve the performance of the entire system.

5. Conclusion

Although digital printmaking is still a new thing in China, its contribution to the art of printmaking is indelible. It not only changes the habitual thinking mode of printmaking and broadens the artistic language of printmaking, but also plays a positive role in traditional printmaking. Some traditional printmakers can look for inspiration from digital printmaking, and they can also apply digital technology to their own creation, saving creative time and improving work efficiency. Therefore, on the basis of combining the characteristics of printmaking and kneading the most advanced digital technology at present, the integrated printmaking art has the mainstream significance of fitting in with the times and public aesthetics, thus being accepted by more aesthetic groups.

Data Availability

No data were used to support this study.

Conflicts of Interest

The authors declare that there are no conflicts of interest with any financial organizations regarding the material reported in this manuscript.

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References

[1] Z. Zhou, H. Liao, B. Gu, K. M. S. Huq, S. Mumtaz, and J. Rodriguez, “Robust mobile Crowd sensing: when deep learning meets edge computing,” *IEEE Network*, vol. 32, no. 4, pp. 54–60, 2018.

[2] L. Zhi, W. M. Wang, L. Guo, L. Liu, and G. Q. Huang, “Toward open manufacturing: a cross-enterprises knowledge and services exchange framework based on blockchain and edge computing,” *Industrial Management & Data Systems*, vol. 118, no. 9, pp. 303–320, 2018.

[3] T. Taleb, K. Samdanis, B. Mada, H. Flinck, S. Dutta, and D. Sabella, “On multi-access edge computing: a survey of the emerging 5G network edge cloud architecture and orchestration,” *IEEE Communications Surveys & Tutorials*, vol. 19, no. 3, pp. 1657–1681, 2017.

[4] Z. Ke, Y. Mao, S. Leng, Y. He, and Z. Yan, “Mobile-edge computing for vehicular networks: a promising network paradigm with predictive off-loading,” *IEEE Vehicular Technology Magazine*, vol. 12, no. 2, pp. 36–44, 2017.

[5] L. He, K. Ota, and M. Dong, “Learning IoT in edge: deep learning for the Internet of things with edge computing,” *IEEE Network*, vol. 32, no. 1, pp. 96–101, 2018.

[6] J. Larsen, "ENERGY-CURABLE INKS making digital print viable alternative," *Flexible packaging*, vol. 22, no. 7, pp. 24-25, 2019.
[7] P. Haggett, "Digital Print developments and what it means for paper," *Appita*, vol. 71, no. 1, pp. 14-15, 2018.
[8] D. Brunton, "Digital print and cutting investment," *International Paper Board Industry*, vol. 61, no. 4, pp. 84–88, 2018.
[9] X. Liu, Y. S. Jiang, and G. W. Zhang, "Overview of 5G and IoT technology application development," *Internet of Things Technologies*, vol. 12, no. 5, pp. 60–64, 2022.
[10] X. H. Hong and Y. Wang, "Edge computing technology: development and countermeasures," *Chinese Journal of Engineering Science*, vol. 20, no. 2, pp. 20–26, 2018.
[11] S. Gu, "Edge computing industry alliance: building an open ecosystem to accelerate the digital transformation of the industry," *Automation Panorama*, vol. 15, no. 1, pp. 18–25, 2018.
[12] X. Yang and F. Yang, "The progress, challenge and suggestions of telco edge cloud," *Information and Communications Technologies*, vol. 15, no. 4, pp. 19–25, 2021.
[13] S. Nastic, T. Rausch, O. Scekic, S. Dustdar, M. Gusev, and B. Koteska, "A serverless real-time data analytics platform for edge computing," *IEEE Internet Computing*, vol. 21, no. 4, pp. 64–71, 2017.
[14] Q. Yuan, H. Zhou, J. Li, Z. Liu, F. Yang, and X. S. Shen, "Toward efficient content delivery for automated driving services: an edge computing solution," *IEEE Network*, vol. 32, no. 1, pp. 80–86, 2018.
[15] Z. Xiong, Y. Zhang, N. Dusit, P. Wang, and H. Zhu, "When mobile blockchain meets edge computing," *IEEE Communications Magazine*, vol. 56, no. 8, pp. 33–39, 2017.
[16] M. D. De Assuncao, A. D. S. Veith, and R. Buyya, "Distributed data stream processing and edge computing: a survey on resource elasticity and future directions," *Journal of Network and Computer Applications*, vol. 103, pp. 1–17, 2018.
[17] X. Chen, Q. Shi, L. Yang, and J. Xu, "ThriftyEdge: resource-efficient edge computing for intelligent IoT applications," *IEEE Network*, vol. 32, no. 1, pp. 61–65, 2018.
[18] E. Ahmed, A. Ahmed, I. Yaqoob, J. Shuja, A. Gani, and M. Imran, "Bringing computation closer toward the user network: is edge computing the solution?" *IEEE Communications Magazine*, vol. 55, no. 11, pp. 138–144, 2017.
[19] Y. Q. Song, "Tracing the origin of Chinese printmaking," *Journal of Changchun Education Institute*, vol. 30, no. 16, pp. 64-65, 2014.
[20] F. Liu, "The interweaving of tradition and modernity: a study on the development of modern printmaking," *Art Education*, vol. 6, no. 6, pp. 188–191, 2021.